

Specifications

for:

Water Treatment Plant Improvements

London Utility Commission
801 North Main Street
London, Kentucky 40741

October 2024



Prepared by:



TABLE OF CONTENTS

SECTION	DESCRIPTION	PAGE
BIDDING REQUIREMENTS, CONTRACT FORMS AND REQUIREMENTS OF THE CONTRACT		
00010	ADVERTISEMENT FOR BIDS	1 - 2
00100	INSTRUCTIONS TO BIDDERS	1 - 5
00201	BID BOND.....	1 - 3
00300	BID FORM.....	1 - 3
00400	SUPPLEMENTS TO BID FORM	1 - 3
00500	AGREEMENT FORMS.....	1 - 5
00600	BONDS AND CERTIFICATES.....	1 - 7
00700	GENERAL CONDITIONS.....	1 - 39
00800	SUPPLEMENTAL GENERAL CONDITIONS	1 - 49
DIVISION 1 - GENERAL REQUIREMENTS		
01010	SUMMARY OF WORK.....	1 - 2
01015	WORK SEQUENCE.....	1 - 2
01020	ALLOWANCES	1 - 1
01021	ADDITIONAL ALLOWANCES	1 - 1
01025	MEASUREMENT AND PAYMENT	1 - 4
01030	LABOR PROVISIONS.....	1 - 14
01040	COORDINATION	1 - 1
01045	CUTTING AND PATCHING	1 - 1
01070	ABBREVIATIONS AND SYMBOLS	1 - 2
01300	SUBMITTALS.....	1 - 4
01380	CONSTRUCTION PHOTOGRAPHS.....	1 - 2
01400	QUALITY CONTROL	1 - 2
01450	SERVICES OF MANUFACTURER'S REPRESENTATIVES	1 - 2
01510	TEMPORARY UTILITIES	1 - 3
01530	BARRIERS	1 - 1
01535	PROTECTION OF INSTALLED WORK.....	1 - 1
01540	SECURITY	1 - 1
01550	ACCESS ROADS AND PARKING AREAS.....	1 - 2
01560	TEMPORARY CONTROLS	1 - 1
01565	EROSION AND SEDIMENT CONTROL.....	1 - 3
01580	PROJECT IDENTIFICATION AND SIGNS.....	1 - 1
01600	MATERIAL AND EQUIPMENT	1 - 2
01620	STORAGE AND PROTECTION.....	1 - 2
01700	PROJECT CLOSEOUT	1 - 3
01710	CLEANING	1 - 2
01720	PROJECT RECORD DOCUMENTS.....	1 - 2
01730	OPERATING AND MAINTENANCE DATA.....	1 - 3
01740	WARRANTIES AND BONDS	1 - 2

SECTION	DESCRIPTION	PAGE

DIVISION 2 - SITE WORK

02110	SITE CLEARING	1 - 2
02150	SHORING AND BRACING	1 - 1
02211	ROUGH GRADING	1 - 3
02221	ROCK REMOVAL	1 - 1
02222	EXCAVATION.....	1 - 5
02223	EMBANKMENTS AND BACKFILL.....	1 - 5
02225	EXCAVATING, BACKFILLING AND COMPACTING FOR UTILITIES	1 - 8
02510	ASPHALT CONCRETE PAVING.....	1 - 3
02605	VALVE VAULT.....	1 - 4
02610	WATER PIPE AND FITTINGS.....	1 - 7
02615	CHEMICAL PIPING, VALVES AND APPURTENANCES.....	1 - 12
02640	WATER VALVES AND GATES	1 - 15
02642	SEWAGE VALVES AND GATES.....	1 - 15
02675	DISINFECTION OF POTABLE WATER PIPE.....	1 - 1
02731	GRAVITY SEWERS	1 - 11
02732	SEWAGE FORCE MAINS	1 - 5
02735	MANHOLES.....	1 - 8
02900	LANDSCAPING.....	1-14
02930	SEEDING AND SODDING	1 - 3

DIVISION 3 - CONCRETE

03100	CONCRETE FORMWORK	1 - 5
03210	REINFORCING STEEL	1 - 3
03251	EXPANSION AND CONTRACTION JOINTS	1 - 2
03310	STRUCTURAL CONCRETE	1 - 17
03350	CONCRETE FINISHES	1 - 2
03370	CONCRETE CURING	1 - 3
03460	CONTROLLED LOW STRENGTH MATERIAL	1 - 3
03600	PRECISION GROUTING	1 - 3

DIVISION 5 - METALS

05120	STRUCTURAL STEEL.....	1 - 2
05500	MISCELLANEOUS METALS, FASTENERS, SPECIAL FINISHES	1 - 16
05530	ALUMINUM GRATING	1 - 3

DIVISION 9 - FINISHES

09900	PAINTING	1 - 14

SECTION	DESCRIPTION	PAGE

DIVISION 11 - EQUIPMENT

11281	ELECTRIC VALVE/GATE ACTUATORS.....	1 - 5
11400	ON-SITE GENERATED MIXED OXIDANT SYSTEM (OSGMOS)	1 - 32
11401	WATER ONLY BACKWASH LOW PROFILE UNDERDRAIN SYS	1 - 7

DIVISION 12 - FURNISHINGS

12345	LABORATORY FURNISHINGS AND FIXTURES	1 - 7

DIVISION 13 - SPECIAL CONSTRUCTION

13410	BASIC INSTRUMENTATION MATERIALS AND METHODS	1 - 7
13421	FLOW MEASUREMENT DEVICES	1 - 4
13422	LEVEL MEASUREMENT DEVICES	1 - 2
13429	MISCELLANEOUS INSTRUMENTS	1 - 2
13430	BOXES, PANELS, AND CONTROL CENTERS	1 - 28
13440	INDICATORS, RECORDERS, AND CONTROLLERS.....	1 - 4
13450	CENTRAL CONTROL	1 - 4
13480	FUNCTIONAL DESCRIPTIONS	1 - 7
13490	MEASUREMENT AND CONTROL COMMISSIONING	1 - 9

DIVISION 15 - MECHANICAL

15010	GENERAL MECHANICAL PROVISIONS	1 - 16
15016	HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIP. .	1 - 6
15076	IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT.....	1 - 5
15085	PLUMBING PIPING INSULATION.....	1 - 13
15088	HVAC REFRIGERANT PIPING INSULATION.....	1 - 13
15140	PIPE AND PIPE FITTINGS - PLUMBING SYSTEMS.....	1 - 10
15183	REFRIGERANT PIPING	1 - 9
15412	EMERGENCY PLUMBING FIXTURES	1 - 6
15441	PLUMBING PUMPS.....	1 - 2
15738	DUCTLESS SPLIT SYSTEM AIR CONDITIONERS.....	1 - 7
15838	HVAC POWER VENTILATORS	1 - 4

SECTION	DESCRIPTION	PAGE

DIVISION 16 - ELECTRICAL

16050	BASIC ELECTRICAL MATERIALS AND METHODS.....	1 - 9
16070	SUPPORTING DEVICES	1 - 1
16075	ELECTRICAL IDENTIFICATION	1 - 1
16120	CONDUCTORS AND CABLES.....	1 - 5
16130	RACEWAYS	1 - 7
16131	BOXES.....	1 - 2
16140	WIRING DEVICES	1 - 3
16150	WIRE CONNECTIONS AND CONNECTING DEVICES.....	1 - 3
16440	MOTOR CONTROL	1 - 3
16446	VARIABLE FREQUENCY DRIVES	1 - 9
16710	COMMUNICATION SYSTEMS.....	1 - 3

END OF TABLE OF CONTENTS

Bidding Requirements, Contract Forms and Requirements of the Contract

SECTION 00010 - ADVERTISEMENT FOR BIDS

Sealed Bids for “**London Water Treatment Plant Improvements**” for the London Utility Commission, will be received until **2:30 p.m.** (local time) on **November 1, 2024**, at the **London Utility Commission, 801 North Main Street, London, Kentucky 40741**, and then publicly opened and read aloud.

The primary scope of work includes a new OSG mixed oxidant disinfection system, new chemical feed pump skid systems, sedimentation basin covers, filter piping, filter no. 5 installation, high service pump VFDs, new bacteriological laboratory, window replacements, and various electrical improvements including raw water and backwash magnetic flow meters, LED lighting, and SCADA replacement, and related appurtenances.

The Instructions to Bidders, Bid Form, Agreement Forms, Performance and Payment Bonds, Plans, Specifications and other Contract Documents may be viewed online at lynnimaging.com or examined at the following locations:

London Utility Commission
801 North Main Street
London, KY 40741
(606) 864-2103

Eclipse Engineers, PLLC
113 West Mt. Vernon Street
Somerset, KY 42501
(606) 451-0959

Copies of plans and specifications may be obtained from Lynn Imaging, 328 Old Vine Street, Lexington, Kentucky 40507 (859-255-1021) upon payment of a non-refundable price of \$500.00 for each set (including shipping and handling). No bid will be accepted unless the BIDDER is a *registered plan holder*. To become a *registered plan holder*, BIDDER must purchase at least one set of documents from Lynn Imaging and provide accurate name and contact information. Partial sets of documents will not be provided. Half-sized sets may be purchased for the full price. Digital download sets may be purchased for half of the full price. Questions shall be addressed to Alan R. Robinson, P.E. of Eclipse Engineers, PLLC, 113 West Mt. Vernon Street, Somerset, Kentucky 42501 (606-451-0959) as stated in the Specifications or by email to aarobinson@eclipseengineers.net.

All BIDDERS must comply with Title VI of the Civil Rights Act of 1964, the Anti-Kickback Act, and the Contract Work Hours Standard Act.

All BIDDERS must comply with the President's Executive Order No. 11,246 (Equal Employment Opportunity) as amended, which prohibit discrimination in employment regarding race, creed, color, sex or national origin.

All BIDDERS, Contractors and Subcontractors must comply with 41 CFR 60-4, in regard to Affirmative Action, to ensure equal opportunity to females and minorities and will apply the timetables and goals set forth in 41 CFR 60-4 as applicable.

All BIDDERS, Contractors and Subcontractors must comply with all American Iron and Steel

Requirements.

All BIDDERS must make positive efforts to use small, minority, women owned, and disadvantage businesses.

Method of award will be made to the lowest, responsive, responsible BIDDER. The OWNER reserves the right to waive any informality or to reject any or all bids.

Each BIDDER must deposit with his Bid, security in the amount, form and subject to the conditions provided in the Instructions to Bidders.

No BIDDER may withdraw his Bid within ninety (90) consecutive calendar days after the actual date of the opening thereof.

This project will be subject to DOW Procurement Guidance including the Davis-Bacon Act.

This project will be funded in part with an SRF loan.

“EQUAL EMPLOYMENT OPPORTUNITY”

SECTION 00100 - INSTRUCTIONS TO BIDDERS

PART 1 - GENERAL INSTRUCTIONS AND INFORMATION

- 1.01 Each BIDDER is responsible for inspecting the work site and for being thoroughly familiar with the Contract Documents, including Addenda. The BIDDER shall in no way be relieved from any bidding obligation because of unfamiliarity with the site or documents. Neither the OWNER nor Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of bidding documents.
- 1.02 All applicable laws, ordinances, and the rules and regulations of all authorities having jurisdiction over construction of the Project shall apply throughout the Contract and they will be deemed to be included in the Contract the same as though herein written out in full.
- 1.03 Information pertinent to the conditions of the work site is made available to the BIDDER in Section 00200 (if applicable), Information Available to Bidders.
- 1.04 The Owner of the Project is the **London Utility Commission, 801 North Main Street, London, Kentucky 40741, Phone (606) 864-2103.**
- 1.05 The Engineer of the Project is **Eclipse Engineers, PLLC, 113 West Mt. Vernon Street, Somerset, Kentucky 42501, Phone (606) 451-0959, Alan R. Robinson, P.E., Project Manager.**
- 1.06 The Contract Documents contain the provisions for construction of the Project. Information obtained from an officer, agent, or employee of the OWNER, or from any other person, shall not affect the risk or obligations assumed by the Contractor or relieve the Contractor from fulfilling any of the conditions of the Contract.
- 1.07 The OWNER may make such investigations as deemed necessary to determine the ability of the BIDDER to perform the work, and the BIDDER shall furnish to the OWNER all such information and data for this purpose as the OWNER may request. The OWNER reserves the right to reject any Bid if the evidence submitted by, or an investigation of, such BIDDER fails to satisfy the OWNER that such BIDDER is properly qualified to carry out the obligations of the Agreement and to complete the work.

PART 2 - SPECIAL INSTRUCTIONS AND INFORMATION

- 2.01 Bids are to be submitted on the forms provided by completing all blank spaces in the Bid Form.
- 2.02 The Contract will be awarded based on the lowest responsive Base Bid by a qualified BIDDER.

- 2.03 All BIDDERS must comply with the President's Executive Order No. 11,246 as amended, which prohibit discrimination in employment regarding race, creed, color, sex or national origin.
- 2.04 All BIDDERS must make positive efforts to use minority and women owned businesses.
- 2.05 All BIDDERS, Contractors and Subcontractors must comply with 41 CFR 60-4, in regard to Affirmative Action, to ensure equal opportunity to females and minorities and will apply the timetables and goals set forth in 41 CFR 60-4 as applicable.
- 2.06 All BIDDERS must comply with Title VI of the Civil Rights Act of 1964, the Anti-Kickback Act, and the Contract Work Hours Standard Act.
- 2.07 Method of Award (to the low responsive, responsible bidder unless all bids are rejected). Refer to 40 CFR 31.36(d). All bids shall not be rejected without proper justification.
- 2.08 All BIDDERS must comply with OSHA (P.L. 91-596) and the Contract Work Hours and Safety Standards Act (P.L. 91-54).

PART 3 - BIDDING PROCEDURE

- 3.01 Bids will be received by the London Utility Commission, 801 North Main Street, London, Kentucky, 40741 until **2:30 p.m. (local time) on November 1, 2024**, and then publicly opened and read aloud.
- 3.02 Each Bid must be submitted in a sealed envelope, addressed to the **London Utility Commission, 801 North Main Street, London, Kentucky 40741**. Each envelope containing a Bid must be plainly marked on the outside as **“Sealed Bid for London Water Treatment Plant Improvements”** and the envelope shall bear on the outside the BIDDER'S name, address and license number (if applicable), and date and time of opening. If forwarded by mail, the sealed envelope containing the Bid must be enclosed in another envelope addressed to **London Utility Commission, 801 North Main Street, London, Kentucky 40741**.
- 3.03 All Bids must be made on the required Bid Form. All blank spaces for Bid prices must be filled in, in ink or typewritten, and the Bid Form must be fully completed and executed when submitted.
- 3.04 Each Bid must be accompanied by a separate Bid Bond for the Contract payable to the OWNER for five percent (5%) of the total amount of the Bid on the Contract. As soon as the Bid prices are compared, the OWNER will return the Bonds of all except the three lowest responsible BIDDERS. When the Agreements are executed, the Bonds of the two remaining unsuccessful BIDDERS will be returned. The Bid Bond of the successful BIDDER will be retained until the Payment Bonds and Performance Bonds have been executed and approved, after which it will be returned. Certified checks payable to the OWNER, equal to five percent (5%) of the Bids, may be substituted for

the Bid Bond.

- 3.05 A Bid may be withdrawn prior to the scheduled time for the opening of Bids, or authorized postponement thereof. A Bid received after the time and date specified will not be considered. No BIDDER may withdraw a Bid within ninety (90) consecutive calendar days after the actual date of the opening. Should the Contract not be awarded within the specified period, the time may be extended by mutual agreement between the OWNER and the BIDDER.
- 3.06 The OWNER may consider informal any Bid not prepared and submitted in accordance with the provisions hereof. The OWNER may waive any bidding informalities or minor defects or reject any and all Bids.
- 3.07 A conditional or qualified Bid will not be accepted.
- 3.08 The OWNER reserves the right to add, delete or change any part or portion of the proposed work.
- 3.09 Any BIDDER may modify his/her Bid by telegraphic communication at any time prior to the scheduled closing time for receipt of Bids, provided such telegraphic communication is received by the OWNER prior to the closing time, and provided further, the OWNER is satisfied that a written confirmation of the telegraphic modification over the signature of the BIDDER was mailed prior to the closing time. The telegraphic communication should not reveal the Bid price but should provide the addition or subtraction or other modification so that the OWNER will not know the final prices or terms until the sealed Bid is opened. If written confirmation is not received within two (2) consecutive calendar days from the closing time, no consideration will be given to the telegraphic modification. No facsimile bids or bid modifications will be accepted.
- 3.10 The successful BIDDER, upon his/her failure or refusal to execute and deliver the Contract and bonds required within ten (10) consecutive calendar days after he/she has received notice of the acceptance of his/her Bid, shall forfeit to the OWNER, as liquidated damages for such failure or refusal, the security deposited (Bid Bond) with his/her Bid.
- 3.11 Each BIDDER must inform him/herself fully of the conditions relating to the construction of the project and the employment of labor thereon. Failure to do so will not relieve a successful BIDDER of his/her obligation to furnish all material and labor necessary to carry out the provisions of his/her Contract. Insofar as possible, the Contractor, in carrying out the work, must employ such methods or means as will not cause any interruption of or interference with the work of any other Contractor.
- 3.12 No interpretation of the meaning of the plans, specifications or other pre-bid documents will be made to any BIDDER orally. Every request for such interpretation should be in writing addressed to **Alan R. Robinson, P.E., Project Manager, Eclipse Engineers, PLLC, 113 West Mt. Vernon Street, Somerset, Kentucky 42501** and to be given consideration must be received at least five (5) consecutive calendar days

prior to the date fixed for the opening of Bids. Any and all such interpretations and any supplemental instructions will be in the form of written Addenda to the specifications which, if used, will be mailed to all prospective BIDDERS (at the respective addresses furnished for such purposes), not later than three (3) consecutive calendar days prior to the date fixed for the opening of Bids. Failure of any BIDDER to receive any such addendum or interpretation shall not relieve such BIDDER from any obligation under his/her Bid as submitted. All Addenda so issued shall become part of the Contract Documents.

- 3.13 At the time of the opening of Bids, each BIDDER will be presumed to have inspected the site and to have read and to be thoroughly familiar with the plans and Contract Documents (including all Addenda). The failure or omission of any BIDDER to examine any form, instrument or document shall in no way relieve any BIDDER from any obligation in respect of his/her Bid.

PART 4 - AWARD OF CONTRACT (AGREEMENT)

- 4.01 Award of Contract will be made to the qualified BIDDER with the lowest responsive Bid as determined in accordance with Part 2 of this Section, unless all Bids are rejected. The OWNER reserves the right to reject any and all Bids, to waive any bidding informalities, and to disregard all nonconforming, non-responsive or conditional Bids. Discrepancies between words and figures will be resolved in favor of words. Discrepancies between the indicated total unit amount and the correct total unit amount thereof will be resolved in favor of the correct total unit amount.
- 4.02 The BIDDER to whom the Contract is awarded will be required to execute the Agreement and obtain the Performance Bond and Payment Bond within ten (10) consecutive calendar days from the date of the Notice of Award. The Notice of Award will be accompanied by the necessary Agreement and Bond forms. In case of failure of the BIDDER to execute the Agreement, the OWNER may consider the BIDDER in default, in which case the Bid Bond accompanying the proposal shall become the property of the OWNER.
- 4.03 A Performance Bond and a Payment Bond each in the amount of 100 percent (100%) of the Contract price, with a corporate surety approved by the OWNER, will be required for the faithful performance of the Contract. Such Bonds shall not be dated with a date earlier than the date of the Agreement for the Contract (Project) being bonded.
- 4.04 Attorneys-in-fact who sign Bid Bonds or Payment Bonds and Performance Bonds must file with each Bond a certified and effective dated copy of their Power of Attorney and must be registered in the Commonwealth of Kentucky or counter-signed by a Kentucky Resident Agent, which will be subject to verification by the OWNER.
- 4.05 The OWNER, within ten (10) consecutive calendar days of receipt of acceptable Performance Bond, Payment Bond and Agreement signed by the BIDDER to whom the Agreement was awarded, shall sign the Agreement and return to such party an executed duplicate of the Agreement. Should the OWNER not execute the Agreement

within such period, the BIDDER may by written notice, withdraw the signed Agreement. Such notice of withdrawal shall be effective upon receipt of the notice by the OWNER.

- 4.06 The Notice to Proceed shall be issued by the OWNER within ten (10) consecutive calendar days of the execution of the Agreement by the OWNER. Should there be reasons why the Notice to Proceed cannot be issued within such period, the time may be extended by mutual agreement between the OWNER and Contractor. If the Notice to Proceed has not been issued within the specified periods or the period mutually agreed upon, the Contract or may terminate the Agreement without further liability on the part of either party. Refer to Section 00500 for details related to the commencement of work.

END OF SECTION 00100

SECTION 00201 – BID BOND

PART 1 - BID BOND

KNOW ALL PERSONS BY THESE PRESENTS: that we, the undersigned,

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

Name of OWNER: **London Utility Commission**

Address of OWNER: **801 North Main Street, London, Kentucky 40741**

hereinafter called "OWNER", in the total aggregate penal sum of:

_____ Dollars (\$_____).

in lawful money of the United States, for the payment of which sum will and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assign, jointly and severally, firmly by these presents.

The Condition of this Obligation is such that whereas, the PRINCIPAL has submitted a certain Bid to the OWNER, dated the _____ day of _____ 2024, a copy of which is hereto attached and made a part hereof, to enter into a contract in writing for the construction of the **London Water Treatment Plant Improvements**, London, Kentucky.

NOW, THEREFORE, if said Bid shall be rejected, or in the alternate; if said Bid shall be accepted and the Principal shall execute and deliver a contract in the Form of Contract attached hereto (properly completed in accordance with said Bid) and shall furnish a bond for his faithful performance of said contract, and for the payment of all persons performing labor or furnishing materials in connection therewith, and shall in all other respects perform the agreement created by the acceptance of such 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 any 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 corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers, this the _____ day of _____ 2024.

ATTEST:

PRINCIPAL:

(PRINCIPAL) Secretary

By: _____

Address: _____

WITNESS TO PRINCIPAL

Address: _____

ATTEST:

SURETY

Witness to SURETY

By Attorney in Fact

Address: _____

Address: _____

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

BID BOND Requirements (5% of Contracts over \$100,000)

IMPORTANT: SURETY companies executing BONDS must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the state where the Project is located.

END OF SECTION 00201

SECTION 00300 - BID FORM

BIDDER'S PROPOSAL
London Water Treatment Plant Improvements
London Utility Commission

Proposal of _____ (hereinafter called
“BIDDER”), a _____ (corporation, partnership, or
individual) organized and existing under the laws of the state of _____,
doing business as _____,
to the **London Utility Commission**, (hereinafter called “OWNER”).

In compliance with the Advertisement for Bids, BIDDER hereby proposes to furnish all equipment, materials and labor for the WORK required for project completion included in this Bidder's proposal. The improvements shall be constructed in strict accordance with the CONTRACT DOCUMENTS, within the time set forth herein, and at the prices provided in this Bidder's proposal.

The OWNER will select the successful BIDDER based on criteria identified in the CONTRACT DOCUMENTS (total amount of base bid, qualifications, etc.).

The BID amounts provided shall include all labor, materials, overhead, profit, insurance and other costs necessary to cover the finished WORK of the several kinds. The BIDDER must fill in all blank spaces provided in the Bid Form including all unit and total costs.

By submission of this BID, the BIDDER certifies, and in the case of a joint BID, each party thereto certifies as to its own organization, that this BID has been arrived at independently, without consultation, communication or agreement as to any matter relating to this BID, with any other BIDDER or with any competitor.

BIDDER hereby agrees to commence WORK under this CONTRACT on or before a date to be specified in the Notice to Proceed and to fully complete the project within **three hundred sixty five (365)** consecutive calendar days thereafter. BIDDER hereby agrees to complete the WORK for the price provided in the Bid Schedule. BIDDER further agrees to pay liquidated damages, in accordance with the Schedule of Liquidated Damages included provided in Section 00700 – General Conditions, for each consecutive calendar day beyond the authorized contract period.

BID SCHEDULE
London Water Treatment Plant Improvements

ITEM NO.	DESCRIPTION	LUMP SUM PRICE	
		(WORDS)	(FIGURES)
1.	TOTAL LUMP SUM BID AMOUNT (Including Allowances Listed in Sections 01020 and 01021).	_____ _____ _____ dollars and ____ cents.	\$ _____

TOTAL BASE BID AMOUNT expressed in words:

 _____ Dollars and _____ Cents.

Accompanying this Bidder's Proposal is a certified check or BID BOND in the sum of (words and figures):

 _____ Dollars and _____ Cents (\$ _____).

that equals five percent (5%) of the BID amount. The BIDDER, by submittal of this BID, agrees with the OWNER that the amount of the BID security deposited with this BID fairly and reasonably represents the amount of damages the OWNER will suffer due to the failure of the BIDDER to successfully secure and enter into the AGREEMENT.

ADDITIVE ALTERNATE NO. 1 BID SCHEDULE
London Water Treatment Plant Improvements

ITEM NO.	DESCRIPTION	LUMP SUM PRICE	
		(WORDS)	(FIGURES)
1.	TOTAL LUMP SUM ADDITIVE ALTERNATE NO. 1 BID AMOUNT (Sedimentation Basin FRP Covers – Materials and Installation)	_____ _____ _____ dollars and ____ cents.	\$ _____

TOTAL ADDITIVE ALTERNATE NO. 1 BID AMOUNT expressed in words:

 _____ Dollars and _____ Cents.

NOTE: THE CONTRACT WILL BE AWARDED TO THE QUALIFIED BIDDER WITH THE LOWEST RESPONSIVE **BASE BID**. THEREFORE, THE ADDITIVE ALTERNATE BIDS WILL ONLY BE EVALUATED AFTER THE AFORMENTIONED BASE BID CONTRACTOR IS DETERMINED.

BIDDER acknowledges receipt of the following ADDENDA:

Addendum No. ___ dated _____ Addendum No. ___ dated _____

BIDDER agrees that the OWNER reserves the right to delete the whole or any part of the PROJECT from the CONTRACT. 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) consecutive calendar days after the actual date of BID opening.

Within ten (10) consecutive calendar days after receiving written Notice of Award of this BID by the OWNER, the BIDDER will execute and deliver to the OWNER four (4) copies of the AGREEMENT and such other required CONTRACT DOCUMENTS.

BIDDER:

Signed By:

Name:

(type or print)

Title:

Address:

END OF SECTION 00300

SECTION 00400 - SUPPLEMENTS TO BID FORM

PART 1 - BIDDER'S QUALIFICATIONS

- A. The required names and addresses of all persons interested in the foregoing Bid, as PRINCIPALS, are as follows:

- B. The requested statement of work of a similar character to that included in the proposed Contract and references to enable the OWNER to judge the BIDDER'S experience, skill and business standing are as follows:

(Add supplementary pages if necessary)

PART 2 - SUBCONTRACTORS

Proposed subcontractors must be listed below for each branch of work included in the proposed Contract. (All subcontractors are subject to the approval of the OWNER. Failure to submit a completed list may be cause for rejection of the Bid.)

BRANCH OF WORK	NAME AND ADDRESS OF SUBCONTRACTOR
1. Electrical	
2. Chemical Piping	
3. Painting	
4.	
5.	
6.	
7.	

(Add supplemental pages if necessary)

PART 3 - LIST OF PROPOSED MANUFACTURERS

NOTICE: This list is required to be completed by the apparent low bidder within fifteen (15) minutes after completion of the Bid Tabulation by the Owner and then submitted to the Owner as a required part of the bidding process. All material manufacturers are subject to review and approval of the Owner. Failure to complete and submit this completed list can be cause of rejection of the Bid.

MATERIAL (EQUIPMENT)	NAME AND ADDRESS OF MATERIAL MANUFACTURER
1. On Site Gen. Mixed Oxidant System (Section 11400)	DeNora Water Technologies
2. Filter Underdrain (Section 11401)	
3. Variable Frequency Drives	
4. Magnetic Flow Meter	
5. Motor Control Centers	
6.	

7.	
8.	
9.	
10.	

Submission of this Material Manufacturers List by the apparent low bidder and subsequent acceptance by the Owner **does not** constitute approval by the Owner of specific product, nor does such acceptance waive the BIDDER'S responsibility to fully comply with all requirements of the Drawings or Specifications. Variance from this list can only be accomplished by written approval from the Owner and then only after approvable justification. If a manufacturer cannot be accepted by the Owner within 24 hours of the bid opening, then the apparent low bidder must submit an approvable manufacturer within five (5) days of the bid opening or the Owner may select one of the manufacturers listed in Specifications. (Should no manufacturer be listed, then the Owner may select one that meets the requirements of the Specifications.)

END OF SECTION 00400

SECTION 00500 - AGREEMENT FORMS

PART 1 - NOTICE OF AWARD

TO: _____

PROJECT: **London Water Treatment Plant Improvements**
London Utility Commission, London, Kentucky

The OWNER has considered the Bid submitted by you for the above-described Work on
_____, 2024.

You are hereby notified that your Bid has been accepted for items in the amount of

_____ (\$ _____).

You are required by the Instructions to Bidders to execute the AGREEMENT and furnish the required CONTRACTOR'S Performance Bond, and Payment Bond and certificates of insurance within ten (10) consecutive calendar days from the date of this notice to you.

If you fail to execute said AGREEMENT and to furnish said BONDS within **ten (10) consecutive calendar days** from the date of this Notice, said OWNER will be entitled to consider all your rights arising out of the OWNER'S acceptance of your Bid as abandoned and as a forfeiture of your Bid Bond. 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.

Dated this _____ day of _____ 2024.

OWNER: London Utility Commission

By: _____

Name: Zach Creech

Title: Superintendent

ACCEPTANCE OF NOTICE OF AWARD

Receipt of the above NOTICE OF AWARD is hereby acknowledged this the _____ day of _____ 2024.

CONTRACTOR:

By:

Name:

Title:

PART 2 - AGREEMENT

THIS AGREEMENT, made this _____ day of _____ 2024, by and between the **London Utility Commission**, hereinafter called "OWNER", and _____ doing business as (a corporation, a partnership, or an individual), hereinafter called "CONTRACTOR."

WITNESSETH: That for and in consideration of the payments and agreements hereinafter mentioned:

1. The CONTRACTOR will commence and complete "**London Water Treatment Plant Improvements**", London, Kentucky.
2. The CONTRACTOR will furnish all of the materials, supplies, tools, equipment, labor and other services necessary for the completion of the project described herein.
3. The CONTRACTOR will commence the work required by the Contract Documents after the date of the Notice to Proceed and to complete the project **within three hundred sixty five (365)** consecutive calendar days thereafter, unless the period for completion is extended otherwise by the Contract Documents.
4. The CONTRACTOR agrees to perform all of the work described in the Contract Documents and comply with the terms therein for the sum of:

(\$ _____)

as shown in the Bidder's Proposal.

5. The term "Contract Documents" means and includes the following:

- a. Advertisement for Bids.
- b. Instructions to Bidders.
- c. Information Available to Bidders.
- d. Bidder's Proposal.
- e. Bid Bond.
- f. Agreement.
- g. General Conditions.
- h. Payment Bond.
- i. Performance Bond.
- j. Notice of Award.
- k. Notice to Proceed.
- l. Change Order(s), if any.
- m. Drawings prepared by Eclipse Engineers, PLLC and dated **September 2024.**
- n. Technical Specifications prepared by Eclipse Engineers, PLLC and dated **September 2024.**
- o. Addenda:

No. _____, Dated _____
 No. _____, Dated _____

- 6. The OWNER will pay to the CONTRACTOR in the manner and at such times as set forth in the General Conditions such amounts as required by the Contract Documents.
- 7. This AGREEMENT shall be binding upon all parties hereto and their respective heirs, executors, administrators, successors and assigns.

IN WITNESS WHEREOF, the parties hereto have executed or caused to be executed by their duly authorized officials, this AGREEMENT in four (4) copies each of which shall be deemed an original on the date first above written.

OWNER:

By:

Name:

Title:

ATTEST:

Name:

(type or print)

Title:

CONTRACTOR:

By:

Name:

Address:

ATTEST:

Name:

(type or print)

Title:

PART 3 - NOTICE TO PROCEED

TO: _____

PROJECT: **London Water Treatment Plant Improvements**
London Utility Commission, London, Kentucky

You are hereby notified to commence work in accordance with the AGREEMENT dated _____, 2024, on or before _____, 2024, and you are to complete the project within **three hundred sixty five (365)** consecutive calendar days thereafter. The date of completion of all work is therefore _____, 2025.

OWNER:

By: _____
Zach Creech, Superintendent
London Utility Commission

ACCEPTANCE OF NOTICE TO PROCEED

Receipt of the above NOTICE TO PROCEED is hereby acknowledged by

this the _____ day of _____ 2024.

By: _____

Name: _____

Title: _____

END OF SECTION 00500

SECTION 00600 - BONDS AND CERTIFICATES

PART 1 - PERFORMANCE BOND

KNOW ALL PERSONS BY THESE PRESENTS:

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

Name of OWNER: **London Utility Commission**

Address of OWNER: **801 North Main Street, London, Kentucky 40741**

hereinafter called "OWNER", in the total aggregate penal sum of:

Dollars (\$).

in lawful money of the United States, for the payment of which sum will and truly to be made, we bind ourselves, our heirs, executors, administrators, 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 _____ 2024, a copy of which is hereto attached and made a part hereof for the construction of: **“London Water Treatment Plant Improvements”**.

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 year guaranty period, and if the PRINCIPAL 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 change, extension of time, alteration or addition to the terms of the AGREEMENT or Work to be performed thereunder or the Specifications accompanying the same shall in any way affect its obligation on this BOND, and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the Contract or to the Work or to the Specifications.

PROVIDED, FURTHER, that it is expressly agreed that the BOND shall be deemed amended automatically and immediately, without formal and separate amendments hereto, upon amendment to the AGREEMENT not increasing the Contract price more than 20 percent (20%), so as to bind the PRINCIPAL and the SURETY to the full and faithful performance of the AGREEMENT as so amended. The term "Amendment", wherever used in this BOND, and whether referring to this BOND, the AGREEMENT or the Loan Documents shall include any alteration, addition, extension, or modification of any character whatsoever.

IN WITNESS WHEREOF, this instrument is executed in four (4) counterparts, each one of which shall be deemed an original, this the ____ day of _____ 2024.

ATTEST:

PRINCIPAL:

(PRINCIPAL) Secretary

By:

Address:

WITNESS TO PRINCIPAL

Address:

ATTEST:

SURETY

Witness to SURETY

By Attorney in Fact

Address:

Address:

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

100% Performance Bond and 100% Payment Bond for contracts over \$100,000. Single Payment and Performance Bonds may be used for contracts under \$100,000. Performance Bond must be valid for one year beyond date of acceptance of the completed project.

IMPORTANT: SURETY companies executing BONDS must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the state where the Project is located.

PART 2 - PAYMENT BOND

KNOW ALL PERSONS 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

Name of OWNER: **London Utilities Commission**

Address of OWNER: **801 North Main Street, London, Kentucky 40741**

hereinafter called "OWNER", in the total aggregate penal sum of:

	Dollars	(\$		).

in lawful money of the United States, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, 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 _____ 2024, a copy of which is hereto attached and made a part hereof for the construction of: **“London Water Treatment Plant Improvements.”**

NOW, THEREFORE, if the PRINCIPAL shall promptly make payment to all persons, firms, and corporations furnishing materials for or performing labor in the prosecution of the Work provided for in such AGREEMENT, and any authorized extensions or modifications thereof, including all amounts due for materials, lubricants, oil, gasoline, coal and coke, repairs on machinery, equipment and tools, consumed or used in connection with the construction of such Work, and for all labor cost incurred in such Work including that by a SUBCONTRACTOR, and to any mechanic or materialman lienholder whether it acquires its lien by operation of State or Federal law; then this obligation shall be void, otherwise to remain in full force and effect.

PART 2 - PAYMENT BOND (continued)

PROVIDED, that beneficiaries or claimants hereunder shall be limited to the Subcontractors, and persons, firms, and corporations having a direct Contract with the PRINCIPAL or its Subcontractors, in addition to the OWNER.

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

PROVIDED, FURTHER, that no suit or action shall be commenced hereunder by any claimant: (a) Unless claimant, other than one having a direct Contract with the PRINCIPAL, shall have given written notice to any two of the following: The PRINCIPAL, the OWNER, or the SURETY above named within ninety (90) consecutive calendar days after such claimant did or performed the last of the Work or labor, or furnished the last of the materials for which said claim is made, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were furnished, or for whom the Work or labor was done or performed. Such notice shall be served by mailing the same by registered mail or certified mail, postage prepaid, in an envelope addressed to the PRINCIPAL, OWNER, or SURETY, at any place where an office is regularly maintained for the transaction of business, or served in any manner in which legal process may be served in the state in which the aforesaid Project is located, save that such service need not be made by a public officer; (b) After the expiration of eighteen (18) months following the date of which PRINCIPAL ceased Work on said AGREEMENT, it being understood, however, that if any limitation embodied in the BOND is prohibited by any law controlling the construction hereof, such limitation shall be deemed to be amended so as to be equal to the minimum period of limitation permitted by such law.

PROVIDED, FURTHER, that it is expressly agreed that this BOND shall be deemed amended automatically and immediately, without formal and separate amendments hereto, upon amendment to the AGREEMENT not increasing the Contract price more than 20 percent (20%), so as to bind the PRINCIPAL and the SURETY to the full and faithful performance of the AGREEMENT as so amended. The term "Amendment", wherever used in this BOND and whether referring to this BOND, the AGREEMENT or the Loan Documents shall include any alteration, addition, extension or modification of any character whatsoever.

IN WITNESS WHEREOF, this instrument is executed in four (4) counterparts, each one of which shall be deemed an original, this the ____ day of _____ 2024.

ATTEST:

(PRINCIPAL) Secretary

WITNESS TO PRINCIPAL

Address: _____

ATTEST:

Witness to SURETY

Address: _____

PRINCIPAL:

By: _____

Address: _____

SURETY

By Attorney in Fact

Address: _____

NOTE:

Date of BOND must not be prior to date of AGREEMENT. If CONTRACTOR is a Partnership, all partners should execute BOND.

100% Performance Bond and 100% Payment Bond for contracts over \$100,000. Single Payment and Performance Bonds may be used for contracts under \$100,000. Performance Bond must be valid for one year beyond date of acceptance of the completed project.

IMPORTANT:

SURETY companies executing BONDS must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the state where the Project is located.

PART 3 - CERTIFICATE OF OWNER'S ATTORNEY

I, the undersigned, _____, the duly authorized
and acting legal representative of the:

London Utility Commission _____,
do hereby certify as follows:

I have examined the attached Contract(s) and Performance Bond and Payment Bond and the manner of execution thereof, and I am of the opinion that each of the aforesaid AGREEMENTS has been duly executed by the proper parties thereto acting through their duly authorized representatives; that said representatives have full power and authority to execute the same and that the foregoing AGREEMENTS constitute valid and legally binding obligations on the parties executing the same, in accordance with terms, conditions and provisions thereof.

Signature: _____

Date: _____

END OF SECTION 00600

SECTION 00700 - GENERAL CONDITIONS

INDEX

- 1.01 Contract Documents
- 1.02 Definitions and Meanings of Terms
- 1.03 Drawings and Specifications
- 1.04 Shop Drawings
- 1.05 Discrepancies in Drawings, Specifications and Shop Drawings
- 1.06 Contractor
- 1.07 Notice and Service Thereof on Contractor
- 1.08 Assignment of Contract
- 1.09 Subletting Contract
- 1.10 Commencement and Completion of Work
- 1.11 Prosecution of Work
- 1.12 Contract Time - Delays and Extensions
- 1.13 Failure to Complete Work on Time
- 1.14 Character of Workmen, Equipment and Material
- 1.15 Engineer's Status
- 1.16 Engineer's Decision
- 1.17 Review of Work
- 1.18 Review of Work Away From the Site
- 1.19 Standard Specifications
- 1.20 Specific Brands, Makes or Manufacturers
- 1.21 "OR EQUAL" Clause
- 1.22 Permits and Codes
- 1.23 Wages and Hours
- 1.24 Non-Rebate of Wages
- 1.25 Contract Security or Performance and Payment Bond
- 1.26 Safety
- 1.27 Insurance - Contractor's Coverage and Cancellation Provision
- 1.28 Insurance - Workmen's Compensation
- 1.29 Insurance - Public Liability
- 1.30 Insurance - Builders Risk
- 1.31 Minimum Insurance Limits
- 1.32 Insurance - Proof of Carriage
- 1.33 Royalties and Patent Fees
- 1.34 Responsibility for Damage, Claims, etc.
- 1.35 Handling and Distribution
- 1.36 Materials - Samples - Review
- 1.37 Payment for Materials Stored at Site of Project
- 1.38 Materials
- 1.39 Defective Materials and Workmanship
- 1.40 Guaranty
- 1.41 Field Office

- 1.42 Sanitary Facilities
- 1.43 Employment Qualifications
- 1.44 NOT USED IN THIS CONTRACT
- 1.45 Payment of Employees
- 1.46 Schedules, Reports and Records
- 1.47 Planning and Progress Schedules
- 1.48 Payments by Contractor
- 1.49 Funds for Partial Payment Estimates
- 1.50 Partial Payment Estimates
- 1.51 OWNER'S Right to Withhold Payments
- 1.52 Deductions for Uncorrected Work
- 1.53 Protection of Work, Property and Persons
- 1.54 Work on "Private Property"
- 1.55 Lands for Work
- 1.56 Interference with and Protection of Streets
- 1.57 Existing Utilities
- 1.58 Arbitration
- 1.59 Alteration in Drawings and Specifications
- 1.60 Changes in the Work
- 1.61 Claims for Extra Work
- 1.62 Determination of the Value of Extra (Additional) or Omitted Work
- 1.63 Separate Contracts
- 1.64 OWNER'S Right to Do Work
- 1.65 Suspension of Work
- 1.66 Right of OWNER to Terminate Contract
- 1.67 Contractor's Right to Stop Work or Terminate Contract
- 1.68 Using Completed Portion of Work
- 1.69 Acceptance and Final Payment
- 1.70 Contractor's Final Release
- 1.71 Final Clean-Up

SECTION 00700 - GENERAL CONDITIONS

PART I - GENERAL

1.01 CONTRACT DOCUMENTS

The Advertisement for Bids, Instructions to Bidders, Bidder's Proposal, Bid Bond, Agreement, Performance and Payment Bonds, Certificate of Insurance, Notice of Award, Notice to Proceed, Change Orders, General Conditions, Supplementary General Conditions, Special Conditions, Drawings, Addenda and Specifications shall all be binding on the Contractor, and shall be fully a part of the Contract as if thereto attached or therein repeated in words and figures.

1.02 DEFINITIONS AND MEANINGS OF TERMS

Whenever in the Contract Documents the following terms or pronouns referring to them are used, the intent and meaning shall be interpreted as follows which shall be applicable to both the singular and plural thereof:

- A. The Contract shall mean the Contract executed by the OWNER and the Contractor, of which these General Conditions form a part; the terms Contract and Agreement are synonymous.
- B. The terms OWNER and Contractor shall mean the respective parties to the Contract; the OWNER being a public or quasi-public body or authority, corporation, association, partnership, or individual for whom the work is to be performed; the Contractor being the individual, partnership or corporation with whom the OWNER has executed the Contract.
- C. The term Engineer shall mean Eclipse Engineers, PLLC, successor, or duly authorized representative.
- D. Addenda shall mean written or graphic instruments issued prior to the execution of the Agreement, which modify or interpret the Contract Documents, Drawings and Specifications, by additions, deletions, clarifications or corrections.
- E. Bid shall mean the offer or proposal of the BIDDER submitted on the prescribed form setting forth the prices for the Work to be performed; the terms Bid and Proposal are synonymous.
- F. BIDDER shall mean any individual, partnership or corporation submitting a Bid for the Work.

- G. Bonds shall mean Bid, Performance, and Payment Bonds and other instruments of security, furnished by the Contractor and his surety in accordance with the Contract Documents.
- H. Change Order shall mean a written order to the Contractor authorizing an addition, deletion or revision in the Work within the general scope of the Contract Documents, or authorizing an adjustment in the Contract price or Contract time.
- I. Contract Documents shall mean the Contract, including Advertisement for Bids, Instructions to Bidders, Bidder's Proposal, Bid Bond, Agreement, Payment Bond, Performance Bond, Certificate of Insurance, Notice of Award, Notice to Proceed, Change Orders, Drawings, General Conditions, Supplementary General Conditions, Special Conditions, Addenda and Specifications.
- J. Contract price shall mean the total monies payable to the Contractor under the terms and conditions of the Contract Documents.
- K. Contract time shall mean the number of consecutive calendar days stated in the Contract Documents for the completion of the Work.
- L. Drawings shall mean the part of the Contract Documents, which show the characteristics, and scope of the Work to be performed and which have been prepared or approved by the Engineer.
- M. Field order shall mean a written order effecting a change in the Work not involving an adjustment in the Contract price or an extension of the Contract time, issued by the Engineer to the Contractor during construction.
- N. Notice of award shall mean the written notice of the acceptance of the Bid from the OWNER to the successful BIDDER.
- O. Notice to proceed shall mean written communication issued by the OWNER to the Contractor authorizing him to proceed with the Work and establishing the date of commencement of the Work.
- P. Project shall mean the undertaking to be performed as provided in the Contract Documents.
- Q. Resident project representative shall mean the authorized representative of the OWNER who is assigned to the project site or any part thereof.
- R. Shop drawings shall mean all drawings, diagrams, illustrations, brochures, schedules and other data which are prepared by the Contractor, a subcontractor, manufacturer, supplier, or distributor, which illustrate how specific portions of the Work shall be fabricated or installed; the terms shop drawings and submittals are synonymous.

- S. Specifications shall mean a part of the Contract Documents consisting of written descriptions of a technical nature of materials, equipment, construction systems, standards and workmanship.
- T. Subcontractor shall mean individual, partnership or corporation having a direct contract with the Contractor or with any other subcontractor for the performance of a part of the Work at the site.
- U. Substantial completion shall mean that date as certified by the Engineer when the construction of the project or a specified part thereof is sufficiently completed, in accordance with the Contract Documents, so that the project or specified part can be utilized for the purposes for which it is intended.
- V. Suppliers shall mean any person, supplier or organization who supplies materials or equipment for the Work, including that fabricated to a special design, but who does not perform labor at the site.
- W. Work shall mean labor necessary to produce the construction required by the Contract Documents, and all materials and equipment incorporated or to be incorporated in the project.
- X. Written notice shall mean any notice to any party of the Agreement relative to any part of this Agreement in writing and considered delivered and the service thereof completed, when posted by certified or registered mail to the said party at his last given address, or delivered in person to said party of his authorized representative on the Work.

1.03 DRAWINGS AND SPECIFICATIONS

The intent of the Drawings and Specifications is that the Contractor shall furnish all labor, materials, tools, equipment, and transportation necessary for the proper execution of the Work in accordance with the Contract Documents and all incidental work necessary to complete the project in an acceptable manner, ready for use, occupancy or operation by the OWNER.

The Engineer, without charge, will furnish to the Contractor not more than three (3) sets of the Drawings and Specifications. If additional sets of documents are required by the Contractor for the proper handling of the work, such documents will be furnished to the Contractor at cost.

The Contractor shall keep one set of the Drawings and Specifications on the site of the work. This set shall be kept current by the addition of all reviewed changes, addenda and amendments thereto.

The Drawings and Specifications are intended to be explanatory to each other, but should any discrepancy appear or any misunderstanding arise as to the importance of anything contained in either, the Engineer shall make the necessary interpretation. Corrections of errors or omissions in the Drawings or Specifications may be made by the Engineer when such corrections are necessary for the proper fulfillment of their intention as construed by the Engineer.

All work or materials shown on the Drawings and not mentioned in the Specifications, or any work specified and not shown on the Drawings, shall be furnished, performed, and done by the Contractor as if same were both mentioned in the Specifications and shown on the Drawings.

Should the Contractor in preparing his Bid find anything necessary for the construction of the project that is not mentioned in the Specifications or shown on the Drawings, or find any other discrepancy in the Contract Documents, he shall notify the Engineer so that such discrepancies may be corrected by Addenda prior to the Bid opening. Should the Contractor fail to notify the Engineer of such discrepancies, it will be assumed that his Bid included everything necessary for the complete construction in the spirit and intent of the designs shown.

The Contractor may be furnished additional instructions and detail drawings, by the Engineer, as necessary to carry out the Work required by the Contract Documents. The additional drawings and instructions thus supplied will become a part of the Contract Documents. The Contractor shall carry out the Work in accordance with the additional detail drawings and instructions.

1.04 SHOP DRAWINGS

The Contractor shall submit shop and working drawings of concrete reinforcement, structural details, piping layout, wiring, materials fabricated especially for the Contract, and materials and equipment for which such drawings are specifically requested.

Such drawings shall show the principal dimensions, weight, structural and operating features, space required, clearances, type and/or brand of finish or shop coat, grease fittings, etc., depending on the subject of the drawing. When it is customary to do so, when the dimensions are of particular importance, or when so specified, the drawings shall be certified by the manufacturer or fabricator as correct for the Contract.

When so specified or if considered by the Engineer to be acceptable, manufacturer's specifications, catalog data, descriptive matter, illustrations, etc., may be submitted in place of shop and working drawings. In such case, the requirements shall be as specified for shop and working drawings, insofar as possible, except that the submission shall be in quadruplicate.

The Contractor shall be responsible for the prompt and timely submittal of all shop

and working drawings so that there shall be no delay to the Work due to the absence of such drawings. Prior to the submittal of any shop drawings, the Contractor shall submit a schedule of proposed shop drawing transmittals. The schedule shall identify the subject matter of each transmittal, the corresponding specification section number and the proposed date of submission. During the progress of the Work, the schedule shall be revised and resubmitted as necessary.

No material or equipment shall be purchased or fabricated especially for the Contract until the required shop and working drawings have been submitted as herein above provided and reviewed for conformance to the Contract requirements. All such materials and equipment and the work involved in their installation or incorporation into the Work shall then be as shown in and represented by said drawings. Until the necessary review has been made, the Contractor shall not proceed with any portion of the Work (such as the construction of foundations), the design or details of work, materials, equipment or other features for which review is required.

All shop and working drawings shall be submitted to the Engineer by and/or through the Contractor, who shall be responsible for obtaining shop and working drawings from his subcontractors and returning reviewed drawings to them. All shop and working drawings shall be prepared on standard size, 24-inch by 36-inch sheets, except those, which are made by changing existing standard shop or working drawings. All drawings shall be clearly marked with the names of the OWNER, Contractor, and building, equipment, or structure to which the drawing applies, and shall be suitably numbered. Each shipment of drawings shall be accompanied by a letter of transmittal giving a list of the Drawing numbers and the names mentioned above.

Only drawings, which have been checked and corrected by the fabricator, should be submitted to the Contractor by his subcontractors and vendors. Prior to submitting drawings to the Engineer, the Contractor shall check thoroughly all such drawings to satisfy him that the subject matter thereof conforms to the Drawings and Specifications in all respects. All Drawings, which are correct, shall be marked with the date, checker's name, and indication of the Contractor's approval, and then shall be submitted to the Engineer; other drawings shall be returned for correction.

If a shop drawing shows any deviation from the Contract requirements, the Contractor shall make specific mention of the deviations in his letter of transmittal.

The review of shop and working drawings hereunder will be general only, and nothing contained in these general conditions shall relieve, diminish or alter in any respect the responsibilities of the Contractor under the Contract Documents and in particular, the specific responsibility of the Contractor for details of design and dimensions necessary for proper fitting and construction of the work as required by the Contract and for achieving the result and performance specified there under.

Should the Contractor submit equipment that requires modifications to the structures,

pipng, electrical conduit, wires and appurtenances, layout, etc., detailed on the Drawings, he shall also submit details of the proposed modifications. If such equipment and modifications are accepted, the Contractor, at no additional cost to the OWNER, shall do all work necessary to make such modifications.

The marked-up shop and working drawings or one marked-up copy of catalog cuts will be returned to the Contractor. The Contractor shall furnish additional copies of such drawings or catalog cuts when so requested.

1.05 DISCREPANCIES IN DRAWINGS, SPECIFICATIONS AND SHOP DRAWINGS

In case of a discrepancy on the Drawings, figure dimensions shall govern over scale dimensions and large-scale drawings shall govern over small-scale drawings. In case of a discrepancy in the Specifications and Contract Documents, detailed technical specifications and special or supplementary conditions shall govern over general conditions and other sections of the Contract Documents. In case of a discrepancy between the Drawings and Specifications, the Specifications shall govern; addenda shall govern over all Drawings, Specifications and Contract Documents. Supplementary conditions shall govern over these General Conditions.

In case of discrepancy between the shop drawings and the requirements of the Drawings, Specifications and Contract Documents, the provisions of the Drawings, Specifications, and Contract Documents shall prevail, even though the shop drawings have been specifically waived in writing by the Engineer.

Any discrepancies found between the Drawings and Specifications and site conditions or any inconsistencies or ambiguities in the Drawings or Specifications shall be immediately reported to the Engineer, in writing, who shall promptly correct such inconsistencies or ambiguities in writing. Work done by the Contractor after his discovery of such discrepancies, inconsistencies or ambiguities shall be done at the Contractor's risk.

1.06 CONTRACTOR

Only one Contractor is recognized as a party to this Contract and where the term Contractor is used, the prime Contractor who signed this Contract is referred to. For convenience, the Specifications may have been divided into separate headings or divisions to cover the various trades represented in the work, and where "Electrical Contractor", "Mechanical Contractor", "Plumbing Contractor" and other such "Contractors" are referred to, it is for convenience only.

It is understood and agreed that the Contractor has satisfied himself as to the nature and location of the work, the topography of the ground, the character and quality of materials to be encountered, the character of equipment or other facilities needed for the proper execution of the Work, the general and local conditions, and all other

matters which in any way affect the work under the Contract. No verbal statement of any officer, agent or employee of the OWNER or the Engineer, either before or after the execution of the Contract, shall affect or modify any of the terms or obligations contained herein.

1.07 NOTICE AND SERVICE THEREOF ON CONTRACTOR

The address given in the Proposal upon which this Contract is founded and the Contractor's office at or near the site of the work are hereby designated as places to either of which notices, letters and other communications to the Contractor shall be certified, mailed or delivered. The delivering at the above name places, or depositing in a postpaid wrapper directed to the first named place, in any post office box regularly maintained by the United States Postal Service, of any notice, letter or other communication to the Contractor shall be deemed sufficient service thereof upon the Contractor, and the date of said service shall be the date of delivery or mailing. The first named address may be changed at any time by an instruction in writing, executed and acknowledged by the Contractor and delivered to the Engineer and the OWNER. Nothing herein contained shall be deemed to preclude or render inoperative the service of any notice, letter, or other communication upon the Contractor personally.

1.08 ASSIGNMENT OF CONTRACT

The Contractor shall not assign, sell, transfer or otherwise dispose of his Contract or any monies due or that may become due there under, without the prior written consent of the OWNER.

1.09 SUBLETTING CONTRACT

The Contractor may utilize the services of specialty subcontractors on those parts of the Work, which, under contracting practices, are performed, by specialty subcontractors. However, the Contractor will not be permitted to sublet any portion of his contract to any individual, co-partnership, or corporation without the prior written consent of the OWNER and the approval of the Engineer. The Contractor shall not sublet more than fifty percent (50%) of the work without the consent of the OWNER and the approval of the Engineer prior to the receipt of Bids. The Contractor shall, if requested, notify the OWNER in writing of the names of subcontractors proposed for the work.

The Contractor shall be as fully responsible to the OWNER for the acts and omissions of his subcontractors, and of persons either directly or indirectly employed by them, as he is for the acts and omissions of persons directly employed by him.

The Contractor shall cause appropriate provisions to be inserted in all subcontracts relative to the Work to bind subcontractors to the Contractor by the terms of the General Conditions and other Contract Documents insofar as applicable to the work of

subcontractors and to give the Contractor the same power as regards terminating any subcontract that the OWNER may exercise over the Contractor under any provisions of the Contract Documents. Nothing contained in this contract shall create any contractual relation between any subcontractor and the OWNER.

1.10 COMMENCEMENT AND COMPLETION OF WORK

The Contractor shall commence work on a date to be specified in a written order of the OWNER, and shall fully complete all work under the Contract within the number of consecutive calendar days set out in the Bid and Contract. As set forth in the Bid and Contract, the work under the Contract will be subject to liquidated damages in the event the work is not completed within the Contract time.

1.11 PROSECUTION OF WORK

The Contractor shall give his personal superintendence to the work or shall have a competent superintendent, satisfactory to the OWNER and the Engineer on the work at all times during its progress with full authority to act for him. The superintendent shall have been designated in writing by the Contractor as the Contractor's representative at the site. All communications given to the superintendent shall be as binding as if given to the Contractor. The Contractor shall also provide an adequate staff for properly coordinating and expediting his work. The Contractor shall be solely responsible for the means, methods, techniques, sequences and procedures of construction.

The Contractor shall be prepared to start the work as stipulated in the Proposal, but not until he has received official notice from the OWNER to do so. Official notice will be in the form of a written Notice to Proceed. The work shall be prosecuted in a manner and with sufficient materials, equipment, and labor as is considered necessary to insure completion within the time set forth in the Contract. The Contractor shall not suspend the work or any portion of it without the written consent of the OWNER and the approval of the Engineer.

1.12 CONTRACT TIME - DELAYS AND EXTENSIONS

The number of consecutive calendar days in which the Contractor shall fully perform the proposed work has been set out in the Proposal and/or Contract. The date of beginning and the time for completion of the Work are essential conditions of the Contract.

In arriving at any credit due the Contractor for an extension of time on the Contract, the OWNER, upon the recommendation of the Engineer, may allow such credit as in his judgment is deemed equitable and just for all delays occasioned by any act, or failure to act, on the part of the Contractor or caused by forces beyond the Contractor's control. Additional time will also be allowed the Contractor to cover approved over-

runs or additions to the Contract in the same proportion that the said over-runs or additions in monetary value bears to the original Contract amount. Delays caused by normal and ordinary weather conditions foreseeable at the time the work is Bid will not be the basis for an extension of the Contract time.

If the Contractor claims that any instructions by Drawings or otherwise involve an extension of time, he shall give the Engineer written notice of said claim within ten (10) consecutive calendar days after the receipt of such instructions, and in any event before proceeding to execute the work, stating clearly and in detail the basis of his claim or claims. No such claim shall be valid unless so made.

The Contractor shall make no claim for extra compensation due to delays of the project beyond his control. Such delays may include those caused by any act of neglect on the part of the OWNER or Engineer, or by any employee of either, or by any separate contractor employed by the OWNER, or by changes ordered in the work, or by labor disputes, fire, unusual delays in transportation, adverse weather conditions not reasonably anticipated, unavoidable casualties, or by delay authorized by the OWNER pending arbitration, or by any other cause which the Engineer determines may justify the delay.

Time extensions may be granted upon proper justification by the Contractor. Any claim for time extensions under these provisions shall be submitted in writing to the Engineer not more than twenty (20) consecutive calendar days following commencement of the delay; otherwise claim will be waived. With submission of claim, Contractor shall provide an estimate of the probable effect of such delay on the progress of the work.

Additional costs incurred in accelerating the work to compensate for such delays (as defined above) shall also not form the basis for extra compensation claims.

1.13 FAILURE TO COMPLETE WORK ON TIME

Should the Contractor fail or refuse to complete the work within the time specified in his Proposal and/or Contract (or extension of time granted by the OWNER), the Contractor shall pay liquidated damages in an amount set out in said Proposal and/or Contract. The amount of liquidated damages shall in no event be considered as a penalty, nor other than an amount agreed upon by the Contractor and the OWNER for damages, losses, additional engineering, additional resident representation and other costs that will be sustained by the OWNER, if the Contractor fails to complete the work within the specified time. Liquidated damages will be applied on a rate per day for each and every calendar day (Sundays and holidays included) beyond the Contract expiration date stipulated in the Contract Documents, considering all time extensions granted.

Should no liquidated damages amount be specified in the Proposal and/or Contract,

then the following amounts shall be fixed and agreed upon by and between the contractor and OWNER because of the impracticability and extreme difficulty of fixing and ascertaining the actual damages the OWNER would in such event sustain.

SCHEDULE OF LIQUIDATED DAMAGES

<u>Original Amount of Contract</u>	<u>Liquidated Damages Per Day</u>
Up to \$100,000	\$150
\$100,000 to \$500,000	\$200
\$500,000 to \$1,000,000	\$250
\$1,000,000 to \$2,000,000	\$300
Over \$2,000,000	\$300 plus \$150 per each additional million dollars or fractions thereof

1.14 CHARACTER OF WORKMEN, EQUIPMENT, AND MATERIAL

The Contractor shall employ only workmen skilled in their various duties and shall remove from the project, at the request of the Engineer, any person employed in, about, or upon the work, which misconducts himself or is incompetent or negligent in the performance of the duties assigned to him.

The Contractor shall at all times enforce strict discipline and good order among his employees, and shall not employ on the work any unfit person or anyone not skilled in the work assigned to him. Any careless, untrustworthy, or incompetent workman shall be removed forthwith upon the request of the Engineer or his duly authorized representative. Particular application shall be to workmen who ignore quality specifications on pipe bedding, laying, and backfilling, below grade building, concrete pouring, and other work to be covered up or assuming an unalterable set.

Unless otherwise specified, all materials shall be new and both workmanship and materials shall be of good quality. The Contractor shall furnish satisfactory evidence as to the kind and quality of materials. Materials and equipment shall be so stored as to insure the preservation of their quality and fitness for the Work. Stored materials and equipment to be incorporated in the Work shall be located so as to facilitate prompt review. Manufactured articles, materials and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned as directed by the manufacturer.

Materials, supplies or equipment to be incorporated into the Work shall not be purchased by the Contractor or any subcontractor subject to a chattel mortgage or

under a conditional sale contract or other agreement by which an interest is retained by the seller.

Review of manufacturer's shop drawings of materials and equipment shall not mean final acceptance, but shall be subject to review and test on delivery and installation. The Contractor shall repair, replace, or adjust any materials or equipment found defective or not operating properly due to improper materials, workmanship, and adjustment on his part, for a period of one year after completion and acceptance of his work.

1.15 ENGINEER'S STATUS

In rendering general engineering service, resident engineering and review of construction, the Engineer is not in charge of, and shall not be responsible for, the methods of construction, the construction forces or the construction equipment, construction safety procedures, or Contractor payment for labor and materials on the project.

The Engineer may review the work as the authorized representative of the OWNER and will have authority to stop the work whenever, in his opinion, such action is necessary to insure the proper execution of the Contract. He will also have authority to reject work and materials, which do not conform to the Drawings, Specifications and Contract Documents, and to direct the place or places where work shall be prosecuted. The Engineer is the agent of the OWNER only to the extent provided in the Specifications and Contract Documents, except in special instances when this authority is extended; in such latter instances he will, upon request, show the Contractor written proof of his authority.

The Engineer will also interpret the meaning and requirements of the Drawings, Specification and Contract Documents, decide all engineering questions, and decide all disputes that may arise between the OWNER and the Contractor. The Engineer's decisions on these matters will be final and binding on both the Contractor and the OWNER unless the dispute is submitted to arbitration or either party resorts to legal action for settlement.

The Engineer is the interpreter of the conditions of the Contract and the judge of its performance. In this duty, he will not favor either the OWNER or the Contractor but will use his authority under the Contract to insure and enforce its faithful performance by both parties.

In case of the termination of the employment of the Engineer, the OWNER will appoint a capable and reputable Engineer, whose status under the Contract will be the same as that of the former Engineer; any dispute in connection with such appointment shall be subject to arbitration.

1.16 ENGINEER'S DECISION

The Engineer shall, within a reasonable time after their presentation to him, make decisions on all claims of the OWNER or Contractor and on all matters relating to the execution and progress of the work or the interpretations of the Drawings, Specifications and Contract Documents.

Unless otherwise expressly provided in the Specifications and Contract Documents, all the Engineer's decisions are subject to arbitration, provided arbitration is agreed to by both the OWNER and the Contractor.

If, however, the Engineer fails to render a decision within ten (10) consecutive calendar days after the parties have presented their evidence, either party may then request arbitration. If the Engineer renders a decision after arbitration proceedings have been initiated, such decision may be entered as evidence but shall not disturb or interrupt such proceedings except when acceptable to the parties concerned.

1.17 REVIEW OF WORK

The City's Superintendent of Public Works shall serve as the City's on-site representatives for the purposes of coordination with the Contractor, resolving technical issues, and inspecting the materials and work. All materials and each part or detail of the work shall be subject to inspection by the Superintendent. The Superintendent shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the Contractor as is needed to adequately evaluate the work. Should the need arise, the City's Street Superintendent may consult with the City Administrator on particular issues.

1.18 REVIEW OF WORK AWAY FROM THE SITE

If work to be done away from the construction site is to be inspected on behalf of the OWNER during its fabrication, manufacture, or testing, or before shipment, the Contractor shall give notice to the Engineer of the place and time where such fabrication, manufacture, testing, or shipping is to be done. Such notice shall be in writing and delivered to the Engineer in ample time so that the necessary arrangements for the review can be made.

1.19 STANDARD SPECIFICATIONS

Where standard specifications, such as those of the American Society for Testing and Materials, the American National Standards Institute, the American Water Works Association, the American Association of State Highway and Transportation Officials, The Federal Aviation Agency, the Federal Specifications, etc., are referred to in the Specifications and Contract Documents and on the Drawings, said references shall be construed to mean the latest amended and/or revised versions of the said standard or tentative specification.

1.20 SPECIFIC BRANDS, MAKES OR MANUFACTURERS

Wherever in the Specifications one or more specific brands, makes or manufacturers are set out and qualified by the "or equal" clause, it is intended to denote the quality standard of the article desired, but unless otherwise noted does not restrict the Contractor to the specific brand, make or manufacturer. In cases where one or more specific brands, makes or manufacturers are named and these names are not qualified by the "or equal" clause, it is intended that the Contractor be restricted to one of those named unless otherwise set out.

The Contractor may recommend the substitution of a material, article, or piece of equipment of equal substance and function for those referred to in the Specifications by reference to brand name or catalogue number, and if, in the opinion of the Engineer, such material, article, or piece of equipment is of equal substance and function to that specified, the Engineer may accept its substitution and use by the Contractor. Any cost differential shall be deductible from the Contract price and the Contract Documents shall be appropriately modified by Change Order. The Contractor warrants that if substitutes are accepted, no major changes in the function or general design of the Project will result. Incidental changes or extra component parts required to accommodate the substitute shall be made by the Contractor without a change in the Contract price or Contract time.

1.21 "OR EQUAL" CLAUSE

Whenever the words "or approved equal", or "or equal", or "similar to", etc., appear in the Specifications, they shall be interpreted to mean an item of material or equipment that, in the opinion of the Engineer is similar to that named, suited to the same use, capable of performing the same function as that named, has a record of service equal to that named, and is equal in quality, capacity and/or efficiency to that named.

The Engineer's decision as to the equality of any material or equipment to that specified shall be final, but acceptance by the Engineer shall not relieve the Contractor from his responsibility concerning such materials or equipment or affect the guarantee covering the workmanship, materials and equipment.

1.22 PERMITS AND CODES

Unless otherwise set out in the Specifications or required by the agencies involved, the Contractor shall make application for, obtain and pay for all licenses and permits of a temporary nature necessary for the prosecution of the Work and shall pay for all fees and charges in connection therewith. Permits, licenses and easements for permanent structures or permanent changes in existing facilities will be secured and paid for by the OWNER, unless otherwise specified. The Contractor shall be required to comply with all state or municipal ordinances, laws, and/or codes insofar as the same are

binding on the OWNER.

The intent of this Contract is that the Contractor shall base his Bid upon the Drawings and Specifications, but that all work installed shall comply with all applicable codes and regulations as amended by any waivers. Before installing the work, the Contractor shall examine the Drawings and the Specifications for compliance with applicable codes and regulations bearing on the Work, and shall immediately report any discrepancy to the Engineer. Where the requirements of the Drawings and Specifications fail to comply with the applicable code or regulation, the OWNER will adjust the Contract by change order to conform to the code or regulation (unless waivers in writing covering the differences have been granted by the governing authority) and shall make appropriate adjustment in the Contract price. Should the Contractor fail to observe the foregoing provisions and install work at variance with any applicable code or regulation as may be amended by waivers (notwithstanding the fact that such installation is in compliance with the Drawings and Specifications), the Contractor shall remove and/or replace such work without cost to the OWNER, except that a change order will be issued to cover any additional cost the Contractor would have been entitled to receive if the change had been made before the Contractor commenced work on the items involved.

1.23 WAGES AND HOURS

The Contractor shall refer to Section 01030 for project wage determinations.

1.24 NON-REBATE OF WAGES

The Contractor shall comply with the regulations, rulings and interpretations of the Secretary of Labor of the United States, pursuant to the Federal Anti-Kickback Act of June 13, 1934, as amended, 48 Stat. 948; 62 Stat. 74; 63 Stat. 108 (Title 18, U.S.C. Sec. 874 and Title 40 U.S.C. Sec. 276c) including all subsequent amendments which makes it unlawful to induce any person employed in the construction or repair of public buildings or public works to give up any part of the compensation to which he is entitled under his Contract of Employment; and the Contractor agrees to insert a like provision in all subcontracts hereunder. The Contractor may be required to execute an affidavit covering each weekly payroll and certifying compliance with said Anti-Kickback Act.

1.25 CONTRACT SECURITY OR PERFORMANCE AND PAYMENT BOND

The Contractor will be required to furnish the OWNER with a Performance Bond and a Payment Bond to run for one year after the date of final acceptance of the Work by the OWNER and the Engineer. The Bonds shall be executed by a surety company duly authorized to do business in the state in which the work is to be performed and named on the current list of "Surety Companies Acceptable on Federal Bonds" as published in the Treasury Department Circular 570. Each Bond shall be in the amount

not less than one hundred percent (100%) of the Contract price, as security for the faithful performance of this Contract and as security for the payment of all persons performing labor and furnishing materials in connection with this Contract. These Bonds must be executed in the form provided as a part of the Contract Documents, and the surety company shall hold a current certificate of authority, as issued by the Treasury Department, as an acceptable surety on Federal Bonds under an act of Congress approved July 30, 1947. The expense of these Bonds shall be borne by the Contractor.

If at any time a surety on any such Bond is declared bankrupt or loses its right to do business in the state in which the Work is to be performed or is removed from the list of Surety Companies acceptable on Federal Bonds, the Contractor shall within ten (10) consecutive calendar days after notice from the OWNER to do so, substitute an acceptable Bond (or Bonds) in such form and sum and signed by such other surety or sureties as may be satisfactory to the OWNER. The Contractor shall pay the premiums on such Bond. No further payments shall be deemed due nor shall be made until the new surety or sureties shall have furnished an acceptable bond to the OWNER.

1.26 SAFETY

The Contractor shall take all necessary precautions and provide all necessary safeguards to prevent personal injury and property damage. The Contractor shall provide protection for all persons including but not limited to his employees and employees of other contractors or subcontractors; members of the public; and employees, agents, and representatives of the OWNER, the Engineer, and regulatory agencies that may be on or about the Work. The Contractor shall provide protection for all public and private property including but not limited to structures, pipes, and utilities, above and below ground.

The Contractor shall provide and maintain all necessary safety equipment such as fences, barriers, signs, lights, walkways, guards and fire prevention and fire-fighting equipment and shall take such other action as is required to fulfill his obligations under this subsection.

The Contractor shall comply with all federal, state and local laws, ordinances, rules and regulations and lawful orders of all authorities having jurisdiction for the safety of persons and protection of property.

The Contractor shall designate a responsible member of his organization at the site whose duty shall be the prevention of accidents. This responsible person shall have the authority to take immediate action to correct unsafe or hazardous conditions and to enforce safety precautions and programs.

1.27 INSURANCE, CONTRACTOR'S COVERAGE AND CANCELLATION

PROVISION

The Contractor will not be permitted to commence work until he has obtained all insurance required by these documents and such insurance has been approved by the OWNER, nor shall the Contractor allow any subcontractor to commence work on his subcontract until all insurance required has been so obtained and approved. Certificates of Insurance acceptable to the OWNER shall be filed with the OWNER prior to commencement of the Work.

Such insurance shall be secured from an insurance company authorized to write casualty insurance in the state where the Work is located and shall protect the Contractor, his subcontractors, and the OWNER from claims of bodily injury, death, property damage, fire and other risks set out herein.

Each policy of insurance covering the Contractor's operations under the Contract shall provide either in the body of the policy, or by appropriate endorsement (rider) to the policy, that such policy cannot be altered or canceled in less than ten (10) consecutive calendar days after the mailing of written notice of such alteration or cancellation to the OWNER (insured) or not less than five (5) consecutive calendar days after actual receipt by the OWNER (insured), of written notice of such pending alteration or cancellation.

Certificates of Insurance coverage shall include a statement of alteration or cancellation provisions of the policy, sufficient to show definitely that such provisions comply with the requirements stated herein.

1.28 INSURANCE, WORKER'S COMPENSATION

The Contractor shall take out and maintain during the life of this Contract, Workmen's Compensation Insurance, as required by statute, for all of his employees employed at the site of the Project, and in case any work is sublet, for all the subcontractor's employees not otherwise insured. In case any class of employees engaged in hazardous work under this Contract at the site of the project is not protected under the Workmen's Compensation Statute, the Contractor shall provide adequate coverage for the protection of the employees not otherwise protected.

1.29 INSURANCE, PUBLIC LIABILITY

The Contractor shall take out and maintain during the life of this Contract such Public Liability (Bodily Injury and Property Damage) Insurance as shall protect him and any subcontractor performing work covered by this Contract from claims for damages because of bodily injury, including accidental death and from claims for property damages, which may arise from operations under this Contract, whether such operations be by him or by any subcontractor, or by anyone directly or indirectly employed by either of them.

Where work on railroad rights-of-way is involved, the Contractor shall also be covered by Railroad Protective Liability Insurance with limits of liability as required by the railroad company on whose property the work is being performed.

1.30 INSURANCE, BUILDERS RISK

The Contractor shall provide Builders Risk Insurance (fire and extended coverage) on all work in place and/or materials stored at the site where there is any considerable risk from such causes for damage. Such insurance shall provide coverage as set forth in Paragraph 1.31 hereinafter. The policy shall name as the insured the Contractor, the Engineer and the OWNER.

1.31 MINIMUM INSURANCE LIMITS

The minimum amounts of insurance to be furnished by and for the Contractor and the subcontractors, and for the OWNER as a named insured, under this Contract are:

A. Workmen's Compensation:

1. Applicable state statutes.
2. Employers Liability = \$100,000 limit of liability.

B. Commercial General Liability:

1. Coverage A - Bodily Injury Liability and Property Damage:
 - a. General Policy Aggregate = \$1,000,000.
 - b. Products - Completed Operations Aggregate = \$1,000,000.
 - c. Each Occurrence = \$500,000.
2. Coverage B - Personal and Advertising Injury Liability = \$1,000,000.

C. Comprehensive Automobile Liability:

1. Bodily Injury Liability:
 - a. \$500,000 each person.
 - b. \$1,000,000 each accident.
2. Property Damage Liability: \$100,000 each accident or a combined single limit of \$500,000.

D. Builders Risk Insurance: To include coverage for not less than the losses due to Fire, Explosion, Hail, Lightning, Vandalism, Malicious Mischief, Wind, Collapse, Riot,

Aircraft, Smoke, Transportation and Extended Coverage for benefit of the OWNER, Engineer, Contractor, and subcontractors as their interests may appear during the Contract time and until the Work is accepted by the OWNER.

Property insurance to the full insurable value of the Work in accordance with the scope of Work as defined in these General Conditions as provided by the OWNER.

E. Railroad Protection Insurance - (where work to be within railroad right-of-way):

1. Loss of Life or Injury to Person: As required by Railroad.
2. Property Damage: As required by Railroad.

1.32 INSURANCE, PROOF OF CARRIAGE

The Contractor shall furnish the OWNER and the Engineer with satisfactory proof of carriage of the insurance required by submitting completed Insurance Certificates.

1.33 ROYALTIES AND PATENT FEES

The Contractor shall pay license fees and royalties and assume all costs incident to the use of any invention, design, process or device which is the subject of patent rights or copyrights held by others. As set forth in Paragraph 1.34, hereinafter, he shall indemnify and hold harmless the OWNER and all of its officers, agents and employees from and against all claims, damages, losses and expenses (including attorneys' fees) arising out of any infringement of such rights during or after completion of the work, and shall defend all such claims in connection with any alleged infringement of such rights.

1.34 RESPONSIBILITY FOR DAMAGE, CLAIMS, ETC.

The Contractor shall indemnify and save harmless the OWNER, the Engineer and sub consultants and all of their officers, agents and employees, from all claims, damages, losses and expenses including attorneys' fees of any character, name and description brought for, or on account of any injuries or damages received or sustained by any person, persons, or property by or from the said Contractor or by or in consequence of any neglect in safeguarding the Work or through the use of unacceptable materials used on construction or by or on account of any act or omission, neglect, or misconduct of the said Contractor or by or on account of any claims or amounts recovered from any infringement of patent, trademark or copyright, or from any claims or amounts arising or recovered under any law, ordinance, order, or decree, and so much of the money due the said Contractor under and by virtue of his Contract as shall be considered necessary by the OWNER may be retained for the use of the OWNER, or in case no money is due, his surety shall be held until such suit or suits, action or actions, claim or claims for injuries or damages as aforesaid, shall have been settled and suitable evidence to that effect furnished to the OWNER. Contractor shall

purchase public liability, workers compensation and automobile liability insurance, for OWNER'S protection in the amounts set forth in Paragraph 1.31.

In any and all claims against the OWNER or the Engineer, or any of their agents or employees, by any employee of the Contractor, and subcontractor, anyone directly or indirectly employed by any of them, or anyone for whose acts any of them may be liable, the indemnification obligation shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for the Contractor or any subcontractor under Workmen's Compensation acts, disability benefit acts or other employee benefit acts.

The obligation of the Contractor under this paragraph shall not extend to the liability of the Engineer, his agents or employees arising out of the preparation or approval of maps, Drawings, opinions, reports, surveys, Change Orders, designs or Specifications.

1.35 HANDLING AND DISTRIBUTION

The Contractor shall handle, haul, and distribute all materials and all surplus materials on the different portions of the Work, as necessary or required; shall provide suitable and adequate storage room for materials and equipment during the progress of the Work; and shall be responsible for the protection, loss of, or damage to materials and equipment furnished by him, until the final completion and acceptance of the Work.

Storage and demurrage charges by transportation companies and vendors shall be borne by the Contractor.

1.36 MATERIALS - SAMPLES - REVIEW

Unless otherwise expressly provided on the Drawings or in any of the other Contract Documents, only new materials and equipment shall be incorporated in the Work. All materials and equipment furnished by the Contractor to be incorporated in the Work shall be subject to the review of the Engineer. No material shall be processed or fabricated for the Work or delivered to the Work site without prior concurrence of the Engineer.

As soon as possible after execution of the Agreement, the Contractor shall submit to the Engineer the names and addresses of the manufacturers and suppliers of all materials and equipment he proposes to incorporate into the Work. When shop and working drawings are required as specified below, the Contractor shall submit prior to the submission of such drawings, data in sufficient detail to enable the Engineer to determine whether the manufacturer and/or the supplier have the ability to furnish a product meeting the Specifications. The Contractor shall also submit data relating to the materials and equipment he proposes to incorporate into the Work in sufficient detail to enable the Engineer to identify and evaluate the particular product and to determine whether it conforms to the Contract requirements. Such data shall be

submitted in a manner similar to that specified for submission of shop and working drawings.

The Contractor shall furnish facilities and labor for the storage, handling, and inspection of all materials and equipment. Defective materials and equipment shall be removed immediately from the site of the Work. If the Engineer so requires, either prior to or after commencement of the Work, the Contractor shall submit samples of materials for such special tests, as the Engineer deems necessary to demonstrate that they conform to the Specifications. Such samples, including concrete test cylinders, shall be furnished, taken, stored, packed, and shipped by the Contractor as directed. The Contractor shall furnish suitable molds for making concrete test cylinders.

All samples shall be packed so as to reach their destination in good condition, and shall be labeled to indicate the material represented, the name of the building or work and location for which the material is intended, and the name of the Contractor submitting the sample. To ensure consideration of samples, the Contractor shall notify the Engineer by letter that the samples have been shipped and shall properly describe the samples in the letter. The letter of notification shall be sent separate from and should not be enclosed with the samples.

The Contractor shall submit data and samples, or place his orders, sufficiently early to permit consideration, review and testing before the materials and equipment are needed for incorporation in the Work. The consequences of his failure to do so shall be the Contractor's sole responsibility.

In order to demonstrate the proficiency of workmen, or to facilitate the choice among several textures, types, finishes, surfaces, etc., the Contractor shall provide such samples of workmanship of wall, floor, finish, etc., as may be required.

When required, the Contractor shall furnish to the Engineer triplicate sworn copies of manufacturer's shop or mill tests (or reports from independent testing laboratories) relative to materials, equipment performance ratings, and concrete data.

After review of the samples, data, etc., the materials and equipment used on the Work shall in all respects conform therewith.

1.37 PAYMENT FOR MATERIALS STORED AT SITE OF PROJECT

Payment for materials or equipment purchased and stored at the site of the Project will be allowed by the OWNER at the cost of such materials or equipment, less the same percentage of retanage applicable to payment for completed work, upon specific recommendation of the Engineer. Such payment shall be conditional upon submission by the Contractor of bills of sale of such other procedure as will establish the OWNER'S title to such material or otherwise adequately protect the OWNER'S interest.

Only durable materials and equipment, which in the opinion of the Engineer have been properly stored and protected shall be included in materials, furnished in partial payment estimates. Clay pipe, brick and tile will be excluded. In the interest of simplification of checking and bookkeeping, miscellaneous supplies will also be excluded.

1.38 MATERIALS

- A. Materials, Domestic and Foreign Manufacture: Unless otherwise specified, only such non-manufactured articles, materials and supplies as have been mined or produced in the United States of America, and only such manufactured articles, materials and supplies as have been manufactured in the United States of America substantially all from articles, materials, or supplies mined, produced, or manufactured--as the case may be--in the United States of America, shall be employed under this Contract in the construction of the Project.
- B. Materials, Convict Manufacture: No materials manufactured or produced in a penal or correctional institution shall be incorporated in the Work under this Contract.

1.39 DEFECTIVE MATERIALS AND WORKMANSHIP

Materials brought to the site which are not in accordance with the Specifications shall be removed from the site of the Work by the Contractor at his own expense. Such material shall be so disposed of that there will be no probability of their being used on the work or in the construction.

Upon notice from the Engineer, the Contractor, at his own expense, shall immediately remedy all defective workmanship.

If the Contractor fails to remove defective materials or to correct defective workmanship within a reasonable time, fixed in the notice from the Engineer, the OWNER may remove the defective materials and/or correct the defective work and charge all the expense in connection therewith to the Contractor.

1.40 GUARANTY

The Contractor shall guarantee all materials and equipment furnished and Work performed for a period of one (1) year from the date of Substantial Completion. The Contractor warrants and guarantees for a period of one (1) year from the date of Substantial Completion of the system that the completed system is free from all defects due to faulty materials or workmanship and the Contractor shall promptly make such corrections as may be necessary by reason of such defects including the repairs of any damage to other parts of the system resulting from such defects. The OWNER will give notice of observed defects with reasonable promptness. In the

event that the Contractor should fail to make such repairs, adjustments, or other Work that may be made necessary by such defects, the OWNER may do so and charge the Contractor the cost thereby incurred. The Performance Bond shall remain in full force and effect through the guarantee period.

1.41 FIELD OFFICE

(NOT USED IN THIS CONTRACT)

1.42 SANITARY FACILITIES

The Contractor shall provide adequate sanitary facilities for the use of those employed on the Work. Such facilities shall be made available when the first employees arrive on the site of the Work, shall be properly secluded from public observation, and shall be constructed and maintained during the progress of the Work in suitable numbers and at such points and in such manner as may be required.

The Contractor shall maintain the sanitary facilities in a satisfactory and sanitary condition at all times and shall enforce their use. He shall rigorously prohibit the committing of nuisances on the site of the Work, on the lands of the OWNER, or on adjacent property.

1.43 EMPLOYMENT QUALIFICATIONS

No person under the age of eighteen (18) years and no convict labor shall be employed to perform any work under this Contract. No person whose age or physical condition is such as to make his employment dangerous to his health or safety or to the health or safety of others shall be employed to perform any work under this Contract, provided that this shall not operate against the employment of physically handicapped persons, otherwise employable, where such persons may be safely assigned to work which they can ably perform. There shall be no discrimination because of race, creed, color, sex or political affiliation in the employment of persons for work under this Contract.

1.44 EMPLOYMENT SERVICES AND LABOR PREFERENCES

(NOT USED IN THIS CONTRACT)

1.45 PAYMENT OF EMPLOYEES

The Contractor and each of his subcontractors shall pay each of his employees engaged in work on the Project in full (less deductions made mandatory by law) in cash or by check once each week.

1.46 SCHEDULES, REPORTS AND RECORDS

The Contractor shall submit to the OWNER such schedule of quantities and costs, progress schedules, payrolls, reports, estimates, records and other data as the OWNER may request concerning Work performed or to be performed.

When required, the Contractor shall furnish the OWNER with proof that all payrolls for services rendered and invoices for materials or equipment supplied have been duly paid. The Contractor shall provide all such other data as the Engineer and/or OWNER may require.

In connection with all lump sum contracts or lump sum portions of unit price contracts, the Contractor shall furnish the Engineer a detailed breakdown on which to base partial payment estimates. The detailed breakdown shall be subject to review by the Engineer.

The Contractor shall furnish and keep current a progress chart or schedule showing the estimated and actual progress of the Work. The progress chart or schedule shall be subject to review by the Engineer.

The Contractor shall furnish all the necessary information for and assist in the preparation of, and/or prepare the partial payment estimates on forms furnished by the Engineer.

1.47 PLANNING AND PROGRESS SCHEDULES

Before starting the Work and from time to time (at least once per month) during its progress, as the Engineer may request, the Contractor shall submit to the Engineer a written description of the methods he plans to use in doing the Work and the various steps he intends to take. Within fifteen (15) consecutive calendar days after the date of formal execution of the Agreement, the Contractor shall prepare and submit to the Engineer: (a) a written schedule fixing the dates on which additional drawings, if any, will be needed by the Contractor; and (b) a written schedule fixing the respective dates for the start and completion of various parts of the Work. Each such schedule shall be subject to review from time to time during the progress of the Work.

The Contractor shall also submit a schedule of payments that he anticipates he will earn during the course of the Work.

The OWNER, or his authorized representatives and agents, shall be permitted to inspect all payroll, records of personnel, invoices for materials or equipment and other relevant data and records.

For lump sum bid projects, the Progress Schedule shall contain at least 10 line items showing labor and material for each item and shall be made current and submitted as a part of the partial payment estimate. For unit price bid projects, the Bid Schedule shall contain all the unit price line items, however should the OWNER require additional

break-down of bid items, then the Contractor shall provide whatever the OWNER requests without change in the Contract price.

1.48 PAYMENTS BY CONTRACTOR

The Contractor shall pay: (a) for all transportation and utility services not later than the 20th day of the calendar month following the month in which such services are rendered; (b) for all materials, tools and other expendable equipment to the extent of ninety percent (90%) of the cost thereof, not later than the 20th day of the calendar month following the month in which such materials, tools and equipment are delivered at the site of the Project, and the balance of the cost thereof not later than the 30th day following completion of that part of the work in or on which such materials, tools and equipment are incorporated or used; and (c) to each of his subcontractors, not later than the 5th day following each payment to the Contractor, the respective amounts allowed the Contractor on account of the work performed by his subcontractors, to the extent of each subcontractor's interest therein.

1.49 FUNDS FOR PARTIAL PAYMENT ESTIMATES

The OWNER has provided funds for partial payment estimates so that they may be paid as set out herein. The Contractor must understand, however, that in handling the financing of such work, delays beyond the control of the OWNER are liable to occur in meeting the partial payments, and a reasonable delay on the part of the OWNER in making payment to the Contractor for any period shall not be construed as a breach of contract on the part of the OWNER.

1.50 PARTIAL PAYMENT ESTIMATES

On or about the 15th of each calendar month, the OWNER will make partial payment to the Contractor on the basis of a duly certified approved estimate of the Work performed during the preceding calendar month by the Contractor, but the OWNER will retain not more than ten percent (10%) of the amount of each estimate until final completion and acceptance of all Work covered by this Contract, subject to possible modification as set out hereinafter. After fifty percent (50%) of the Work has been completed, if the Engineer and the OWNER determines that the Contractor's performance and progress have been satisfactory, the OWNER may make the remaining partial (monthly) payments for the Work completed in full, thereby decreasing the retainage to five percent (5%) of the total Contract price upon completion but prior to acceptance.

The partial payment estimate shall be completed and signed by the Contractor and shall be supported by such data as the Engineer may reasonably require. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at or near the site, the partial payment estimate shall also be accompanied by such supporting data, satisfactory to the OWNER, as will establish

the OWNER'S title to the material and equipment and protect his interest therein, including applicable insurance. The Engineer will, within ten (10) consecutive calendar days after receipt of each partial payment estimate, either indicate in writing his approval of payment or present the partial payment estimate to the Contractor indicating in writing his reasons for refusing to approve payment. In the latter case, the Contractor may make the necessary corrections and resubmit the partial payment estimate. The OWNER will, within ten (10) consecutive calendar days of presentation to him of an approved partial payment estimate, pay the Contractor a progress payment on the basis on the approved partial payment estimate.

The request for payment may also include an allowance for the cost of such major materials and equipment, which are suitably stored either at or near the site.

All Work covered by partial payment made shall thereupon become the sole property of the OWNER, but this provision shall not be construed as relieving the Contractor of the sole responsibility for the care and protection of the Work upon which payments have been made or the restoration of any damaged Work, or as a waiver of the right of the OWNER to require the fulfillment of all terms of the Contract Documents.

Upon completion and acceptance of the Work, the Engineer shall issue a certificate attached to the final payment request that the Work has been accepted by him under the conditions of the Contract Documents. The entire balance found to be due the Contractor, including the retained percentages, but except such sums as may be lawfully retained by the OWNER, shall be paid to the Contractor within thirty (30) consecutive calendar days of completion and acceptance of the Work.

The Contractor will indemnify and save the OWNER and the OWNER'S agents harmless from all claims growing out of the lawful demands of subcontractors, laborers, workmen, mechanics, materialmen, and furnishers of machinery and parts thereof, equipment, tools, and all supplies, incurred in the furtherance of the performance of the Work. The Contractor shall, at the OWNER'S request, furnish satisfactory evidence that all obligations of the nature designated above have been paid, discharged, or waived. If the Contractor fails to do so the OWNER may, after having notified the Contractor, either pay unpaid bills or withhold from the Contractor's unpaid compensation a sum of money deemed reasonably sufficient to pay any and all such lawful claims until satisfactory evidence is furnished that all liabilities have been fully discharged whereupon payment to the Contractor shall be resumed, in accordance with the terms of the Contract Documents, but in no event shall the provisions of this sentence be construed to impose any obligations upon the OWNER to either the Contractor, his Surety, or any third party. In paying any unpaid bills of the Contractor, any payment so made by the OWNER shall be considered as a payment made under the Contract Documents by the OWNER to the Contractor and the OWNER shall not be liable to the Contractor for any such payments made in good faith.

If the OWNER fails to make payment thirty (30) consecutive calendar days after

approval by the Engineer, in addition to other remedies available to the Contractor, there shall be added to each such payment interest at the maximum legal rate commencing on the first day after said payment is due and continuing until the payment is received by the Contractor.

1.51 OWNER'S RIGHT TO WITHHOLD PAYMENTS

In order to protect the OWNER from loss, payment may be withheld which would otherwise be due the Contractor on account of:

- A. Defective work not remedied or defective materials not removed from site.
- B. Claims filed, or reasonable evidence indicating imminent filing of claims, against the Contractor.
- C. Failure of the Contractor to make payments properly to subcontractors or for material or labor.
- D. A reasonable doubt that the Contract can be completed for the balance then unpaid.
- E. Damage to another Contractor.
- F. Performance of work in violation of the terms of the Contract.
- G. Expiration of Contract time.

Should the OWNER withhold payment for any of the reasons listed in Article 1.51, the OWNER will provide written notice to the Contractor giving reason for withholding payment.

1.52 DEDUCTIONS FOR UNCORRECTED WORK

If the Engineer and OWNER deem it inexpedient to correct work damaged or not done in accordance with the Contract, a deduction from the Contract price may be negotiated.

1.53 PROTECTION OF WORK, PROPERTY AND PERSONS

The Contractor will be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. He shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to all employees on the Work and other persons who may be affected thereby, all the Work and all materials or equipment to be incorporated therein, whether in storage on or off the site, and other property at the site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways structures and utilities not designated for removal, relocation or replacement in the course of

construction.

The Contractor shall comply with all applicable laws, ordinances, rules, regulations and orders of any public body having jurisdiction. He shall erect and maintain, as required by the conditions and progress of the Work, all necessary safeguards for safety and protection. He shall notify owners of adjacent utilities when prosecution of the Work may affect them. The Contractor shall remedy all damage, injury or loss to any property caused, directly or indirectly, in whole or in part, by the Contractor, any subcontractor of anyone directly and indirectly employed by any of them or anyone for whose acts any of them be liable, except damage or loss attributable to the fault of the Contract Documents or to the acts or omissions of the OWNER or the Engineer or anyone employed by either of them or anyone for whose acts either of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of the Contractor.

In emergencies affecting the safety of persons or the Work or property at the site or adjacent thereto, the Contractor with special instruction or authorization from the Engineer or OWNER, shall act to prevent threatened damage, injury or loss. He shall give the Engineer prompt Written Notice of any significant changes in the Work or deviations from the Contract Documents caused thereby, and a Change Order shall thereupon be issued covering the changes and deviations involved.

1.54 WORK ON "PRIVATE PROPERTY"

Private property is defined as property other than that belonging to the OWNER.

Highway and railroad rights-of-way, public parks, schoolyards and other such properties shall be considered "private properties" for the purpose of this Paragraph.

In connection with water line, sewer line, gas line or similar work performed on "private property", the Contractor shall confine his equipment, the storage of materials and the operations of his workmen to the limits indicated on the Drawings, or to lands and rights-of-way provided for the Project by the OWNER, and shall take every precaution to avoid damage to the buildings, grounds and facilities of the owners' of private property.

Fences, walls, hedges, shrubs, etc., shall be carefully removed, preserved, and replaced when the construction is completed. Grassed areas, other than lawns, shall be graded, fertilized and seeded when construction is completed and in accordance with the requirements of the technical Specifications. Where ditches or excavations cross lawns, the sod shall be removed carefully and replaced when the backfilling has been completed. If sod is damaged or not handled properly, it shall be replaced with new sod equal to existing sod at the Contractor's expense. When construction is completed, the facilities and grounds of the private property owners shall be restored to as good or better condition than found as quickly as possible at the Contractor's expense.

When directed by the Engineer, large trees or other facilities that cannot be preserved and replaced shall be removed by the Contractor. The OWNER will assume the responsibility for settling with the property owner for the loss of said trees or facilities. The Contractor shall be solely and entirely responsible for any damage to all other trees or facilities.

Foundations, adjacent to where an excavation is to be made below the bottom of the foundation, shall be supported by shoring, bracing or underpinning as long as the excavation shall remain open, or thereafter if required to insure the stability of the foundation and the Contractor shall be held strictly responsible for any damage to said foundations.

1.55 LANDS FOR WORK

The OWNER will provide the lands upon which the work under this Contract is to be done or the necessary easements over said lands to include sufficient space for the proper execution of the work, together with right of access to same. The OWNER will provide the Contractor information, which delineates and describes the lands owned and rights-of-way acquired. The Contractor shall, at his own expense and without liability to the OWNER, provide land required for storage of his construction materials and for any temporary construction facilities for the storage of his equipment. The Contractor will construct at his own expense, any temporary roads or bridges necessary for his own use; he will also furnish his own power and water supply unless otherwise specifically set out herein.

1.56 INTERFERENCE WITH AND PROTECTION OF STREETS

The Contractor shall not close or obstruct any portion of a street, road, or private way without obtaining permits therefore from the proper authorities. If any street, road or private way shall be rendered unsafe by the Contractor's operations, he shall make such repairs or provide such temporary ways or guards as shall be acceptable to the proper authorities.

Streets, roads, private ways, and walks not closed shall be maintained passable and safe by the Contractor, who shall assume and have full responsibility for the adequacy and safety of provisions made therefore.

The Contractor shall, at least twenty-four (24) hours in advance, notify the Police and Fire Departments in writing, with a copy to the Engineer, if the closure of a street or road is necessary. He shall cooperate with the Police Department in the establishment of alternate routes and shall provide adequate detour signs, plainly marked and well lighted, in order to minimize confusion.

All excavated materials and equipment to be incorporated in the Work shall be placed

so as not to injure any part of the Work or existing facilities and so that free access can be had at all times to all parts of the Work and to all public utility installations in the vicinity of the Work. Materials and equipment shall be kept neatly piled and compactly stored in such locations as will cause a minimum of inconvenience to public travel and adjoining owners, tenants and occupants.

1.57 EXISTING UTILITIES

Special precautions shall be taken by the Contractor to avoid damage to existing overhead and underground utilities owned and operated by the OWNER or by public or private utility companies.

The location of existing underground utilities is *sometimes* shown on the Drawings. When utilities are shown, it is believed that the locations are reasonably correct but neither the Engineer nor the OWNER can guarantee the accuracy or adequacy of the information presented. Before proceeding with the Work, the Contractor shall confer with all public or private companies, agencies or departments that own and operate utilities in the vicinity of the Construction Work. The purpose of the conference, or conferences, shall be to notify said companies, agencies or departments of the proposed construction schedule, verify the location of, and possible interference with, the existing utilities that are shown on the Drawings, arrange for necessary suspension of service, and make arrangements to locate and avoid interference with all utilities (including house connections) that are not shown on the Drawings. The Engineer and OWNER have no objection to the Contractor arranging for the said utility companies, agencies, or departments to locate and uncover their own utilities; however, the Contractor shall bear the entire responsibility and cost for locating and avoiding, or repairing, damage to said existing utilities.

The Contractor shall locate all unknown metallic hazards, namely buried pipe, metals, etc., by using a pipe locator. The pipe locator shall immediately precede the trench ditching and all hazards located shall be marked in such a manner as to notify the machine operator of such hazard.

Where existing utilities or appurtenant structures, either underground or aboveground, are encountered, they shall not be displaced or molested unless necessary, and in such case shall be replaced in as good or better condition than found as quickly as possible. Relocation and/or replacement of all utilities and appurtenant structures to accommodate the construction work shall be at the Contractor's expense, unless such relocation and/or replacement is by statute or agreement the responsibility of the owner of the utility.

1.58 ARBITRATION

- A. Request for Arbitration: Any decision of the Engineer, which is subject to arbitration, may be submitted to arbitration only upon agreement of both parties to the dispute.

The Contractor shall not cause a delay of the Work because of pending arbitration proceedings, except with the written permission of the Engineer, and then only until the arbitrators shall have had an opportunity to determine whether or not the Work shall continue until they decide the matters in dispute.

The request for arbitration shall be delivered in writing to the Engineer and the adverse party, either personally or by registered mail to the last known address of each, within ten (10) consecutive calendar days of the receipt of the Engineer's decision, and in no case after final payment has been accepted except as otherwise expressly stipulated in the Contract Documents. If the Engineer fails to make a decision within a reasonable time, a request for arbitration may be made as if his decision has been rendered against a requesting party.

- B. Arbitrator: No one shall be nominated or act as an arbitrator who is in any way financially interested in this Contract or in the business affairs of the OWNER, or the Contractor, or the Engineer or otherwise connected with any of them. Each arbitrator shall be a person in general familiar with the work or the problem involved in the dispute submitted to arbitration, preferably a recognized Engineer, experienced in the type of construction in question.

Unless otherwise provided by controlling statutes, the parties may agree upon one arbitrator; otherwise there shall be three, one named in writing by each party to this Contract, and a third chosen by these two arbitrators, or, if they should fail to select a third within fifteen (15) consecutive calendar days, then he shall be appointed by the presiding officer, if a disinterested party, of the Bar Association nearest to the location of the Work. Should the party requesting arbitration fail to name an arbitrator within ten (10) consecutive calendar days and upon his failure to do so then such arbitrator shall be appointed, on the petition of the party requesting arbitration, by a judge of the Federal Court in the District where such arbitration is to be held.

The said presiding officer shall have the power to declare the position of any arbitrator vacant by reason of refusal or inability to act, sickness, death, resignation, absence or neglect. Any vacancy shall be filled by the party making the original appointment, and unless so filled within five (5) consecutive calendar days after the same has been declared vacant, it shall be filled by the said presiding officer. If testimony has been taken before the presiding officer has filled a vacancy, the matter must be reheard unless a rehearing is waived in the submission or by the written consent of the parties. If there be one arbitrator, his decision shall be binding; if three, the decision of any two shall be binding in respect to both the matters submitted and the procedure followed during the arbitration.

- C. Arbitration Procedure: The arbitrators shall deliver a written notice to each of the parties and to the Engineer, either personally or by registered mail to the last known address of each, of the time and place for the beginning of the hearing of the matters

submitted to them. Each party may submit to the arbitrators such evidence and argument as he may desire and the arbitrators may consider pertinent. The arbitrators shall, however, be the judge of all matters of law and fact relating to both the subject matter of and the procedure during arbitration and shall not be bound by technical rules of law or procedure. They may hear evidence in whatever form they desire. The parties may be represented before them by such person or persons as each may select, subject to the disciplinary power of the arbitrators if such representative shall not interfere with the orderly or speedy conduct of the proceedings.

Each party and the Engineer shall supply the arbitrators with such papers and information as they may request, or with any witness whose movements are subject to the respective control, and upon refusal to comply with such requests, the arbitrators may render their decision without the evidence which might have been elicited there from and the absence of such evidence shall afford no ground for challenge of the award by the party refusing or neglecting to comply with such demand.

The submission to arbitrators (the statement of the matters in dispute between the parties to be passed upon by the arbitrators) shall be in writing duly acknowledged before a notary. Unless waived in writing by both parties to the arbitration, the arbitrators, before hearing testimony, shall be sworn by an officer authorized by law to administer an oath, to faithfully and fairly hear and examine the matters in controversy and to make a just award according to the best of their understanding.

The arbitrators, if they deem the case demands it, are authorized to award to the party whose contention is sustained such sums as they shall consider proper for the time, expense and trouble incident to the arbitration, and if the arbitration was requested without reasonable cause, damages for delay and other losses. The arbitrators shall fix their own compensation, unless otherwise provided by agreement, and shall assess the costs and charges of the arbitration upon either or both parties.

The award of the arbitrators shall be in writing and acknowledged like a deed to be recorded, and a duplicate shall be delivered personally or by registered mail, forthwith upon its rendition, to each of the parties to the controversy and to the Engineer. Judgment may be rendered upon the award by the Federal Court or the highest State Court having jurisdiction to render same.

The award of the arbitrators shall not be open to objection on account of the form of proceedings or the award, unless otherwise provided by controlling statutes. In the event such statutes provide otherwise on any matter covered by this Article than hereinbefore specified, the method procedure throughout and the legal effect of the award shall be wholly in accord with said statutes, it being the intention hereby to lay down a principle of action to be followed, leaving its local application to be adapted to the legal requirements of the jurisdiction having authority over the arbitration. The Engineer shall not be deemed a party to the dispute. He is given the right to appear before the arbitrators to explain the basis of his decision and give such evidence as

they may require.

1.59 ALTERATION IN DRAWINGS AND SPECIFICATIONS

The OWNER reserves the right to make such alteration in the Drawings and Specifications or in the character of the Work as may be considered by the Engineer necessary or desirable from time to time to complete the Project in an acceptable manner; provided that, if alterations are made, the general character of the Work as a whole is not changed thereby.

Such alterations shall not be considered as a waiver of any condition of the Contract nor to invalidate any of the provisions nor to release the bond thereof.

1.60 CHANGES IN THE WORK

The OWNER may make changes in the work of the Contractor by making alterations therein, or by making additions thereto, or by omitting work there from, without invalidating the Contract, and without relieving or releasing the Contractor from any guarantee given by him pursuant to the Contract provisions, and without affecting the validity of the guaranty bonds, and without relieving or releasing the surety or sureties of said bonds. All such changes shall be in the form of a Change Order issued by the Engineer, and executed by the OWNER and Contractor, under the conditions of the original Contract.

Except in an emergency endangering life or property, no change shall be made by the Contractor unless in pursuance of a written Change Order. No claim for an adjustment of the Contract price or time shall be valid unless so ordered.

The Engineer, also, may at any time, by issuing a field order, make changes in the details of the Work. The Contractor shall proceed with the performance of any changes in the Work so ordered by the Engineer unless the Contractor believes that such field order entitles him to a change in Contract price or time, or both, in which event he shall give the Engineer written notice thereof within fifteen (15) consecutive calendar days after the receipt of the ordered change, and the Contractor shall not execute such changes pending the receipt of an executed Change Order or further instruction from the OWNER.

Should the Contractor encounter or discover during the progress of the Work subsurface or latent conditions at the site materially differing from those shown on the Drawings or indicated in the Specifications, the attention of the Engineer shall immediately be called to such conditions before they are disturbed. If the Engineer finds that they so materially differ, he will at once make such changes in the Drawings or Specifications as he may find necessary. Any adjustment in the Contract price or time as may be justifiable shall be made by means of a written change order as provided herein.

1.61 CLAIMS FOR EXTRA WORK

If the Contractor claims that any instructions by Drawings or otherwise involve extra cost, he shall give the Engineer written notice of said claim within ten (10) consecutive calendar days after the receipt of such instructions, and in any event before proceeding to execute the Work, stating clearly and in detail the basis of his claim or claims. No such claim shall be valid unless so made.

Claims for additional compensation for extra work, due to alleged errors in spot elevations, contour lines, or bench marks, will not be recognized unless accompanied by certified survey data, made prior to the time the original ground was disturbed, clearly showing that errors exist which resulted, or would result, in handling more material, or performing more work than would reasonably be estimated from the Drawings and topographical maps issued.

Any discrepancies which may be discovered between actual conditions and those represented by the topographical maps and Drawings shall at once be reported to the Engineer, and Work shall not proceed, except at the Contractor's risk, until written instructions have been received by him from the Engineer.

If, on the basis of the available evidence, the Engineer determines that an adjustment of the Contract price or time is justifiable, the procedure shall then be as provided herein for "Changes in the Work".

By execution of this Contract, the Contractor warrants that he has visited the site of the proposed work and fully acquainted himself with the conditions there existing relating to construction and labor, and that he fully understands the facilities, difficulties, and restrictions attending the execution of the work under this Contract. The Contractor further warrants that he has thoroughly examined and is familiar with the Drawings, Specifications and all other documents comprising the Contract. The Contractor further warrants that by execution of this Contract his failure when he was bidding on this Contract to receive or examine any form, instrument or document, or to visit the site and acquaint himself with conditions there existing, in no way relieves him from any obligation under the Contract, and the Contractor agrees that the OWNER shall be justified in rejecting any claim based on facts regarding which he should have been on notice as a result thereof.

1.62 DETERMINATION OF THE VALUE OF EXTRA (ADDITIONAL) OR OMITTED WORK

The value of extra (additional) or omitted work shall be determined in one or more of the following ways:

- A. On the basis of the actual cost of all the items of labor (including on-the-job

supervision), materials, and use of equipment, plus fifteen percent (15%) which shall cover the Contractor's general supervision, overhead and profit. In case of subcontracts, the fifteen percent (15%) is interpreted to mean the subcontractor's supervision, overhead and profit, and an additional five percent (5%) may then be added to such costs to cover the Contractor's supervision, overhead and profit. The cost of labor shall include required insurance, taxes and fringe benefits. Equipment costs shall be based on current rental rates in the areas where the work is being performed but, in no case shall such costs be greater than the current rates published by the Associated Equipment Distributors, Chicago, IL.

- B. By estimate and acceptance in a lump sum.
- C. By unit prices named in the Contract or subsequently agreed upon. Provided, however, that the cost or estimated cost of all extra (additional) work shall be determined in advance of authorization by the Engineer and approved by the OWNER.

All extra (additional) work shall be executed under the conditions of the original Contract. Any claim for extension of time shall be adjusted according to the proportionate increase or decrease in the final total cost of the work unless negotiated on another basis.

Except for over-runs in Contract unit price items, no extra (additional) work shall be done except upon a written change order from the Engineer, and no claim on the part of the Contractor for pay for extra (additional) work shall be recognized unless so ordered in writing by the Engineer.

1.63 SEPARATE CONTRACTS

The OWNER reserves the right to let other contracts in connection with this Work. The Contractor shall afford other contractors reasonable opportunity for ingress, egress, storage of their materials, the execution of their work, and shall properly connect and coordinate his work with theirs. The respective rights of various interests involved shall be established by the Engineer to secure proper completion of the various portions of the Work.

If the proper execution or results of any part of the Contractor's Work depends upon the work of any other Contractor, the Contractor shall inspect and promptly report to the Engineer any defects in such work that render it unsuitable for such proper execution and results.

1.64 OWNER'S RIGHT TO DO WORK

If the Contractor should neglect or fail to prosecute the Work properly or fail or refuse to perform any provision of the Contract, the OWNER, after ten (10) consecutive calendar days written notice to the Contractor, may without prejudice to any other

remedy he may have, make good such deficiencies and may deduct the cost thereof from any monies due or which may thereafter become due to the Contractor.

1.65 SUSPENSION OF WORK

The OWNER shall have authority to suspend the Work in whole or in part by giving five (5) consecutive calendar days notice to the Contractor in writing. The written notice shall fix the date on which the Work shall be resumed, and the Contractor shall resume the Work on the date so fixed. The OWNER shall reimburse the Contractor for expenses incurred by him in connection with the Work under this Contract as a result of suspension if the suspension of the Work is caused through no fault of the Contractor himself.

1.66 RIGHT OF OWNER TO TERMINATE CONTRACT

If the Contractor fails to begin the Work under the Contract within the specified time, or fails to perform the Work with sufficient workmen and equipment or with sufficient materials to insure the prompt completion of said Work within the specified time, or shall, in the opinion of the Engineer, perform the Work improperly, or shall neglect or refuse to remove materials or perform anew such Work as shall be rejected as defective or unsuitable or shall be stopped by court order resulting from injunctive action, or shall become insolvent or be declared bankrupt or commit any act of bankruptcy or insolvency, or allow any final judgment to stand against him unsatisfied for a period of five (5) consecutive calendar days, or shall fail or refuse to remove within forty-eight (48) hours after receipt of proper notice, any employee or person engaged in work under the Contract, or shall make an assignment for the benefit of creditors or from any other cause whatsoever shall not carry out the Work in an acceptable manner, the OWNER shall give notice in writing to the Contractor and his surety, of such delay, neglect, or default, specifying the same, and if the Contractor within a period of ten (10) consecutive calendar days after such notice shall not proceed in accordance therewith, then the OWNER shall, upon written certificate from the Engineer of the face of such delay, neglect or default, and the Contractor's failure to comply with such notice, have full power and authority without violating the Contract to terminate the Contractor's right to proceed with the Work, to take over the prosecution of the work of said Contractor, to appropriate or use any and all materials and equipment on the ground as may be suitable and acceptable, and may enter into an agreement for the completion of said Contract according to the terms and provisions thereof, and use such other methods as in the OWNER'S opinion shall be required for the completion of said Contract in an acceptable manner. All costs and charges incurred by the OWNER, together with the costs of completing the work under Contract, shall be deducted from any monies due or which may become due said Contractor. In case the expense so incurred by the OWNER shall be less than the sum which would have been payable under the Contract, if it had been completed by said Contractor, then the Contractor shall be entitled to receive the difference, and in case such expense shall exceed the sum which would have been payable under the Contract,

then the Contractor and/or his surety shall be liable and shall pay to the OWNER the amount of said excess.

After ten (10) consecutive calendar days from delivery of a Written Notice to the Contractor and the Engineer, the OWNER may, without cause and without prejudice to any other right or remedy, elect to abandon the Project and terminate the Contract. In such case, the Contractor shall be paid for all Work executed and any expense sustained plus reasonable profit.

1.67 CONTRACTOR'S RIGHT TO STOP WORK OR TERMINATE CONTRACT

If the Work shall be stopped under an order of any court, or other public authority, for a period of three (3) months, through no fault of the Contractor or of anyone employed by him, or if the Engineer should fail to issue any estimate of payment within thirty (30) consecutive calendar days after it is due, or if the OWNER shall fail to pay the Contractor within thirty (30) consecutive calendar days of its maturity and presentation of any sum certified by the Engineer or award by arbitrators, then the Contractor may, upon fifteen (15) consecutive calendar days written notice to the OWNER and the Engineer, terminate this Contract and recover from the OWNER payment for all work executed, plus loss sustained upon any plant or materials, plus reasonable profit and damages.

In addition and in lieu of terminating the Contract, if the Engineer has failed to make any payment as aforesaid, the Contractor may upon ten (10) consecutive calendar days notice to the OWNER and the Engineer stop the Work until he has been paid all amounts then due, in which event and upon resumption of the Work, Change Orders shall be issued for adjusting the Contract price or extending the Contract time or both to compensate for the costs and delays attributable to the stoppage of the Work.

1.68 USING COMPLETED PORTION OF WORK

The OWNER shall have the right to take possession of and use any completed portion or portions of the Work even though the time of completing the entire work or such portions may not have expired. The possession and use by the OWNER shall not be deemed an acceptance of any work not completed in accordance with the Contract. If such prior use increases the cost of or delays the Work, the Contractor shall be entitled to such extra compensation, or extension of time, or both as the Engineer may determine. The use by the OWNER of any portion of the Work shall release the Contractor from his Builders Risk Insurance covering such portion used.

1.69 ACCEPTANCE AND FINAL PAYMENT

Upon written notice from the Contractor that the work is ready for final inspection, the Engineer will make such a review and subsequent reviews as required. When, in the Engineer's opinion, the Work is acceptable under the Contract, he will promptly issue

a Certificate of Acceptance.

Upon acceptance of the Work by the OWNER, the balance due the Contractor including the percentage retained during the construction period, will then be paid in approximately sixty (60) consecutive calendar days, and said final payment shall evidence the OWNER'S acceptance of the Work unless the OWNER has made acceptance or partial acceptance thereof in writing prior to said final payment.

Before the OWNER makes final payment, the Contractor shall submit to the OWNER a final release, as described hereinafter, stating that all payrolls, material bills, subcontractors, and other indebtedness connected with the Work have been paid and providing for handling claims that may be outstanding or that may arise after the settlement.

Any payment, however, final or otherwise, shall not release the Contractor or his sureties from any obligations under the Contract Documents or the Performance Bond and Payment Bond.

1.70 CONTRACTOR'S FINAL RELEASE

Before the OWNER pays the Contractor his final payment on the Work, the Contractor will be required to sign a final release as set out hereinbefore. This final release shall be notarized and shall state that all claims against the OWNER on the Contractor's part have been met in full; it shall further state that all accounts for labor performed, materials furnished, liens, judgments and claims of every nature against the Contractor have been satisfied by him. It shall further state that any obligation or lawsuit whatsoever arising from the Contractor's operations on the Project, which may be presented or filed after the settlement, shall be borne by the Contractor. In case the Contractor is unable to settle any claim that may be in dispute or litigation, the OWNER may allow him to furnish a proper bond to indemnify the OWNER against the claim and then release the final payment to him.

It is understood that the Contractor is to guarantee to the OWNER all construction against defective materials, equipment and workmanship for a period of twelve (12) months after acceptance, and shall take immediate steps to correct or replace such defective materials, equipment or workmanship without cost to the OWNER.

1.71 FINAL CLEAN UP

The Work will not be considered as completed, and final payment will not be made, until all final clean up has been done by the Contractor in a manner satisfactory to the Engineer.

END OF SECTION 00700

SUPPLEMENTAL GENERAL CONDITIONS

FOR

CLEAN WATER STATE REVOLVING FUND

DRINKING WATER STATE REVOLVING FUND

(Drinking Water and Wastewater)

Project Name: London Water Treatment Plant Improvements

Project Number: WX21125024

KIA Number: F22-015

The attached instructions and regulations as listed below shall be incorporated into the Specifications and comprise Special Conditions.

	<u>Attachment No.</u>
SRF Special Provisions	1
KRS Chapter 45A Kentucky Model Procurement Code	2
Equal Employment Opportunity (EEO) Documents:	
Notice of Requirement for Affirmative Action	3
Construction Contract Specifications	4
EEO Goals for Region 4 Economic Areas	5
Check List of EEO Documentation for Bidders	6
Employer Information Report EEO-1 (SF 100)	7
Labor Standards Provisions for Federally Assisted Construction	8
Certifications:	
Debarment, Suspension and Other Responsibility Matters	9
Anti-lobbying	10
Disadvantaged Business Enterprise (DBE) Program	11
Bonds and Insurance	12
Storm Water General Permit	13
Davis-Bacon Wage Rate Requirements	14
American Iron and Steel Requirement	15

SRF SPECIAL PROVISIONS

- (a) Line crossings of all roads and streets shall be done in accordance with the Kentucky Transportation Cabinet requirements as may be set forth in the Special Conditions.
- (b) Construction is to be carried out so as to prevent by-passing of flows during construction unless a schedule has been approved by the State or EPA, whichever is applicable. Siltation and soil erosion must be minimized during construction. All construction projects with surface disturbance of more than 1 acre during the period of construction must have a KPDES Storm Water General Permit. The permit can be found at this [webpage](#).

If you have any questions regarding the completion of this form call the Surface Water Permits Branch at (502) 564-3410.
- (c) Restore disturbed areas to original or better condition.
- (d) Use of Chemicals: All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant or of other classification, must show approval of either DOW or EPA. Use of all such chemicals and disposal of residues shall be in conformance with instructions on the manufacturer's label.
- (e) The construction of the project, including the letting of contracts in connection therewith, shall conform to the applicable requirements of state, territorial, and local laws and ordinances to the extent that such requirements do not conflict with Federal laws and this subchapter.
- (f) The owner shall provide and maintain competent and adequate supervision and inspection.
- (g) The Kentucky Infrastructure Authority and Kentucky Division of Water shall have access to the site and the project work at all times.
- (h) In the event Archaeological materials (arrowheads, stone tools, stone axes, prehistoric and historic pottery, bottles, foundations, Civil War artifacts, and other types of artifacts) are uncovered during the construction of this project, work is to immediately cease at the location and the Kentucky Heritage Council shall be contacted. The telephone number is (502) 564-7005. Construction shall commence at this location until a written release is received from the Kentucky Heritage Council. Failure to report a find could result in legal action.
- (i) This procurement will be subject to DOW Procurement Guidance including the Davis-Bacon Act.
- (j) Reasonable care shall be taken during construction to avoid damage to vegetation. Ornamental shrubbery and tree branches shall be temporarily tied back, where appropriate, to minimize damage. Trees which receive damage to branches shall be trimmed of those branches to improve the appearance of the tree. Tree trunks receiving damage from equipment shall be treated with a tree dressing.
- (k) No wastewater bypassing will occur during construction unless a schedule has been approved by the Kentucky Division of Water.
- (l) Change orders to the construction contract (if required) must be negotiated pursuant to DOW/KIA Procurement Guidance for Construction and Equipment Contracts.

KRS CHAPTER 45A
KENTUCKY MODEL PROCUREMENT CODE

45A.075 Methods of awarding state contracts.

Except as otherwise authorized by law, all state contracts shall be awarded by:

- (1) Competitive sealed bidding, pursuant to KRS 45A.080; or
- (2) Competitive negotiation, pursuant to KRS 45A.085 and 45A.090 or 45A.180; or
- (3) Noncompetitive negotiation, pursuant to KRS 45A.095; or
- (4) Small purchase procedures, pursuant to KRS 45A.100.

Effective: June 24, 2003

History: Amended 2003 Ky. Acts ch. 98, sec. 4, effective June 24, 2003. -- Created 1978 Ky. Acts ch. 110, sec. 16, effective January 1, 1979.

45A.080 Competitive sealed bidding.

(1) Contracts exceeding the amount provided by KRS 45A.100 shall be awarded by competitive sealed bidding, which may include the use of a reverse auction, unless it is determined in writing that this method is not practicable. Factors to be considered in determining whether competitive sealed bidding is not practicable shall include:

- (a) Whether specifications can be prepared that permit award on the basis of best value; and
- (b) The available sources, the time and place of performance, and other relevant circumstances as are appropriate for the use of competitive sealed bidding.

(2) The invitation for bids shall state that awards shall be made on the basis of best value. In any contract which is awarded under an invitation to bid which requires delivery by a specified date and imposes a penalty for late delivery, if the delivery is late, the contractor shall be given the opportunity to present evidence that the cause of the delay was beyond his control. If it is the opinion of the purchasing officer that there is sufficient justification for delayed delivery, the purchasing officer may adjust or waive any penalty that is provided for in the contract.

(3) Adequate public notice of the invitation for bids and any reverse auction shall be given a sufficient time prior to the date set forth for the opening of bids or beginning of the reverse auction. The notice may include posting on the Internet or publication in a newspaper or newspapers of general circulation in the state as determined by the secretary of the Finance and Administration Cabinet not less than seven (7) days before the date set for the opening of the bids and any reverse auction. The provisions of this subsection shall also apply to price contracts and purchase contracts of state institutions of higher education.

(4) Bids shall be opened publicly or entered through a reverse auction at the time and place designated in the invitation for bids. At the time the bids are opened, or the reverse auction has ended, the purchasing agency shall announce the agency's engineer's estimate, if applicable, and make it a part of the agency records pertaining to the letting of any contract for which bids were received. Each written or reverse auction bid, together with the name of the bidder and the agency's engineer's estimate, shall be recorded and be open to public inspection. Electronic bid opening and posting of the required information for public viewing shall satisfy the requirements of this subsection.

(5) The contract shall be awarded by written notice to the responsive and responsible bidder whose bid offers the best value.

(6) Correction or withdrawal of written or reverse auction bids shall be allowed only to the extent permitted by regulations issued by the secretary.

Effective: July 15, 2010

History: Amended 2010 Ky. Acts ch. 63, sec. 3, effective July 15, 2010. -- Amended 2000 Ky. Acts ch. 509, sec. 1, effective July 14, 2000. -- Amended 1998 Ky. Acts ch. 120, sec. 10, effective July 15, 1998. -- Amended 1997 (1st Extra. Sess.) Ky. Acts ch. 4, sec. 27, effective May 30, 1997. -- Amended 1996 Ky. Acts ch. 60, sec. 2, effective July 15, 1996. -- Amended 1994 Ky. Acts ch. 278, sec. 1, effective July 15, 1994. -- Amended 1982 Ky. Acts ch. 282, sec. 1, effective July 15, 1982. -- Amended 1979 (1st Extra. Sess.) Ky. Acts ch. 9, sec. 1, effective February 10, 1979. -- Created 1978 Ky. Acts ch. 110, sec. 17, effective January 1, 1979.

45A.085 Competitive negotiation.

- (1) When, under administrative regulations promulgated by the secretary or under KRS 45A.180, the purchasing officer determines in writing that the use of competitive sealed bidding is not practicable, and except as provided in KRS 45A.095 and 45A.100, a contract may be awarded by competitive negotiation, which may include the use of a reverse auction.
- (2) Adequate public notice of the request for proposals and any reverse auction shall be given in the same manner and circumstances as provided in KRS 45A.080(3).
- (3) Contracts other than contracts for projects utilizing an alternative project delivery method under KRS 45A.180 may be competitively negotiated when it is determined in writing by the purchasing officer that the bids received by competitive sealed bidding either are unreasonable as to all or part of the requirements, or were not independently reached in open competition, and for which each competitive bidder has been notified of the intention to negotiate and is given reasonable opportunity to negotiate.
- (4) Contracts for projects utilizing an alternative project delivery method shall be processed in accordance with KRS 45A.180.
- (5) The request for proposals shall indicate the relative importance of price and other evaluation factors, and any reverse auction procedures.
- (6) Award shall be made to the responsible and responsive offeror whose proposal is determined in writing to be the most advantageous to the Commonwealth, taking into consideration price and the evaluation factors set forth in the request for proposals and the reciprocal preference for resident bidders required under KRS 45A.494.
- (7) Written or oral discussions shall be conducted with all responsible offerors who submit proposals determined in writing to be reasonably susceptible of being selected for award. Discussions shall not disclose any information derived from proposals submitted by competing offerors. Discussions need not be conducted:
 - (a) With respect to prices, where the prices are fixed by law, reverse auction, or administrative regulation, except that consideration shall be given to competitive terms and conditions;
 - (b) Where time of delivery or performance will not permit discussions; or
 - (c) Where it can be clearly demonstrated and documented from the existence of adequate competition or prior experience with the particular supply, service, or construction item, that acceptance of an initial offer without discussion would result in fair and reasonable best value procurement, and the request for proposals notifies all offerors of the possibility that award may be made on the basis of the initial offers.

Effective: July 15, 2010

History: Amended 2010 Ky. Acts ch. 63, sec. 4, effective July 15, 2010; and ch. 162, sec. 8, effective July 15, 2010. -- Amended 2003 Ky. Acts ch. 98, sec. 5, effective June 24, 2003. -- Amended 1997 (1st Extra. Sess.) Ky. Acts ch. 4, sec. 28, effective May 30, 1997. -- Amended 1979 (1st Extra. Sess.) Ky. Acts ch. 9, sec. 2, effective February 10, 1979. -- Created 1978 Ky. Acts ch. 110, sec. 18, effective January 1, 1979.

45A.090 Negotiation after competitive sealed bidding when all bids exceed available funds.

- (1) In the event that all bids submitted pursuant to competitive sealed bidding under KRS 45A.080 result in bid prices in excess of the funds available for the purchase, and the chief purchasing officer determines in writing:
 - (a) That there are no additional funds available from any source so as to permit an award to the responsive and responsible bidder whose bid offers the best value; and
 - (b) The best interest of the state will not permit the delay attendant to a resolicitation under revised specifications, or for revised quantities, under competitive sealed bidding as provided in KRS 45A.080, then a negotiated award may be made as set forth in subsections (2) or (3) of this section.
- (2) Where there is more than one (1) bidder, competitive negotiations pursuant to KRS 45A.085(3) shall be conducted with the three (3) (two (2) if there are only two (2)) bidders determined in writing to be the most responsive and responsible bidders, based on criteria contained in the bid invitation and the reciprocal preference for resident bidders under KRS 45A.494. Such competitive negotiations shall be conducted under the following restrictions:
 - (a) If discussions pertaining to the revision of the specifications or quantities are held with any potential offeror, all other potential offerors shall be afforded an opportunity to take part in such discussions; and

(b) A request for proposals, based upon revised specifications or quantities, shall be issued as promptly as possible, shall provide for an expeditious response to the revised requirements, and shall be awarded upon the basis of best value.

(3) Where, after competitive sealed bidding, it is determined in writing that there is only one (1) responsive and responsible bidder, a noncompetitive negotiated award may be made with such bidder in accordance with KRS 45A.095.

Effective: July 15, 2010

History: Amended 2010 Ky. Acts ch. 162, sec. 9, effective July 15, 2010. -- Amended 2003 Ky. Acts ch. 98, sec. 6, effective June 24, 2003. -- Amended 1997 (1st Extra. Sess.) Ky. Acts ch. 4, sec. 29, effective May 30, 1997. -- Created 1978 Ky. Acts ch. 110, sec. 19, effective January 1, 1979.

45A.095 Noncompetitive negotiation.

(1) A contract may be made by noncompetitive negotiation only for sole source purchases, or when competition is not feasible, as determined by the purchasing officer in writing prior to award, under administrative regulations promulgated by the secretary of the Finance and Administration Cabinet or the governing boards of universities operating under KRS Chapter 164A, or when emergency conditions exist. Sole source is a situation in which there is only one (1) known capable supplier of a commodity or service, occasioned by the unique nature of the requirement, the supplier, or market conditions. Insofar as it is practical, no less than three (3) suppliers shall be solicited to submit written or oral quotations whenever it is determined that competitive sealed bidding is not feasible. Award shall be made to the supplier offering the best value. The names of the suppliers submitting quotations and the date and amount of each quotation shall be placed in the procurement file and maintained as a public record. Competitive bids may not be required:

(a) For contractual services where no competition exists, such as telephone service, electrical energy, and other public utility services;

(b) Where rates are fixed by law or ordinance;

(c) For library books;

(d) For commercial items that are purchased for resale;

(e) For interests in real property;

(f) For visiting speakers, professors, expert witnesses, and performing artists;

(g) For personal service contracts executed pursuant to KRS 45A.690 to 45A.725; and

(h) For agricultural products in accordance with KRS 45A.645.

(2) The chief procurement officer, the head of a using agency, or a person authorized in writing as the designee of either officer may make or authorize others to make emergency procurements when an emergency condition exists.

(3) An emergency condition is a situation which creates a threat or impending threat to public health, welfare, or safety such as may arise by reason of fires, floods, tornadoes, other natural or man-caused disasters, epidemics, riots, enemy attack, sabotage, explosion, power failure, energy shortages, transportation emergencies, equipment failures, state or federal legislative mandates, or similar events. The existence of the emergency condition creates an immediate and serious need for services, construction, or items of tangible personal property that cannot be met through normal procurement methods and the lack of which would seriously threaten the functioning of government, the preservation or protection of property, or the health or safety of any person.

(4) The Finance and Administration Cabinet may negotiate directly for the purchase of contractual services, supplies, materials, or equipment in bona fide emergencies regardless of estimated costs. The existence of the emergency shall be fully explained, in writing, by the head of the agency for which the purchase is to be made. The explanation shall be approved by the secretary of the Finance and Administration Cabinet and shall include the name of the vendor receiving the contract along with any other price quotations and a written determination for selection of the vendor receiving the contract. This information shall be filed with the record of all such purchases and made available to the public. Where practical, standard specifications shall be followed in making emergency purchases. In any event, every effort should be made to effect a competitively established price for purchases made by the state.

Effective: July 15, 2002

History: Amended 2002 Ky. Acts ch. 344, sec. 9, effective July 15, 2002. -- Amended 1997 (1st Extra. Sess.) Ky. Acts ch. 4, sec. 30, effective May 30, 1997. -- Amended 1990 Ky. Acts ch. 496, sec. 4, effective July 13, 1990. -- Created 1978 Ky. Acts ch. 110, sec. 20, effective January 1, 1979

45A.100 Small purchases by state governmental bodies.

(1) Procurements may be made in accordance with small purchase administrative regulations promulgated by the secretary of the Finance and Administration Cabinet, pursuant to KRS Chapter 13A, as follows:

(a) Up to ten thousand dollars (\$10,000) per project for construction and one thousand dollars (\$1,000) for purchases by any state governmental body, except for those state administrative bodies specified in paragraph (b) of this subsection; and

(b) Up to forty thousand dollars (\$40,000) per project for construction or purchases by the Finance and Administration Cabinet, state institutions of higher education, and the legislative branch of government.

(2) Procurement requirements shall not be artificially divided so as to constitute a small purchase under this section. Reverse auctions may be used for small purchase procurements. At least every two (2) years, the secretary shall review the prevailing costs of labor and materials and may make recommendations to the next regular session of the General Assembly for the revision of the then current maximum small purchase amount as justified by intervening changes in the cost of labor and materials.

(3) The secretary of the Finance and Administration Cabinet may grant to any state agency with a justifiable need a delegation of small purchasing authority which exceeds the agency's small purchase limit provided in subsection (1) of this section. Delegations of small purchasing authority shall be granted or revoked by the secretary of the Finance and Administration Cabinet, in accordance with administrative regulations promulgated by the cabinet pursuant to KRS Chapter 13A. These administrative regulations shall establish, at a minimum, the criteria for granting and revoking delegations of small purchasing authority, including the requesting agency's past compliance with purchasing regulations, the level of training of the agency's purchasing staff, and the extent to which the agency utilizes the Kentucky Automated Purchasing System. The administrative regulations may permit the secretary of the Finance and Administration Cabinet to delegate small purchase procurements up to the maximum amount specified in subsection (1)(b) of this section.

Effective: July 15, 2010

History: Amended 2010 Ky. Acts ch. 63, sec. 5, effective July 15, 2010. -- Amended 2002 Ky. Acts ch. 320, sec. 2, effective July 15, 2002. -- Amended 2000 Ky. Acts ch. 225, sec. 1, effective July 14, 2000. -- Amended 1996 Ky. Acts ch. 60, sec. 1, effective July 15, 1996. -- Amended 1994 Ky. Acts ch. 323, sec. 1, effective July 15, 1994. -- Amended 1990 Ky. Acts ch. 496, sec. 5, effective July 13, 1990. -- Amended 1986 Ky. Acts ch. 384, sec. 1, effective July 15, 1986. -- Amended 1984 Ky. Acts ch. 384, sec. 1, effective July 13, 1984. -- Amended 1982 Ky. Acts ch. 282, sec. 2, effective July 15, 1982. -- Amended 1980 Ky. Acts ch. 242, sec. 1, effective July 15, 1980; and ch. 250, sec. 19, effective April 9, 1980. -- Created 1978 Ky. Acts ch. 110, sec. 21, effective January 1, 1979.

**NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION TO
ENSURE EQUAL EMPLOYMENT OPPORTUNITY (EXECUTIVE ORDER 11246)**

The following excerpts are from 45 FR 65984 (October 3, 1980):

The minority and female goals apply to Federal and federally assisted construction contractors and subcontractors which have covered contracts. The goals are expressed as a percentage of the total hours worked by such a covered or subcontractor's entire onsite construction workforce, which is working on any construction site within a relevant area. The goal applies to each construction craft and trade in the contractor's entire workforce in the relevant area including those employees working on private non-federally involved projects.

Until further notice, the following goals for minority utilization in each construction craft and trade shall be included in all Federal or federally assisted construction contracts and subcontracts in excess of \$10,000 to be performed in the respective geographic area. The goals are applicable to each nonexempt contractor's total onsite construction workforce, regardless of whether or not part of that workforce is performing work on a Federal, federally assisted or non-federally related project, contract or subcontract.

Construction contractors which are participating in an approved Hometown Plan (see 41 CFR 60-4.5) are required to comply with the goals of the Hometown Plan with regard to construction work they perform in the area covered by the Hometown Plan. With regard to all their other covered construction work, such contractors are required to comply as follows:

Goals for female participation in each trade.....6.9%
Goals for minority participation in each trade.....Insert goals for each year
(see Attachment Number 5)

These goals are applicable to all the Contractor's construction work (whether or not it is Federal or Federally assisted) performed in the covered area.

The following excerpts are from 45 FR 65977 (October 3, 1980):

The Contractor's compliance with the Executive Order and the regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3(a), and its efforts to meet the goals established for the geographical area where the contract resulting from this solicitation is to be performed. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade, and the contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor or from project to project for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, the Executive Order and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

The Contractor shall provide written notification to the Director of the Office of Federal Contract Compliance Programs within 10 working days of award of any construction subcontract in excess of \$10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the name, address and telephone number of the subcontractor; employer identification number; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the contract is to be performed.

As used in this Notice, and in the contract resulting from this solicitation, the covered area is (insert description of the geographical areas where the contract is to be performed giving the state, country, and city, if any).

**STANDARD FEDERAL EQUAL EMPLOYMENT OPPORTUNITY
CONSTRUCTION CONTRACT SPECIFICATIONS (EXECUTIVE ORDER 11246)**

EEO Specifications

Following is the standard language, which must be incorporated into all solicitations for offers and bids on all Federal and Federally assisted construction contracts or subcontracts in excess of \$10,000 to be performed in designated geographical areas:

1. As used in these specifications:
 - (a) Covered Area means the geographical area described in the solicitation from which this contract resulted.
 - (b) Director means Director, Office of Federal Contract Compliance Program, United States Department of Labor, or any person to whom the Director delegates authority;
 - (c) Employer identification number means the Federal Social Security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941.
 - (d) Minority includes:
 - (i) Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);
 - (ii) Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish Culture or origin, regardless of race);
 - (iii) Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and
 - (iv) American Indian or Alaskan Native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).
2. Whenever the Contractor or any Subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of \$10,000 the provisions of these specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitations from which this contract resulted.
3. If the Contractor is participating (pursuant to 41 CFR 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors must be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each Contractor or Subcontractor participating in an approved Plan is individually required to comply with its obligations under the EEO clause, and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other Contractors or Subcontractors toward a goal in an approved Plan does not excuse any covered Contractor's or Subcontractor's failure to take a good faith efforts to achieve the Plan goals and timetables.

4. The Contractor shall implement the specific affirmative action standards provided in paragraphs 7-a through p of these specifications. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. The Contractor is expected to make substantially uniform progress toward its goals in each craft during the period specified.
5. Neither the provisions of any collective bargaining agreement, nor the failure by a union with whom the Contractor has a collective bargaining agreement, to refer either minorities or women shall excuse the Contractor's obligations under these specifications, Executive Order 11246, or the regulations promulgated pursuant thereto.
6. In order for the non-working training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees must be employed by the contractor during the training period, and the Contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. Department of Labor.
7. The Contractor shall take specific affirmative action to ensure equal employment opportunity. The evaluation of the Contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. The Contractor shall document these efforts fully, and shall implement affirmative action steps at least as extensively as the following:
 - a. Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and in all facilities at which the contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor shall specifically ensure that all foremen, superintendents, and other on-site supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.
 - b. Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the contractor or its unions have employment opportunities available, and maintain a record of the organizations responses.
 - c. Maintain a current file of the names, addresses and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source or community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to the Contractor by the union or, if referred, not employed by the contractor, this shall be documented in the file with the reason therefore, along with whatever additional actions the contractor may have taken.
 - d. Provide immediate written notification to the Director when the union or unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or woman sent by the Contractor, or when the Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligation.
 - e. Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the Department of Labor. The Contractor shall provide notice of these programs to the sources complied under 7-b above.

- f. Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.
- g. Review, at least annually, the company's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, lay-off, termination or other employment decisions including specific review of these items with on-site supervisory personnel such as Superintendents, General Foreman, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.
- h. Disseminate the Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractor's EEO policy with other Contractors and Subcontractors with whom the Contractor does or anticipates doing business.
- i. Direct its recruitment efforts, both oral and written, to minority, female and community organizations, to schools with minority and female students and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not later than one month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the contractor shall send written notification to organizations such as the above, describing the openings, screening procedures, and tests to be used in the selection process.
- j. Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer and vacation employment to minority and female youth both on the site and in other areas of a Contractor's workforce.
- k. Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR Part 60-3.
- l. Conduct, at least annually, an inventory and evaluation of all minority and female personnel for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc., such opportunities.
- m. Ensure that seniority practices, job classifications, work assignments and other personnel practices, do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that EEO policy and the Contractor's obligations under these specifications are being carried out.
- n. Ensure that all facilities and company activities are nonsegregated except that separate or single-user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.
- o. Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.
- p. Conduct a review, at least annually, of all supervisor's adherence to and performance under the Contractor's EEO policies and affirmative action obligations.

8. Contractors are encouraged to participate in voluntary associations, which assist in fulfilling one or more of their affirmative actions obligations (7 a through p). The efforts of a contractor association, joint contractor-union, contractor-community, of other similar group of which the contractor is a member and participant may be asserted as fulfilling any one or more of its obligations under 7 a through p of these specifications provided that the contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and female workforce participation, makes a good faith effort to meet its individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation to comply, however, is the Contractor's and failure of such a group to fulfill an obligation shall not be defense for the Contractor's noncompliance.
9. A single goal for minorities and a separate single goal for women have been established. The contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, the Contractor may be in violation of the Executive Order if a particular group is employed in a substantially disparate manner (for example: even though the Contractor has achieved its goal for women generally, the Contractor may be in violation of the Executive Order if a specific minority group of women is underutilized).
10. The Contractor shall not use the goals and timetables for affirmative action standards to discriminate against any person because of race, color, religion, sex or national origin.
11. The Contractor shall not enter into any Subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246.
12. The Contractor shall carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause, including suspension, termination and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any Contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications and executive Order 11246, as amended.
13. The Contractor, in fulfilling its obligations under these specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph 7 of these specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director shall proceed in accordance with 41 CFR 60-4.8.
14. The Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the Government and to keep records. Records shall at least include for each employee the name, address, telephone numbers, construction trade, union affiliation, if any, employee identification number when assigned, social security number, race, sex, status (e.g., mechanic, apprentice, trainee, helper or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.
15. Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local or other area residents (e.g., those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

EEO GOALS FOR ECONOMIC AREAS IN REGION 4
SOURCE: APPENDIX B-80 IN 45 FR 65984 (OCTOBER 3, 1980)

Kentucky:

053 Knoxville, TN

SMSA Counties:

3840 Knoxville, TN..... 6.6
 TN Anderson; TN Blount; TN Knox; TN Union.

Non-SMSA Counties 4.5

KY Bell; KY Harlan; KY Knox; KY Laurel; KY McCreary; KY Wayne; KY
 Whitley; TN Campbell; TN Claiborne; TN Cocke; TN Cumberland; TN Fentress;
 TN Grainger, TN Hamblen; TN Jefferson; TN Loudon; TN Morgan; TN Roane;
 TN Scott; TN Sevier.

054 Nashville, TN:

SMSA Counties:

1660 Clarksville - Hopkinsville, TN - KY 18.2
 KY Christian; TN Montgomery.

5360 Nashville - Davidson, TN 15.8

TN Cheatham, TN Davidson; TN Dickson; TN Robertson; TN Rutherford; TN
 Sumner; TN Williamson; TN Wilson.

Non-SMSA Counties 12.0

KY Allen; KY Barren; KY Butler; KY Clinton; KY Cumberland; KY Edmonson;
 KY Logan; KY Metcalfe; KY Monroe; KY Simpson; KY Todd; KY Trigg; KY
 Warren; TN Bedford; TN Cannon; TN Clay; TN Coffee; TN DeKalb; TN Franklin;
 TN Giles; TN Hickman; TN Houston; TN Humphreys; TN Jackson; TN Lawrence;
 TN Lewis; TN Macon; TN Marshall; TN Maury; TN Moore; TN Overton; TN
 Perry; TN Pickett; TN Putnam; TN Smith; TN Stewart; TN Trousdale; TN Van
 Buren; TN Warren; TN Wayne; TN White.

056 Paducah, KY:

Non-SMSA Counties 5.2

IL Hardin; IL Massac; IL Pope; KY Ballard; KY Caldwell; KY Calloway. KY
 Carlisle; KY Crittenden; KY Fulton; KY Graves; KY Hickman; KY Livingston;
 KY Lyon. KY McCracken; KY Marshall.

057 Louisville, KY:

SMSA Counties:

4520 Louisville, KY-IN 11.2
 IN Clark; IN Floyd; KY Bullitt; KY Jefferson; KY Oldham.

Non-SMSA Counties 9.6

IN Crawford; IN Harrison; IN Jefferson; IN Orange; IN Scott; IN Washington; KY
 Breckinridge; KY Grayson; KY Hardin; KY Hart; KY Henry; KY Larue; KY
 Marion; KY Meade; KY Nelson; KY Shelby; KY Spencer; KY Trimble; KY
 Washington.

058 Lexington, KY	
SMSA Counties	
4280 Lexington-Fayette, KY	10.8
KY Bourbon; KY Clark; KY Fayette; KY Jessamine; KY Scott; KY Woodford.	
Non-SMSA Counties	7.0
KY Adair KY Anderson; KY Bath; KY Boyle; KY Breathitt; KY Casey; KY Clay;	
KY Estill; KY Franklin; KY Garrard; KY Green; KY Harrison; KY Jackson; KY	
Knott; KY Lee; KY Leslie; KY Letcher; KY Lincoln; KY Madison; KY Magoffin;	
KY Menifee; KY Mercer; KY Montgomery; KY Morgan. KY Nicholas; KY	
Owsley; KY Perry; KY Powell; KY Pulaski; KY Rockcastle; KY Russell; KY	
Taylor; KY Wolfe.	
059 Huntington, WV:	
SMSA Counties:	
3400 Huntington - Ashland, WV-KY-OH	2.9
KY Boyd; KY Greenup; OH Lawrence; WV Cabell; WV Wayne.	
Non-SMSA Counties	2.5
KY Carter; KY Elliott; KY Floyd; KY Johnson; KY Lawrence; KY Martin; KY	
Pike; KY Rowan; OH Gallia; WV Lincoln; WV Logan; WV Mason; WV Mingo.	
067 Cincinnati, OH:	
SMSA Counties:	
1640 Cincinnati, OH-KY-IN	11.0
IN Dearborn; KY Boone; KY Campbell; KY Kenton; OH Clermont; OH Hamilton;	
OH Warren.	
3200 Hamilton - Middletown, OH	5.0
OH Butler.	
Non-SMSA Counties	9.2
IN Franklin; IN Ohio; IN Ripley; IN Switzerland; KY Bracken; KY Carroll; KY	
Fleming; KY Gallatin; KY Grant; KY Lewis; KY Mason; KY Owen; KY	
Pendleton; KY Robertson; OH Adams; OH Brown; OH Clinton; OH Highland.	
080 Evansville, IN:	
SMSA Counties	
2440 Evansville, IN-KY	4.8
IN Gibson; IN Posey; IN Vanderburgh; IN Warrick; KY Henderson.	
5990 Owensboro, KY	4.7
KY Daviess.	
Non-SMSA Counties	3.5
IL Edwards; IL Gallatin; IL Hamilton; IL Lawrence; IL Saline; IL Wabash; IL	
White; IN Dubois; IN Knox; IN Perry; IN Pike; IN Spencer; KY Hancock; KY	
Hopkins; KY McLean; KY Muhlenberg; KY Ohio; KY Union; KY Webster.	

**CHECK LIST OF EEO DOCUMENTATION FOR BIDDERS ON
GRANT/LOAN CONSTRUCTION (EXECUTIVE ORDER 11246 AS AMENDED)**

The low, responsive responsible bidder must forward the following items, in duplicate, to the owner no later than ten (10) days after bid opening. The owner shall have one (1) copy available for inspection by the Office of Federal Contracts Compliance (OFCC) within 14 days after the bid opening. More information can be found on the [OFCC](#) webpage.

1. Project Number. Project Location. Type of Construction.
2. Proof of registration with the Joint Reporting Commission. (See Attachment Number 7.)
3. Copy of Affirmative Action Plan of contractor. Indicate company official responsible for EEO.
4. List of current construction contracts, with dollar amount. List contracting Federal Agency, if applicable.
5. Statistics concerning company percent workforce, permanent and temporary, by sex, race, trade, handicapped, and age. 40 CFR Part 7.
6. List of employment sources for project in question. If union sources are utilized, indicate percentage of minority membership within the union crafts.
7. Anticipated employment needs for this project, by sex, race and trade, with estimate of minority participation in specific trades.
8. List of subcontractors (name, address and telephone) with dollar amount and duration of subcontract. Subcontractor contracts over \$10,000 must submit items 1- 7. The following information must be provided for all supplier contracts regardless of contract size: name of company, contact person, address, telephone number, dollar value of the contract, and a list of the materials to be supplied to the prime contractor.
9. List of any subcontract work yet to be committed with estimate of dollar amount and duration of contract.
10. Contract Price. Duration of prime contract.
11. DBE Documents - See special instructions regarding use of Minority, and Women Owned, and Small Businesses.

EMPLOYER INFORMATION REPORT EEO-1

Under the direction of the US Equal Employment Opportunity Commission, the Joint Reporting Committee is responsible for the full-length, multi-phase processing of employment statistics collected on the Employer Information Report EEO-1. This report, also termed Standard Form 100, details the sex and race/ethnic composition of an employer's work force by job category.

The Employer Information EEO-1 survey is conducted annually under the authority of Public Law 88-352, Title VII of the Civil Rights Act of 1964, as amended by the Equal Employment Opportunity Act of 1972. All employers with 15 or more employees are covered by Public Law 88-352 and are required to keep employment records as specified by Commission regulations. Based on the number of employees and federal contract activities, certain large employers are required to file an EEO-1 Report on an annual basis.

The EEO-1 Report must be filed by:

- (A) All private employers who are: (1) subject to Title VII of the Civil Rights Act of 1964 (as amended by the Equal Employment Opportunity Act of 1972) with 100 or more employees EXCLUDING State and local governments, primary and secondary school systems, institutions of higher education, Indian tribes and tax-exempt private memberships clubs other than labor organizations; OR (2) subject to Title VII who have fewer than 100 employees if the company is owned or affiliated with another company, or there is centralized ownership, control or management (such as central control of personnel policies and labor relations) so that the group legally constitutes a single enterprise and the entire enterprise employs a total of 100 or more employees.
- (B) All federal contractors (private employers), who: (1) are not exempt as provided for by 41 CFR 60-1.5, (2) have 50 or more employees, and (a) are prime contractors or first-tier subcontractors, and have a contract, subcontract, or purchase order amounting to \$50,000 or more; or (b) serve as depository of Government funds in any amount, or (c) is a financial institution which is an issuing and paying agent for U.S. Savings Bonds and Notes.

Only those establishments located in the District of Columbia and the 50 states are required to submit the EEO-1 Report. No Reports should be filed for establishments in Puerto Rico, the Virgin Islands or other American Protectorates.

When filing for the EEO-1 Report for the first time, go to the [U.S. Equal Employment Opportunity Commission](#) webpage and select "First Time Filers". Fill out the electronic questionnaire to enter your company into Joint Reporting Committee (JRC) system. Once you have completed the registration process, you will be contacted on how to proceed with the EEO-1 Report. If you have previously registered with the JRC, follow their instructions to update your information.

LABOR STANDARDS PROVISIONS FOR FEDERALLY ASSISTED CONSTRUCTION

Labor standards provisions applicable to contracts covering federally financed and assisted construction (29 CFR 5.5, Contract Provisions and Related Matters) that apply to EPA State Revolving Fund loans are:

(a)(4)(iii) *Equal employment opportunity*. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR Part 30.

(a)(5) *Compliance with Copeland Act requirements*. The contractor shall comply with the requirements of 29 CFR Part 3, which are incorporated by reference in this contract.

(a)(6) *Subcontracts*. The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5 (a)(1) through (10) and such other clauses as the U.S. Environmental Protection Agency may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

(a)(7) *Contract termination: debarment*. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

(b) *Contractor Work Hours and Safety Standards Act*. The Administrator, EPA, shall cause or require the contracting officer to insert the following clauses set forth in paragraphs (b)(1), (2), (3), and (4) of this section in full in any contract in an amount in excess of \$100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by §5.5(a) or §4.6 of part 4 of this title. As used in this paragraph, the terms *laborers* and *mechanics* include watchmen and guards.

(b)(1) *Overtime requirements*. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(b)(2) *Violation; liability for unpaid wages; liquidated damages*. In the event of any violation of the clause set forth in paragraph (b)(1) of this section the contractor and any subcontractor responsible therefore shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for unliquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (b)(1) of this section, in the sum of \$27 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (b)(1) of this section.

(3) *Withholding for unpaid wages and liquidated damages*. The U.S. Environmental Protection Agency shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime

contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (b)(2) of this section.

(4) *Subcontracts.* The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (b)(1) through (4) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (b)(1) through (4) of this section.

(c) In addition to the clauses contained in paragraph (b), in any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in section §5.1, the Administrator of EPA shall cause or require the contracting officer to insert a clause requiring that the contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Further, the Administrator of EPA shall cause or require the contracting officer to insert in any such contract a clause providing that the records to be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the U.S. Environmental Protection Agency and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job. (Approved by the Office of Management and Budget under OMB control numbers 1215-0140 and 1215-0017.)

CERTIFICATIONS

Debarred Firms

All prime Construction Contractors shall certify that Subcontractors have not and will not be awarded to any firm that is currently on the EPA Master List of Debarred, Suspended and Voluntarily Excluded Persons in accordance with the provisions of 40 CFR 32.500(c). Debarment action is taken against a firm for noncompliance with Federal Law.

All bidders shall complete the attached certification (Attachment Number 9) and submit to the owner with the bid proposal.

Anti-lobbying Certification

All prime Construction Contractors must certify (Attachment Number 10) that no appropriated funds were or will be expended for the purpose of lobbying the Executive or Legislative Branches of the Federal Government or Federal Agency concerning this contract (contract in excess of \$100,000). If the Contractor has made or agreed to make payment to influence any member of Congress in regard to award of this contract, a Disclosure Form must be completed and submitted to the owner with the bid proposal.

All prime Contractors must require all Subcontractors to submit the certification, which must also be submitted to the owner.

**CERTIFICATION REGARDING DEBARMENT,
SUSPENSION AND OTHER RESPONSIBILITY MATTERS**

The prospective participant certifies to the best of its knowledge and belief that it and its 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 proposal 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, or Local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and
- (d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or local) terminated for cause or default.

I understand that a false statement on this certification may be grounds for rejection of this proposal or termination of the award. In addition, under 18 USC Sec. 1001, a false statement may result in a fine of up to \$10,000 or imprisonment for up to 5 years, or both.

Typed Name & Title of Authorized Representative

Signature of Authorized Representative

Date

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

**CERTIFICATION REGARDING LOBBYING
CERTIFICATION FOR CONTRACTS,
GRANTS, LOANS, AND COOPERATIVE AGREEMENTS**

The undersigned certifies, to the best of his or her knowledge and belief, that:

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

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

(3) The undersigned shall require that the language of this certification be included in the award documents for all sub-awards at all tiers (including subcontracts, sub-grants, and contracts under grants, loans, and cooperative agreements) and that all sub-recipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

Typed Name & Title of Authorized Representative

Signature of Authorized Representative

Date

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

EPA DISADVANTAGED BUSINESS ENTERPRISE PROGRAM

EPA's Disadvantaged Business Enterprise Program rule applies to contract procurement actions funded in part by EPA assistance agreements awarded after May 27, 2008. The rule is found at Federal regulation Title 40, Part 33. Specific responsibilities are highlighted below.

Loan recipient responsibilities:

- Include in each contract with a primary contractor the following term and condition:

“The contractor shall not discriminate on the basis of race, color, national origin or sex in the performance of this contract. The contractor shall carry out applicable requirements of 40 CFR part 33 in the award and administration of contracts awarded under EPA financial assistance agreements. Failure by the contractor to carry out these requirements is a material breach of this contract which may result in the termination of this contract.” (*Appendix A to Part 33—Term and Condition*)
- Employ the six Good Faith Efforts during prime contractor procurement (§33.301).
- Require the prime contractor to comply with the following prime contractor requirements of Title 40 Part 33:
 - To pay its subcontractor for satisfactory performance no more than 30 days from the prime contractor's receipt of payment from the recipient (§33.302(a)).
 - To notify recipient in writing prior to any termination of a DBE subcontractor for convenience by the prime contractor (§33.302(b)).
 - To employ the six Good Faith Efforts described in §33.301 if soliciting a replacement subcontractor after a DBE subcontractor fails to complete work under the subcontract for any reason (§33.302(c)).
 - To employ the six Good Faith Efforts described in §33.301 even if the prime contractor has achieved its fair share objectives under subpart D of Part 33 (§33.302(d)).
 - To provide EPA Form 6100-2 – *DBE Program Subcontractor Participation Form* to all DBE subcontractors (§33.302(e)). **NOTE: this requirement has been suspended.**
 - To submit EPA Forms 6100-3 – *DBE Program Subcontractor Performance Form* and 6100-4 *DBE Program Subcontractor Utilization Form* as part of the bid package or proposal (§33.302(f) and (g)). **NOTE: this requirement has been suspended.**
 - To employ the six Good Faith Efforts steps in paragraphs (a) through (f) of §33.301 while procuring any subcontracts (§33.302(i)).
- Conduct an Availability Analysis and negotiate fair share objectives with EPA (§33.401), or adopt the fair share objectives of the oversight state agency revolving loan fund for comparable infrastructure (§33.405(b)(3)).
- Maintain all records documenting its compliance with the requirements of Title 40 Part 33, including documentation of its, and its prime contractors', good faith efforts (§33.501(a)).

- Create and maintain a bidders list and require the prime contractor to create and maintain a bidders list (§33.501(b)). This list must include all firms that bid or quote on prime contracts, or bid or quote subcontracts, including both MBE/WBEs and non-MBE/WBEs. This list must be kept until the project period for the identified loan has ended. The following information must be obtained from all prime and subcontractors:
 - (a) Entity's name with point of contact,
 - (b) Entity's mailing address, telephone number, and email address,
 - (c) The procurement on which the entity bid or quoted, and when, and,
 - (d) Entity's status as an MBE/WBE or non-MBE/WBE.

Prime Contractor Responsibilities:

- Include in each contract with a subcontractor the following term and condition:

“The contractor shall not discriminate on the basis of race, color, national origin or sex in the performance of this contract. The contractor shall carry out applicable requirements of 40 CFR part 33 in the award and administration of contracts awarded under EPA financial assistance agreements. Failure by the contractor to carry out these requirements is a material breach of this contract which may result in the termination of this contract.” (*Appendix A to Part 33—Term and Condition*)
- Employ the six Good Faith Efforts during subcontractor procurement (§33.301).
- Pay subcontractors for satisfactory performance no more than 30 days from receipt of payment from the recipient (§33.302(a)).
- Notify recipient in writing prior to termination of a DBE subcontractor for convenience (§33.302(b)).
- Employ the six Good Faith Efforts described in §33.301 if soliciting a replacement subcontractor after a DBE subcontractor fails to complete work under the subcontract for any reason. (§33.302(c)).
- Employ the six Good Faith Efforts described in §33.301 even if the fair share objectives have been achieved under subpart D of Part 33 (§33.302(d)).
- Provide EPA Forms 6100-2 – *DBE Program Subcontractor Participation Form* and 6100-3 – *DBE Program Subcontractor Performance Form* to each DBE subcontractor prior to opening of the subcontractor's bid or proposal (§33.302(e) and (f)). **NOTE: this requirement has been suspended.**
- Complete EPA Form 6100-4 – *DBE Program Subcontractor Utilization Form* (§33.302(g)). **NOTE: this requirement has been suspended.**
- Submit to recipient with the bid package or proposal the completed EPA Form 6100-4, plus an EPA Form 6100-3 for each DBE subcontractor used in the bid or proposal (§33.302(f) and (g)). **NOTE: this requirement has been suspended.**
- Maintain all records documenting its compliance with the requirements of Title 40 Part 33, including documentation of its, and its subcontractors', good faith efforts (§33.501(a)).
- Create and maintain a bidders list and require the subcontractor to create and maintain a bidders list (§33.501(b)). This list must include all firms that bid or quote on subcontracts, including both

MBE/WBEs and non-MBE/WBEs. This list must be kept until the project period for the identified loan has ended. The following information must be obtained from all subcontractors:

- (a) Entity's name with point of contact,
- (b) Entity's mailing address, telephone number, and email address,
- (c) The procurement on which the entity bid or quoted, and when, and,
- (d) Entity's status as an MBE/WBE or non-MBE/WBE.

Subcontractor Responsibilities:

- May submit EPA Form 6100-2 – *DBE Program Subcontractor Participation Form* directly to DOW Project Manager (§33.302(e)). **NOTE: this requirement has been suspended.**
- Must complete EPA Form 6100-3 – *DBE Program Subcontractor Performance Form* and submit it to the prime contractor soliciting services prior to the prime contractor opening bids or quotes. **NOTE: this requirement has been suspended.**

DISADVANTAGED BUSINESS ENTERPRISE PARTICIPATION POLICY

PROJECT NAME: _____ **BID DATE:** _____

1. Name, address and telephone number of contact person on all DBE matters:

Prime Contractor's Name: _____
Contact Person: _____
Address: _____
Phone: _____
Cell Phone: _____
Email: _____
Total Contract Amount: _____

2. Total dollar amount/percent of contract of MBE participation: _____

3. Total dollar amount/percent of contract of WBE participation: _____

4. Are certifications* for each MBE/WBE/DBE subcontractor ☐ Yes ☐ No
enclosed; if no, please explain: _____

5. Are MBE/WBE/DBE subcontracts or letters of intent signed by ☐ Yes ☐ No
both parties enclosed; if no, please explain: _____

6. List of MBE Subcontractors:

Name: _____
Contact Person: _____
Address: _____
Phone: _____
Cell Phone: _____
Email: _____
Type of Contract: _____
Work to be Done: _____
Amount: _____

7. List of WBE Subcontractors:

Name: _____
Contact Person: _____
Address: _____
Phone: _____
Cell Phone: _____
Email: _____
Type of Contract: _____
Work to be Done: _____
Amount: _____

Attach Additional Sheets, If Necessary

*Self-certification: Self certification of MBE/WBE/DBE firms will NOT be accepted as a valid form of certification of MBE/WBE/DBE status.

8. Information and documentation concerning efforts taken to comply with EPA's "six good faith efforts"

- (i). Ensure DBE construction firms or material suppliers are made aware of contracting opportunities to the fullest extent practicable through outreach and recruitment activities; including placing DBEs on solicitation lists and soliciting them whenever they are potential sources. A good source for a list of DBEs is the Kentucky Transportation's [Certified DBE Directory](#) webpage.

☐ The prime contractor certifies that a solicitation list of qualified DBE vendors was developed for current and future solicitations. *Submit a copy of the list as documentation.*

- (ii). Make information on forthcoming opportunities available to DBEs and arrange time frames for contracts and establish delivery schedules, where the requirements permit, in a way that encourages and facilitates participation by DBEs in the competitive process; including, whenever possible, posting solicitation for bids or proposals for a sufficient amount of time as to receive a competitive bid or proposal pool.

☐ The prime contractor certifies that every opportunity was provided to a number of DBEs to encourage their participation in the competitive process and that an adequate amount of time was provided for response. Must do at least one of the below.

- a. List each DBE construction firm or material supplier to which a solicitation was attempted. *Submit copies of letters, emails, faxes, telecommunication logs, certified mail receipts, returned envelopes, certified mail return receipts, etc. as documentation.*

Company name and phone number: _____

Area of work expertise: _____

Date of any follow-ups and person spoke to: _____

- b. Advertisements, if applicable: List each publication in which an announcement or notification was placed. *Submit original advertisement or a copy of the advertisement with an affidavit of publication for each announcement as documentation.*

Name of publication: _____

Date(s) of advertisement: _____

Specific subcontract areas announced: _____

- c. Other, if applicable: List each notification method in which an announcement or outreach was used; list serve, public meeting, etc. *Submit applicable information to document effort.*

Method of notification: _____

Date(s) of notification: _____

- (iii). Consider in the contracting process whether firms competing for large contracts could subcontract with DBEs; including dividing total requirements, when economically feasible, into smaller tasks or quantities to permit maximum participation by DBEs in the competitive process.

☐ The prime contractor certifies that the project was broken into its basic elements (i.e., dirt hauling, landscaping, painting, pipe installation, material supplies, etc.) and that a determination was made whether it's economically feasible to bid the elements separately and that the analysis of this effort was documented with a short memo to the project file.

- (iv). Establishing delivery schedules, where the requirement permits, which encourage participation by small and minority business, and women's business enterprises.
- ☐ The prime contractor certifies that they established delivery schedules which would allow DBEs to participate in the project and the effort was documented with a short memo to the project file.
- (v). Use the services and assistance of the Small Business Administration (SBA). The easiest way to utilize their services is to visit the [SBA](#) webpage and use the electronic tools available there or you may send the nearest SBA office a certified letter that generally describes the solicitation, the dates it will be open, the types of vendors you are seeking and applicable Standard Industrial Classification (SIC) or North American Industry Classification System (NAIC) codes if known. Or, you may use the services and assistance of the Kentucky Procurement Technical Assistance Center (PTAC) **and** the Kentucky Department of Transportation (KDOT). The easiest way to utilize the services of Kentucky PTAC and KDOT is to send an email to kyptacinfo@kstc.com and Melvin.Bynes2@ky.gov and generally describe the solicitation, the dates it will be open, the types of vendors you are seeking and applicable SIC or NAIC codes if known.
- ☐ The prime contractor certifies that the assistance of the SBA or PTAC **and** KDOT was utilized. *Submit pages printed off the SBA websites which evidence efforts to register a solicitation on the site or submit copies of the letter sent and certified mail receipt as documentation; or submit copies of emails sent to PTAC and DOT as documentation.*
- (vi). If a Prime contractor awards any subcontracts, require the subcontractor to take the steps in numbers (i) through (v) above.
- ☐ The prime contractor certifies that subcontractors used for this project will be required to follow the steps of the "six good faith efforts" as listed above.

9. Signature and date:

To the best of my knowledge and belief, all "six good faith efforts" have been met and the information contained in this document is true and correct; the document has been duly authorized by the legal representative.

Signature

Print name and title

Date

BIDDER'S LIST FORM

OWNER: _____

LOAN NO: _____

PROJECT TITLE: _____

BID DATE: _____

Instructions:

1. Per 40 CFR §33.501(b), this list must include all firms that were solicited for participation, bid on, or quoted for a prime contract or subcontract under EPA assisted projects, includes both DBE's and non DBE's.
2. SRF loan participants must keep the Bidder's List until the project period for the identified loan has ended and no funds are remaining.
3. This list must be submitted to DOW in the ATA Package. Contract Award Approval cannot be given until this form has been received by DOW.
4. The following information must be obtained from all prime and subcontractors. Please complete the form below:

ENTITY'S NAME	MAILING ADDRESS	CONTACT PERSON	PHONE#	E-MAIL ADDRESS	M/WBE?

BONDS AND INSURANCE

The minimum requirements shall be as follows:

Bonding requirements for contracts of \$100,000 or less are contained in 40 CFR 31.36(h).

Bond requirements for contracts in excess of \$100,000 are:

- Bid guarantee equivalent to five percent of the bid price. The bid guarantee shall consist of a firm commitment such as a certified check or bid bond submitted with the bid;
- Performance bond equal to 100 percent of the contract price, and
- Payment bond equal to 100 percent of the contract price. Bonds must be obtained from companies holding Certificates of Authority as acceptable sureties, issued by the U.S. Treasury.

Insurance requirements are contained in the General Conditions of the contract. In addition to the other required insurance, the owner or the contractor, as appropriate, must acquire any flood insurance made available by the Federal Emergency Management Agency as required by 44 CFR Parts 59-79, if construction will take place in a flood hazard area identified by the Federal Emergency Management Agency. The owner's requirements on Flood Insurance are contained in the Special Conditions Section of the Contracts Documents.

STORM WATER GENERAL PERMIT

All construction projects with surface disturbance of more than 1 acre during the period of construction must have a KPDES Storm Water General Permit. The permit can be found at this [webpage](#).

If you have any questions regarding the completion of this form call the Surface Water Permits Branch, at (502) 564-3410.

DAVIS-BACON WAGE RATE REQUIREMENTS

CWSRF: The recipient agrees to include in all agreements to provide assistance for the construction of treatment works carried out in whole or in part with such assistance made available by a State water pollution control revolving fund as authorized by title VI of the Federal Water Pollution Control Act (33 U.S.C. 1381 et seq.), or with such assistance made available under section 205(m) of that Act (33 U.S.C. 1285(m)), or both, a term and condition requiring compliance with the requirements of section 513 of that Act (33 U.S.C. 1372) in all procurement contracts and sub-grants, and require that loan recipients, procurement contractors and sub-grantees include such a term and condition in subcontracts and other lower tiered transactions. All contracts and subcontracts for the construction of treatment works carried out in whole or in part with assistance made available as stated herein shall insert in full in any contract in excess of \$2,000 the contract clauses as set forth below titled “Wage Rate Requirements Under The Consolidated and Further Continuing Appropriations Act, 2013 (P.L. 113-6)”. This term and condition applies to all agreements to provide assistance under the authorities referenced herein, whether in the form of a loan, bond purchase, grant, or any other vehicle to provide financing for a project, where such agreements are executed on or after October 30, 2009.

DWSRF: The recipient agrees to include in all agreements to provide assistance for any construction project carried out in whole or in part with such assistance made available by a drinking water treatment revolving loan fund as authorized by section 1452 of the Safe Drinking Water Act (42 U.S.C. 300j-12), a term and condition requiring compliance with the requirements of section 1450(e) of the Safe Drinking Water Act (42 U.S.C. 300j-9(e)) in all procurement contracts and sub-grants, and require that loan recipients, procurement contractors and sub-grantees include such a term and condition in subcontracts and other lower tiered transactions. All contracts and subcontracts for any construction project carried out in whole or in part with assistance made available as stated herein shall insert in full in any contract in excess of \$2,000 the contract clauses as set forth below entitled “Wage Rate Requirements Under The Consolidated and Further Continuing Appropriations Act, 2013 (P.L. 113-6)”. This term and condition applies to all agreements to provide assistance under the authorities referenced herein, whether in the form of a loan, bond purchase, grant, or any other vehicle to provide financing for a project, where such agreements are executed on or after October 30, 2009.

Wage Rate Requirements under the Consolidated and Further Continuing Appropriations Act, 2013 (P.L. 113-6)

Preamble

With respect to the Clean Water and Safe Drinking Water State Revolving Funds, EPA provides capitalization grants to each State which in turn provides subgrants or loans to eligible entities within the State. Typically, the subrecipients are municipal or other local governmental entities that manage the funds. For these types of recipients, the provisions set forth under Roman Numeral I, below, shall apply. Although EPA and the State remain responsible for ensuring subrecipients’ compliance with the wage rate requirements set forth herein, those subrecipients shall have the primary responsibility to maintain payroll records as described in Section 3(ii)(A), below and for compliance as described in Section I-5.

Occasionally, the subrecipient may be a private for profit or not for profit entity. For these types of recipients, the provisions set forth in Roman Numeral II, below, shall apply. Although EPA and the State remain responsible for ensuring subrecipients’ compliance with the wage rate requirements set forth herein, those subrecipients shall have the primary responsibility to maintain payroll records as described in Section II-3(ii)(A), below and for compliance as described in Section II-5.

I. Requirements under the Consolidated and Further Continuing Appropriations Act, 2013 (P.L. 113-6) for Subrecipients that are Governmental Entities:

The following terms and conditions specify how recipients will assist EPA in meeting its Davis-Bacon (DB) responsibilities when DB applies to EPA awards of financial assistance under the FY 2013 Continuing Resolution with respect to State recipients and subrecipients that are governmental entities. If a subrecipient has questions regarding when DB applies, obtaining the correct DB wage determinations, DB provisions, or compliance monitoring, it may contact the State recipient. The recipient or subrecipient may also obtain additional guidance from [Department of Labor's](#) webpage.

1. Applicability of the Davis- Bacon (DB) prevailing wage requirements.

Under the FY 2013 Continuing Resolution, DB prevailing wage requirements apply to the construction, alteration, and repair of treatment works carried out in whole or in part with assistance made available by a State water pollution control revolving fund and to any construction project carried out in whole or in part by assistance made available by a drinking water treatment revolving loan fund. If a subrecipient encounters a unique situation at a site that presents uncertainties regarding DB applicability, the subrecipient must discuss the situation with the recipient State before authorizing work on that site.

2. Obtaining Wage Determinations.

(a) Subrecipients shall obtain the wage determination for the locality in which a covered activity subject to DB will take place prior to issuing requests for bids, proposals, quotes or other methods for soliciting contracts (solicitation) for activities subject to DB. These wage determinations shall be incorporated into solicitations and any subsequent contracts. Prime contracts must contain a provision requiring that subcontractors follow the wage determination incorporated into the prime contract.

(i) While the solicitation remains open, the subrecipient shall monitor the [General Services Administration](#) website weekly to ensure that the wage determination contained in the solicitation remains current. The subrecipients shall amend the solicitation if DOL issues a modification more than 10 days prior to the closing date (i.e. bid opening) for the solicitation. If DOL modifies or supersedes the applicable wage determination less than 10 days prior to the closing date, the subrecipients may request a finding from the State recipient that there is not a reasonable time to notify interested contractors of the modification of the wage determination. The State recipient will provide a report of its findings to the subrecipient.

(ii) If the subrecipient does not award the contract within 90 days of the closure of the solicitation, any modifications or supersedes DOL makes to the wage determination contained in the solicitation shall be effective unless the State recipient, at the request of the subrecipient, obtains an extension of the 90 day period from DOL pursuant to 29 CFR 1.6(c)(3)(iv). The subrecipient shall monitor the [General Services Administration](#) website on a weekly basis if it does not award the contract within 90 days of closure of the solicitation to ensure that wage determinations contained in the solicitation remain current.

(b) If the subrecipient carries out activity subject to DB by issuing a task order, work assignment or similar instrument to an existing contractor (ordering instrument) rather than by publishing a solicitation, the subrecipient shall insert the appropriate DOL wage determination from the [General Services Administration](#) website into the ordering instrument.

(c) Subrecipients shall review all subcontracts subject to DB entered into by prime contractors to verify that the prime contractor has required its subcontractors to include the applicable wage determinations.

(d) As provided in 29 CFR 1.6(f), DOL may issue a revised wage determination applicable to a subrecipient's contract after the award of a contract or the issuance of an ordering instrument if DOL determines that the subrecipient has failed to incorporate a wage determination or has used a wage

determination that clearly does not apply to the contract or ordering instrument. If this occurs, the subrecipient shall either terminate the contract or ordering instrument and issue a revised solicitation or ordering instrument or incorporate DOL's wage determination retroactive to the beginning of the contract or ordering instrument by change order. The subrecipient's contractor must be compensated for any increases in wages resulting from the use of DOL's revised wage determination.

3. Contract and Subcontract provisions.

(a) The Recipient shall insure that the subrecipient(s) shall insert in full in any contract in excess of \$2,000 which is entered into for the actual construction, alteration and/or repair, including painting and decorating, of a treatment work under the CWSRF or a construction project under the DWSRF financed in whole or in part from Federal funds or in accordance with guarantees of a Federal agency or financed from funds obtained by pledge of any contract of a Federal agency to make a loan, grant or annual contribution (except where a different meaning is expressly indicated), and which is subject to the labor standards provisions of any of the acts listed in § 5.1 or the FY 2013 Continuing Resolution, the following clauses:

(1) Minimum wages.

(i) All laborers and mechanics employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (a)(1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in § 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph (a)(1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

Subrecipients may obtain wage determinations from the U.S. Department of Labor's [General Services Administration](#) website.

(ii)(A) The subrecipient(s), on behalf of EPA, shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The State award official shall approve a request for an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the subrecipient(s) agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), documentation of the action taken and the request, including the local wage determination shall be sent by the subrecipient (s) to the State award official. The State award official will transmit the request, to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210 and to the EPA DB Regional Coordinator concurrently. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification request within 30 days of receipt and so advise the State award official or will notify the State award official within the 30-day period that additional time is necessary.

(C) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the subrecipient(s) do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the award official shall refer the request and the local wage determination, including the views of all interested parties and the recommendation of the State award official, to the Administrator for determination. The request shall be sent to the EPA DB Regional Coordinator concurrently. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt of the request and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (a)(1)(ii)(B) or (C) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, provided, that the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

(2) Withholding. The subrecipient(s), shall upon written request of the EPA Award Official or an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the (Agency) may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

(3) Payrolls and basic records.

(i) Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii)(A) The contractor shall submit weekly, for each week in which any contract work is performed, a copy of all payrolls to the subrecipient, that is, the entity that receives the sub-grant or loan from the State capitalization grant recipient. Such documentation shall be available on request of the State recipient or EPA. As to each payroll copy received, the subrecipient shall provide written confirmation in a form satisfactory to the State indicating whether or not the project is in compliance with the requirements of 29 CFR 5.5(a)(1) based on the most recent payroll copies for the specified week. The payrolls shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on the weekly payrolls. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the [Wage and Hour Division's](#) webpage or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the subrecipient(s) for transmission to the State or EPA if requested by EPA, the State, the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the subrecipient(s).

(B) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under §5.5(a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under §5.5(a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(2) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the “Statement of Compliance” required by paragraph (a)(3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

(iii) The contractor or subcontractor shall make the records required under paragraph (a)(3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the State, EPA or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the Federal agency or State may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

(4) Apprentices and trainees.

(i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her 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 Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman’s hourly rate) specified in the contractor’s or subcontractor’s registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice’s level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a 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 on the job site shall not be greater than 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

the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee 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 applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the contractor 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.

(iii) Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

(5) Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

(6) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the EPA determines may be appropriate, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

(7) Contract termination; debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

(8) Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

(9) Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and Subrecipient(s), State, EPA, the U.S. Department of Labor, or the employees or their representatives.

(10) Certification of eligibility.

(i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

4. Contract Provision for Contracts in Excess of \$100,000.

(a) Contract Work Hours and Safety Standards Act. The subrecipient shall insert the following clauses set forth in paragraphs (a)(1), (2), (3), and (4) of this section in full in any contract in an amount in excess of \$100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by Item 3, above or 29 CFR 4.6. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

(1) Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(2) Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (a)(1) of this section the contractor and any subcontractor responsible therefore shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (a)(1) of this section, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (a)(1) of this section.

(3) Withholding for unpaid wages and liquidated damages. The subrecipient, upon written request of the EPA Award Official or an authorized representative of the Department of Labor, shall withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (b)(2) of this section.

(4) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (a)(1) through (4) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (a)(1) through (4) of this section.

(b) In addition to the clauses contained in Item 3, above, in any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in 29 CFR 5.1, the Subrecipient shall insert a clause requiring that the contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Further, the Subrecipient shall insert in any such contract a clause providing that the records to be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the (write the name of agency) and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job.

5. Compliance Verification.

(a) The subrecipient shall periodically interview a sufficient number of employees entitled to DB prevailing wages (covered employees) to verify that contractors or subcontractors are paying the appropriate wage rates. As provided in 29 CFR 5.6(a)(6), all interviews must be conducted in confidence. The subrecipient must use Standard Form 1445 (SF 1445) or equivalent documentation to memorialize the interviews. Copies of the SF 1445 are available from EPA on request.

(b) The subrecipient shall establish and follow an interview schedule based on its assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract. Subrecipients must conduct more frequent interviews if the initial interviews or other information indicates that there is a risk that the contractor or subcontractor is not complying with DB. Subrecipients shall immediately conduct necessary interviews in response to an alleged violation of the prevailing wage requirements. All interviews shall be conducted in confidence.

(c) The subrecipient shall periodically conduct spot checks of a representative sample of weekly payroll data to verify that contractors or subcontractors are paying the appropriate wage rates. The subrecipient shall establish and follow a spot check schedule based on its assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract. At a minimum, if practicable, the subrecipient should spot check payroll data within two weeks of each contractor or subcontractor's submission of its initial payroll data and two weeks prior to the completion date the contract or subcontract. Subrecipients must conduct more frequent spot checks if the initial spot check or other information indicates that there is a risk that the contractor or subcontractor is not complying with DB. In addition, during the examinations the subrecipient shall verify evidence of fringe benefit plans and payments thereunder by contractors and subcontractors who claim credit for fringe benefit contributions.

(d) The subrecipient shall periodically review contractors and subcontractors use of apprentices and trainees to verify registration and certification with respect to apprenticeship and training programs approved by either the U.S Department of Labor or a state, as appropriate, and that contractors and subcontractors are not using disproportionate numbers of, laborers, trainees and apprentices. These reviews shall be conducted in accordance with the schedules for spot checks and interviews described in Item 5(b) and (c) above.

(e) Subrecipients must immediately report potential violations of the DB prevailing wage requirements to the EPA DB contact listed above and to the appropriate DOL Wage and Hour [District Office](#).

II. Requirements under the Consolidated and Further Continuing Appropriations Act, 2013 (P.L. 113-6) for Subrecipients that are not Governmental Agencies

The following terms and conditions specify how recipients will assist EPA in meeting its DB responsibilities when DB applies to EPA awards of financial assistance under the FY2013 Continuing Resolution with respect to subrecipients that are not governmental entities. If a subrecipient has questions regarding when DB applies, obtaining the correct DB wage determinations, DB provisions, or compliance monitoring, it may contact the State recipient for guidance. The recipient or subrecipient may also obtain additional guidance from [DOL's](#) webpage.

Under these terms and conditions, the subrecipient must submit its proposed DB wage determinations to the State recipient for approval prior to including the wage determination in any solicitation, contract task orders, work assignments, or similar instruments to existing contractors.

1. Applicability of the Davis- Bacon (DB) prevailing wage requirements.

Under the FY 2013 Continuing Resolution, Davis-Bacon prevailing wage requirements apply to the construction, alteration, and repair of treatment works carried out in whole or in part with assistance made available by a State water pollution control revolving fund and to any construction project carried out in whole or in part by assistance made available by a drinking water treatment revolving loan fund. If a subrecipient encounters a unique situation at a site that presents uncertainties regarding DB applicability, the subrecipient must discuss the situation with the recipient State before authorizing work on that site.

2. Obtaining Wage Determinations.

(a) Subrecipients must obtain proposed wage determinations for specific localities from the U.S. Department of Labor's [General Services Administration](#) website. After the Subrecipient obtains its proposed wage determination, it must submit the wage determination to (insert contact information for State recipient DB point of contact for wage determination) for approval prior to inserting the wage determination into a solicitation, contract or issuing task orders, work assignments or similar instruments to existing contractors (ordering instruments unless subsequently directed otherwise by the State recipient Award Official).

(b) Subrecipients shall obtain the wage determination for the locality in which a covered activity subject to DB will take place prior to issuing requests for bids, proposals, quotes or other methods for soliciting contracts (solicitation) for activities subject to DB. These wage determinations shall be incorporated into solicitations and any subsequent contracts. Prime contracts must contain a provision requiring that subcontractors follow the wage determination incorporated into the prime contract.

(i) While the solicitation remains open, the subrecipient shall monitor the U.S. Department of Labor's [General Services Administration](#) website on a weekly basis to ensure that the wage determination contained in the solicitation remains current. The subrecipients shall amend the solicitation if DOL issues a modification more than 10 days prior to the closing date (i.e. bid opening) for the solicitation. If DOL modifies or supersedes the applicable wage determination less than 10 days prior to the closing date, the subrecipients may request a finding from the State recipient that there is not a reasonable time to notify interested contractors of the modification of the wage determination. The State recipient will provide a report of its findings to the subrecipient.

(ii) If the subrecipient does not award the contract within 90 days of the closure of the solicitation, any modifications or supersedes DOL makes to the wage determination contained in the solicitation shall be effective unless the State recipient, at the request of the subrecipient, obtains an extension of the 90 day period from DOL pursuant to 29 CFR 1.6(c)(3)(iv). The subrecipient shall monitor the U.S. Department of Labor's [General Services Administration](#) website on a weekly basis if it does not award the contract within 90 days of closure of the solicitation to ensure that wage determinations contained in the solicitation remain current.

(c) If the subrecipient carries out activity subject to DB by issuing a task order, work assignment or similar instrument to an existing contractor (ordering instrument) rather than by publishing a solicitation, the subrecipient shall insert the appropriate DOL wage determination from the U.S. Department of Labor's [General Services Administration](#) website into the ordering instrument.

(c) Subrecipients shall review all subcontracts subject to DB entered into by prime contractors to verify that the prime contractor has required its subcontractors to include the applicable wage determinations.

(d) As provided in 29 CFR 1.6(f), DOL may issue a revised wage determination applicable to a subrecipient's contract after the award of a contract or the issuance of an ordering instrument if DOL determines that the subrecipient has failed to incorporate a wage determination or has used a wage determination that clearly does not apply to the contract or ordering instrument. If this occurs, the subrecipient shall either terminate the contract or ordering instrument and issue a revised solicitation or ordering instrument or incorporate DOL's wage determination retroactive to the beginning of the contract

or ordering instrument by change order. The subrecipient's contractor must be compensated for any increases in wages resulting from the use of DOL's revised wage determination.

3. Contract and Subcontract provisions.

(a) The Recipient shall insure that the subrecipient(s) shall insert in full in any contract in excess of \$2,000 which is entered into for the actual construction, alteration and/or repair, including painting and decorating, of a treatment work under the CWSRF or a construction project under the DWSRF financed in whole or in part from Federal funds or in accordance with guarantees of a Federal agency or financed from funds obtained by pledge of any contract of a Federal agency to make a loan, grant or annual contribution (except where a different meaning is expressly indicated), and which is subject to the labor standards provisions of any of the acts listed in § 5.1 or the FY 2013 Continuing Resolution, the following clauses:

(1) Minimum wages.

(i) All laborers and mechanics employed or working upon the site of the work, will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (a)(1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in § 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph (a)(1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

Subrecipients may obtain wage determinations from the U.S. Department of Labor's [General Services Administration](#) website.

(ii)(A) The subrecipient(s), on behalf of EPA, shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The State award official shall approve a request for an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the subrecipient(s) agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), documentation of the action taken and the request, including the local wage determination shall be sent by the subrecipient(s) to the State award official. The State award official will transmit the report, to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210 and to the EPA DB Regional Coordinator concurrently. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification request within 30 days of receipt and so advise the State award official or will notify the State award official within the 30-day period that additional time is necessary.

(C) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the and the subrecipient(s) do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the award official shall refer the request, and the local wage determination, including the views of all interested parties and the recommendation of the State award official, to the Administrator for determination. The request shall be sent to the EPA Regional Coordinator concurrently. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt of the request and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (a)(1)(ii)(B) or (C) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

(2) Withholding. The subrecipient(s) shall upon written request of the EPA Award Official or an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the (Agency) may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

(3) Payrolls and basic records.

(i) Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the

site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii)(A) The contractor shall submit weekly, for each week in which any contract work is performed, a copy of all payrolls to the subrecipient, that is, the entity that receives the sub-grant or loan from the State capitalization grant recipient. Such documentation shall be available on request of the State recipient or EPA. As to each payroll copy received, the subrecipient shall provide written confirmation in a form satisfactory to the State indicating whether or not the project is in compliance with the requirements of 29 CFR 5.5(a)(1) based on the most recent payroll copies for the specified week. The payrolls shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on the weekly payrolls. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the [Wage and Hour Division's](#) webpage or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the subrecipient(s) for transmission to the State or EPA if requested by EPA, the State, the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the subrecipient(s).

(B) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under § 5.5(a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under § 5.5(a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(2) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph (a)(3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

(iii) The contractor or subcontractor shall make the records required under paragraph (a)(3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the State, EPA or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the Federal agency or State may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

(4) Apprentices and trainees.

(i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her 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 Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a 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 on the job site shall not be greater than 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 the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and

Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee 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 applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the contractor 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.

(iii) Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

(5) Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

(6) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the EPA determines may be appropriate, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

(7) Contract termination: debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

(8) Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

(9) Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and Subrecipient(s), State, EPA, the U.S. Department of Labor, or the employees or their representatives.

(10) Certification of eligibility.

(i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

4. Contract Provision for Contracts in Excess of \$100,000.

(a) Contract Work Hours and Safety Standards Act. The subrecipient shall insert the following clauses set forth in paragraphs (a)(1), (2), (3), and (4) of this section in full in any contract in an amount in excess of \$100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act.

These clauses shall be inserted in addition to the clauses required by Item 3, above or 29 CFR 4.6. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

(1) Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(2) Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (b)(1) of this section the contractor and any subcontractor responsible therefore shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (b)(1) of this section, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (b)(1) of this section.

(3) Withholding for unpaid wages and liquidated damages. The subrecipient shall upon the request of the EPA Award Official or an authorized representative of the Department of Labor, withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (a)(2) of this section.

(4) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (b)(1) through (4) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (b)(1) through (4) of this section.

(c) In addition to the clauses contained in Item 3, above, in any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in 29 CFR 5.1, the Subrecipient shall insert a clause requiring that the contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Further, the Subrecipient shall insert in any such contract a clause providing that the records to be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the (write the name of agency) and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job.

5. Compliance Verification.

(a) The subrecipient shall periodically interview a sufficient number of employees entitled to DB prevailing wages (covered employees) to verify that contractors or subcontractors are paying the appropriate wage rates. As provided in 29 CFR 5.6(a)(6), all interviews must be conducted in confidence. The subrecipient must use Standard Form 1445 (SF 1445) or equivalent documentation to memorialize the interviews. Copies of the SF 1445 are available from EPA on request.

(b) The subrecipient shall establish and follow an interview schedule based on its assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract. Subrecipients must conduct more frequent interviews if the initial interviews or other information indicates that there is a risk that the contractor or subcontractor is not complying with DB. Subrecipients shall immediately conduct necessary interviews in response to an alleged violation of the prevailing wage requirements. All interviews shall be conducted in confidence.

(c) The subrecipient shall periodically conduct spot checks of a representative sample of weekly payroll data to verify that contractors or subcontractors are paying the appropriate wage rates. The subrecipient shall establish and follow a spot check schedule based on its assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract. At a minimum, if practicable the subrecipient should spot check payroll data within two weeks of each contractor or subcontractor's submission of its initial payroll data and two weeks prior to the completion date the contract or subcontract. Subrecipients must conduct more frequent spot checks if the initial spot check or other information indicates that there is a risk that the contractor or subcontractor is not complying with DB. In addition, during the examinations the subrecipient shall verify evidence of fringe benefit plans and payments thereunder by contractors and subcontractors who claim credit for fringe benefit contributions.

(d) The subrecipient shall periodically review contractors and subcontractors use of apprentices and trainees to verify registration and certification with respect to apprenticeship and training programs approved by either the U.S Department of Labor or a state, as appropriate, and that contractors and subcontractors are not using disproportionate numbers of, laborers, trainees and apprentices. These reviews shall be conducted in accordance with the schedules for spot checks and interviews described in Item 5(b) and (c) above.

(e) Subrecipients must immediately report potential violations of the DB prevailing wage requirements to the EPA DB contact listed above and to the appropriate DOL Wage and Hour [District Office](#) or its successor site.

AMERICAN IRON AND STEEL REQUIREMENT

The Contractor acknowledges to and for the benefit of the _____ (“Purchaser”) and the State of Kentucky (the “State”) that it understands the goods and services under this Agreement are being funded with monies made available by the Clean Water State Revolving Fund and/or Drinking Water State Revolving Fund that have statutory requirements commonly known as “American Iron and Steel;” that requires all of the iron and steel products used in the project to be produced in the United States (“American Iron and Steel Requirement”) including iron and steel products provided by the Contractor pursuant to this Agreement.

The Contractor hereby represents and warrants to and for the benefit of the Purchaser and the State that (a) the Contractor has reviewed and understands the American Iron and Steel Requirement, (b) all of the iron and steel products used in the project will be and/or have been produced in the United States in a manner that complies with the American Iron and Steel Requirement, unless a waiver of the requirement is approved, and (c) the Contractor will provide any further verified information, certification or assurance of compliance with this paragraph, or information necessary to support a waiver of the American Iron and Steel Requirement, as may be requested by the Purchaser or the State.

Notwithstanding any other provision of this Agreement, any failure to comply with this paragraph by the Contractor shall permit the Purchaser or State to recover as damages against the Contractor any loss, expense, or cost (including without limitation attorney’s fees) incurred by the Purchaser or State resulting from any such failure (including without limitation any impairment or loss of funding, whether in whole or in part, from the State or any damages owed to the State by the Purchaser).

While the Contractor has no direct contractual privity with the State, as a lender to the Purchaser for the funding of its project, the Purchaser and the Contractor agree that the State is a third-party beneficiary and neither this paragraph (nor any other provision of this Agreement necessary to give this paragraph force or effect) shall be amended or waived without the prior written consent of the State.

Sample Certification

The following information is provided as a sample letter of step certification for AIS compliance. Documentation must be provided on company letterhead.

Date

Company Name
Company Address
City, State Zip

Subject: American Iron and Steel Step Certification for Project (XXXXXXXXXX)

I, (company representative), certify that the (melting, bending, coating, galvanizing, cutting, etc.) process for (manufacturing or fabricating) the following products and/or materials shipped or provided for the subject project is in full compliance with the American Iron and Steel requirement as mandated in EPA's State Revolving Fund Programs.

Item, Products and/or Materials:

1. XXXX
2. XXXX
3. XXXX

Such process took place at the following location:

If any of the above compliance statements change while providing material to this project we will immediately notify the prime contractor and the engineer.

Signed by company representative

Division 1 – General Requirements

SECTION 01010 - SUMMARY OF WORK

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The primary scope of work includes a new OSG mixed oxidant disinfection system, sedimentation basin covers, filter no. 5 installation, high service VFDs, new bacteriological laboratory, window replacements, and various electrical improvements including raw water and backwash magnetic flow meters, and SCADA replacement, and related appurtenances.
- B. The Contractor shall include all materials, labor and equipment necessary for completion of the Project. The Contract Documents are intended to provide the basis for proper completion of the work suitable for the intended use of the Owner. Anything not expressly set forth but which is reasonably implied or necessary for proper performance of the Project shall be included.
- C. Continuous Operations: The existing system must be maintained in continuous operation in such a manner that it meets all local, state, and federal requirements. The Contractor is responsible not to deactivate, demolish, or interfere with any system required for the continuous operation until a temporary or new permanent-like system has been installed and is operational. The Contractor is responsible for payment of all fines resulting from any action or inaction on his part or the part of his subcontractors during performance of the Work that is illegal.
- D. The following major Work items are included in the Contract:
 - 1. OSG Mixed Oxidant Disinfection System
 - 2. Sedimentation Basin Covers
 - 3. Filter Installation
 - 4. Bacteriological Laboratory
 - 5. High Service Pump VFDs
 - 6. Raw Water and Backwash Magnetic Flow Meters
 - 7. SCADA Replacement

1.02 PERMITS

Obtain any permits related or required by the Work in this Contract.

1.03 CODES

Comply with applicable codes and regulations of authorities having jurisdiction.

Submit copies of inspection reports, notices, citations and similar communication to the Owner.

1.04 EXISTING CONDITIONS AND DIMENSIONS

- A. The Work in this Contract will primarily be performed in or around existing facilities of which a portion must remain functional. This Contractor must maintain the required items and/or systems functional without additional effort by the Owner's personnel and at no extra costs to the Owner.
- B. The Contractor is responsible for verifying all existing conditions, elevations, dimensions, etc., and providing his finished work to facilitate existing conditions.

END OF SECTION 01010

SECTION 01015 - WORK SEQUENCE

PART 1 - GENERAL

1.01 WORK INCLUDED

The Contractor shall conform to all miscellaneous requirements as contained in the Contract.

1.02 RELATED REQUIREMENTS

- A. Section 00700 - General Conditions.
- B. Section 01010 - Summary of Work.
- C. Section 01040 - Coordination.

PART 2 - PRODUCTS

2.01 MATERIALS

The Contractor shall comply with the Specifications for type of work to be done.

PART 3 - EXECUTION

3.01 SEQUENCE OF CONSTRUCTION OPERATIONS

- A. The Contractor shall submit to the Engineer for review and acceptance a complete schedule (progress chart) of his proposed sequence of construction operations prior to commencement of work. However, the Engineer shall not accept a construction schedule that fails to utilize the entire time allocated for the construction of the Project. The Contractor shall schedule the various construction activities to complete the Project throughout the entire allotted time period. This schedule requirement in no way prevents the Contractor from completing the Project in a shorter time frame than scheduled. The construction schedule along with a cost breakdown schedule shall be submitted and approved by the Owner prior to the submittal of the first partial payment request in accordance with the General Conditions. A revised construction schedule shall be submitted to the Owner with each pay request. This revised schedule must be approved by the Owner prior to payment.
- B. **All existing utilities must remain in service until the new work is placed into service. Coordination with the Owner and Engineer will be required. No wastewater by-passing or uncoordinated "down time" shall occur during construction unless a schedule has been approved by the State and/or by**

EPA/NEPA permit if required. The Contractor shall develop a sequence of construction that avoids and/or minimizes disruption to the existing system. The Contractor shall provide proper notification and coordination to the Engineer and Owner should a temporary disruption be anticipated or required. The Contractor shall submit a written request to the Engineer and Owner ten (10) days prior to any specific construction activity that disrupts existing operations. The Owner must pre-approve any construction activity that will cause a temporary shutdown of any existing water or sewer lines.

END OF SECTION 01015

SECTION 01020 - ALLOWANCES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Contractor shall include in the lump sum bid allowances for Human Machine Interface (HMI) software and computer hardware as follows:

Item	Amount
HMI Software and Computer Hardware	\$200,000.00

- B. The PLC programming software allowance will provide for the latest version of Rockwell RS Logix 5000. HMI software shall be FactoryTalk View SE, with FactoryTalk Historian SE, XL Reporter, and Win911. Equal software packages will be considered. Details regarding specific software requirements will be provided by the Engineer after the Contract is awarded.

- C. The computer hardware allowance will provide for the following

Quantity	Description	Location
1	Server	Control Room
2	Client Workstation	Office, Lab
2	UPS	Client Workstations

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The HMI software and computer hardware shall be installed, programmed, and commissioned under this Contract.

END OF SECTION 01020

SECTION 01021 – ADDITIONAL ALLOWANCES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Contractor shall include in the Lump Sum Bid additional allowances as follows:

Item	Amount
Window Replacement Material and Labor	\$20,000.00
Tile Floor Replacement Material and Labor	\$30,000.00
Spare Chemical Feed Pumps/Skids Equipment	\$40,000.00
Water Booster Pump Equipment	\$30,000.00
High Service Check Valve Replacement	\$80,000.00
TOTAL ADDITIONAL ALLOWANCES	\$200,000.00

- B. If the budget allows, the Owner may choose from any or all items on this list to implement into the project as necessary. The Owner may also choose to deduct these total amounts from the Lump Sum Bid.

END OF SECTION 01021

SECTION 01025 - MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.01 WORK INCLUDED

The Contractor shall furnish all necessary labor, machinery, tools, apparatus, equipment, materials, services and other necessary supplies and perform all work shown on the Drawings and/or described in the Specifications and Contract Documents at the unit or lump sum price.

1.02 COMPUTATION OF QUANTITIES

For estimating quantities, the appropriate "industry standard" method (where applicable) will be utilized. The Engineer can require the Contractor to provide a detailed itemization of the materials and labor required.

1.03 PROGRESS AND PAYMENT SCHEDULES (Also see Section 00700)

- A. Within fifteen (15) days after the date of formal execution of the Agreement, the Contractor shall prepare and submit to the Engineer, for approval, a construction schedule that depicts the Contractor's plan for completing the Contract requirements and show work placement in dollars versus Contract time. The Contractor's construction schedule must be approved by the Engineer before any payments will be made on this Contract.
- B. Within fifteen (15) days after the date of formal execution of the Agreement, the Contractor shall prepare and submit to the Engineer, for approval, a periodic estimate which depicts the Contractor's cost for completing the Contract requirements and shows by major unit of the project work the Contractor's dollar value for the material and the labor (two separate amounts) to be used as a basis for the periodic payments. The Contractor's periodic estimate must be approved by the Engineer before any payments will be made on this Contract.
- C. The Engineer's decision as to sufficiency and completeness of the Contractor's construction schedule and periodic estimate will be final.
- D. The Contractor must make current, to the satisfaction of the Engineer, the construction schedule and periodic estimate each time he requests a payment on this Contract.
- E. The Contractor's construction schedule and periodic estimate must be maintained at the construction site available for inspection and shall be revised to incorporate approved change orders as they occur.
- F. When the Contractor requests a payment on this Contract, it must be on the approved periodic estimate and be current. Further, the current periodic estimate and construction schedule (both updated and revised) shall be submitted for review and

approval by the Engineer before monthly payments will be made by the Owner. The Contractor shall submit five (5) current copies of each (periodic estimate and construction schedule) when requesting payment.

1.04 CONDITIONS FOR PAYMENT (See also Article 1.50/Section 00700)

- A. The Owner will make payments for acceptable work in place and materials properly stored on-site. The value of payment shall be as established on the approved construction schedule and periodic estimate, EXCEPT the Owner will retain ten percent (10%) of the work in place and ten percent (10%) for items properly stored or untested.
- B. Payment for materials or equipment purchased and stored at the site of the Project will be allowed by the Owner at the cost of such materials or equipment, less the same percentage of retainage applicable to payment for completed work, upon specific recommendation of the Engineer. Such payment shall be conditional upon submission by the Contractor of bills of sale or such other procedure as will establish the Owner's title to such material or otherwise adequately protect the Owner's interest. No payment will be made for stored materials unless a proper invoice from the supplier is attached to the pay request. Furthermore, no item whose value is less than \$1,000.00 will be considered as stored materials for pay purposes.

Only durable materials and equipment that in the opinion of the Engineer have been properly stored and protected shall be included in materials furnished in partial payment estimates. The Contractor must comply with manufacturers' recommendations with respect to equipment storage and maintenance. The Engineer may impose additional storage, maintenance and/or testing requirements as necessary to protect equipment and/or verify that no damage or deterioration has occurred as a result of on-site storage. Damaged equipment shall be repaired or replaced by the Contractor at his expense.

- C. No payment will be made for the labor portion of the piping line items until the piping has been tested and accepted by the Engineer.
- D. Payment for equipment items shall be limited to ninety percent (90%) of their scheduled value (materials portion only) until they are set in place. Ninety percent (90%) payment for stored materials and equipment shall be contingent on proper on-site storage as recommended by the manufacturer or required by the Engineer.
- E. Payment for equipment items set in-place shall be limited to ninety percent (90%) of their scheduled value until they are ready for operation and have been certified by the manufacturer. Ninety percent (90%) payment for installed equipment shall be contingent on proper routine maintenance of the equipment in accordance with the manufacturer's recommendations.

- F. Payment for the labor portion of equipment items will be subject only to the degree of completeness and the appropriate retainage.
- G. The Owner may reduce the percent of retainage once the Project has achieved satisfactory progress and is at the fifty percent (50%) construction status. The dollar amount of retainage for work-in-place will not be reduced but will remain constant following the fifty percent (50%) constructed status. The retainage on the equipment items shall be determined as defined hereinbefore.
- H. Additionally, the Owner may reinstate the retainage to a full ten percent (10%) of the scheduled value of work-in-place and material items should the Owner, at its discretion, determine that the Contractor is not making satisfactory progress or there is other specific cause for such withholding.

1.05 CLAIMS FOR EXTRA WORK (See also Article 1.61/Section 00700)

- A. If the Contractor claims that any instructions by Drawings or otherwise involve extra cost, he shall give the Engineer written notice of said claim within ten (10) days after the receipt of such instructions, and in any event before proceeding to execute the work, stating clearly and in detail the basis of his claim or claims. No such claim shall be valid unless so made.
- B. Claims for additional compensation for extra work, due to alleged errors in spot elevations, contour lines or bench marks, will not be recognized unless accompanied by certified survey data, made prior to the time the original ground was disturbed, clearly showing that errors exist which resulted, or would result, in handling more material or performing more work than would be reasonably estimated from the Drawings and topographical maps issued.
- C. Any discrepancies which may be discovered between actual conditions and those represented by the topographical maps and Drawings shall at once be reported to the Engineer, and work shall not proceed, except at the Contractor's risk, until written instructions have been received by him from the Engineer.
- D. If, on the basis of the available evidence, the Engineer determines that an adjustment of the Contract Price or time is justifiable, the procedure shall then be as provided herein for "Changes in Work".
- E. By execution of this Contract, the Contractor warrants that he has visited the site of the proposed work and fully acquainted himself with the conditions there existing relating to construction and labor, and that he fully understands the facilities, difficulties and restrictions attending the execution of the work under this Contract. The Contractor further warrants that he has thoroughly examined and is familiar with the Drawings, Specifications and all other documents comprising the Contract. The Contractor further warrants that by execution of this Contract his failure when he was bidding on

this Contract to receive or examine any form, instrument or document or to visit the site and acquaint himself with conditions there existing, in no way relieves him from any obligation under the Contract, and the Contractor based on facts regarding which he should have been on notice as a result thereof.

1.06 DETERMINATION OF THE VALUE OF EXTRA (ADDITIONAL) OR OMITTED WORK (See also, Article 1.62/Section 00700)

- A. The value of extra (additional) or omitted work shall be determined in one or more of the following ways:
 - 1. On the basis of the actual cost of all the items of labor (including on-the-job supervision), materials and use of equipment plus a maximum of fifteen percent (15%) which shall cover the Contractor's general supervision, overhead and profit. In case of subcontracts, the fifteen percent (15%) is interpreted to mean the subcontractor's supervision, overhead and profit, and an additional five percent (5%) may then be added to such costs to cover the General Contractor's supervision, overhead and profit. The cost of labor shall include required insurance, taxes and fringe benefits. Equipment costs shall be based on current rental rates in the areas where the work is being performed, but in no case shall such costs be greater than the current rates published by the Associated Equipment Distributors, Chicago, Illinois.
 - 2. By estimate and acceptance in a lump sum.
 - 3. By unit prices named in the Contract or subsequently agreed upon.
- B. Provided, however, that the cost or estimated cost of all extra (additional) work shall be determined in advance of authorization by the Engineer and approved by the Owner.
- C. All extra (additional) work shall be executed under the conditions of the original Contract. Any claim for extension of time shall be adjusted according to the proportionate increase or decrease in the final total cost of the work unless negotiated on another basis.
- D. No extra (additional) work shall be done except upon a written Change Order from the Engineer, and no claim on the part of the Contractor for pay for extra (additional) work shall be recognized unless so ordered in writing by the Engineer.

END OF SECTION 01025

SECTION 01030 - LABOR PROVISIONS

PART 1 - GENERAL

1.01 WORK INCLUDED

The Contractor shall conform to all provisions of the U.S. Department of Labor, Latest Revisions, relative to wages and hours as they may apply to the work to be accomplished.

1.02 WAGE RATES

A copy of the appropriate Wage Determinations are included in these Contract Documents.

END OF SECTION 01030

"General Decision Number: KY20240058 09/06/2024

Superseded General Decision Number: KY20230058

State: Kentucky

Construction Type: Heavy

Counties: Adair, Barren, Casey, Clinton, Cumberland, Green, Hart, Knox, Laurel, Logan, Marion, McCreary, Metcalfe, Pulaski, Russell, Simpson, Taylor, Wayne and Whitley Counties in Kentucky.

HEAVY CONSTRUCTION PROJECTS (including sewer/water construction).

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658.

Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(1).

If the contract is entered	. Executive Order 14026
into on or after January 30,	generally applies to the
2022, or the contract is	contract.

renewed or extended (e.g., an	. The contractor must pay
option is exercised) on or	all covered workers at
after January 30, 2022:	least \$17.20 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 2024.

| _____ | _____ |

If the contract was awarded on	. Executive Order 13658
or between January 1, 2015 and	generally applies to the
January 29, 2022, and the	contract.

contract is not renewed or	. The contractor must pay all
extended on or after January	covered workers at least
30, 2022:	\$12.90 per hour (or the

	applicable wage rate listed
	on this wage determination,
	if it is higher) for all
	hours spent performing on
	that contract in 2024.

| _____ | _____ |

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

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

Modification Number Publication Date

0	01/05/2024
1	03/01/2024
2	05/31/2024
3	07/05/2024
4	09/06/2024

CARP0064-007 04/01/2024

Rates Fringes

CARPENTER (Form Work Only).....\$ 32.90 23.37

ELEC0369-004 09/04/2023

Rates Fringes

LINE CONSTRUCTION

Equipment Operator.....\$ 38.76 23%+7.00

Groundman.....\$ 25.51 23%+7.00

Lineman.....\$ 43.41 23%+7.00

ENGI0181-010 07/01/2024

Rates Fringes

POWER EQUIPMENT OPERATOR

GROUP 1.....\$ 40.05 19.10

GROUP 2.....\$ 37.19 19.10

GROUP 4.....\$ 36.87 19.10

OPERATING ENGINEER CLASSIFICATIONS

GROUP 1 - Crane; Drill; Grader/Blade; Mechanic; Scraper

GROUP 2 - Bobcat/Skid Steer/Skid Loader; Forklift

GROUP 4 - Oiler

Operators on cranes with booms 150 feet and over (including jib) shall receive \$1.00 above Group 1 rate; 250 feet and over including jib shall receive \$1.50 above Class 1 rate.

Combination Rate: All crane operators operating cranes, where the length of the boom in combination with the length of the piling leads equal or exceeds 150 feet, shall receive \$1.00 above the Group 1 rate.

Employees assigned to work below ground level are to be paid 10% above basic wage rate. This does not apply to open cut work.

* IRON0782-010 08/01/2024

	Rates	Fringes

IRONWORKER (Reinforcing &
Structural)

Projects over

\$20,000,000.00.....	\$ 35.75	26.34

Projects under

\$20,000,000.00.....	\$ 34.01	24.83

LABO0189-014 07/01/2023

	Rates	Fringes

LABORER

Concrete Saw (Hand

Held/Walk Behind).....	\$ 24.21	17.57

Concrete Worker.....	\$ 23.96	17.57

SUKY2011-014 06/25/2014

	Rates	Fringes

CEMENT MASON/CONCRETE FINISHER...	\$ 21.60	10.35

ELECTRICIAN.....	\$ 32.35	2.18

LABORER: Common or General.....	\$ 20.60	9.39

LABORER: Flagger.....	\$ 18.31	8.89

LABORER: Pipelayer.....	\$ 20.13	8.63

OPERATOR:

Backhoe/Excavator/Trackhoe.....\$ 23.60 12.65

OPERATOR: Bulldozer.....\$ 21.72 7.45

OPERATOR: Loader.....\$ 30.35 0.00

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 <https://www.dol.gov/agencies/whd/government-contracts>.

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) (iii)).

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.

State Adopted Rate Identifiers

Classifications listed under the ""SA"" identifier indicate that the prevailing wage rate set by a state (or local) government was adopted under 29 C.F.R. §1.3(g)-(h). Example: SAME2023-007 01/03/2024. SA reflects that the rates are state adopted. ME refers to the State of Maine. 2023 is the year during which the state completed the survey on which the listed classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 01/03/2024 reflects the date on which the classifications and rates under the ?SA? identifier took effect under state law in the state from which the rates were adopted.

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 National Office because National Office has 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"

SECTION 01040 - COORDINATION

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The Contractor shall coordinate the Work of all crafts, trades and subcontractors engaged on the Work, and he shall have final responsibility in regards to the schedule, workmanship and completeness of each and all parts of the Work.
- B. All crafts, trades and subcontractors shall be made to cooperate with each other and with others as they may be involved in the installation of work which adjoins, incorporates, precedes or follows the work of another. It shall be the Contractor's responsibility to point out areas of cooperation prior to execution of subcontract agreements and the assignment of the parts of the Work. Each craft, trade and subcontractor shall be made responsible to the Owner, for furnishing embedded items, giving directions for doing all cutting and fitting, making all provisions for accommodating the Work, and for protecting, patching, repairing and cleaning as required to satisfactorily perform the Work.
- C. The Contractor shall be responsible for all cutting, digging and other action of his subcontractors and workmen. Where such action impairs the safety or function of any structure or component of the Project, the Contractor shall make such repairs, alterations and additions as will, in the opinion of the Engineer, bring said structure or component back to its original design condition at no additional cost to the Owner.
- D. Each subcontractor is expected to be familiar with the General Requirements and all Sections of the Detailed Specifications for all other trades and to study all Drawings applicable to his work to the end that complete coordination between the trades will be affected. Each Contractor shall consult with the Engineer if conflicts exist on the Drawings.
- E. No extra compensation will be allowed to cover the cost of removing piping, conduits, etc., or equipment found encroaching on space required by others.

END OF SECTION 01040

SECTION 01045 - CUTTING AND PATCHING

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide cutting and patching work to properly complete the work of the project, complying with requirements for:
 - 1. Connection to existing utility lines and structures.
- B. Do not cut and patch in a manner that would result in a failure of the work to perform as intended, decreased energy performance, increased maintenance, decreased operational life, or decreased safety.

PART 2 - PRODUCTS

2.01 MATERIALS

Match existing materials for cutting and patching work with new materials conforming to project requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Inspect conditions prior to work to identify scope and type of work required. Protect adjacent work. Notify Owner of work requiring interruption to building services or Owner's operations.
- B. Perform work with workmen skilled in the trades involved. Prepare sample area of each type of work for approval.
- C. Cutting: Use cutting tools, not chopping tools. Make neat holes. Minimize damage to adjacent work. Check for concealed utilities and structure before cutting.
- D. Patching: Make patches, seams, and joints durable and inconspicuous. Comply with tolerances for new work.
- E. Clean work area and areas affected by cutting and patching operations.

END OF SECTION 01045

SECTION 01070 - ABBREVIATIONS AND SYMBOLS

PART 1 - GENERAL

1.01 REQUIREMENTS INCLUDED

Where any of the following abbreviations are used in the Contract Documents, they shall have the meaning set forth as follows.

1.02 QUALITY ASSURANCE

- A. For products or workmanship specified by association, trade or federal standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. The date of the standard is that in effect as of the Bid date, or date of Owner-Contractor Agreement when there are no bids, except when a specific date is specified.
- C. When required by individual Specifications section, obtain copy of standard. Maintain a copy at job site during submittals, planning and progress of the specific work, until Substantial Completion.

1.03 SCHEDULE OF REFERENCES

ACI	American Concrete Institute
AFBMA	Anti-Friction Bearing Manufacturers Association
AGMA	American Gear Manufacturers Association
IEEE	Institute of Electrical and Electronics Engineers, Inc.
AISC	American Institute of Steel Construction
ANS	American National Standard
ANSI	American National Standards Institute
API	American Petroleum Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers

ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWPA	American Wood-Preservers' Association
AWWA	American Water Works Association
IBR	Institute of Boiler and Radiator Manufacturers
IPS	Iron Pipe Size
NBS	National Bureau of Standards
NEC	National Electrical Code; latest edition
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
Fed.	Federal Specifications issued by the Federal
Spec.	Supply Service of the General Services Administration, Washington, DC
125-lb. ANS	American National Standard for Cast-Iron Pipe
250-lb. ANS	Flanges and Flanged Fittings, Designation B16.1-1975, for the appropriate class
AWG	American or Brown and Sharpe Wire Gage
NPT	National Pipe Thread
Stl. WG	U.S. Steel Wire, Washburn and Moen, American Steel and Wire or Roebling Gage
UL	Underwriters' Laboratories

END OF SECTION 01070

SECTION 01300 - SUBMITTALS

PART 1 - GENERAL

1.01 WORK INCLUDED

Shop drawing, descriptive literature, project data and samples (when samples are specifically requested) for all manufactured or fabricated items shall be submitted by the Contractor to the Engineer for examination and review in the form and in the manner required by the Engineer. All submittals shall be furnished in at least three (3) copies to be retained by the Engineer and shall be checked and reviewed by the Contractor before submission to the Engineer. The review of the submittal by the Engineer shall not be construed as a complete check, but will indicate only that the general method of construction and detailing is satisfactory. Review of such submittal will not relieve the Contractor of the responsibility for any errors which may exist as the Contractor shall be responsible for the dimensions and design of adequate connections, details, and satisfactory construction of all work.

1.02 RELATED REQUIREMENTS

- A. Section 00700 - General Conditions.
- B. Section 01720 - Project Record Documents (As-Builts).

1.03 DEFINITIONS

The term "submittals" shall mean shop drawings, manufacturer's drawings, catalog sheets, brochures, descriptive literature, diagrams, schedules, calculations, material lists, performance charts, test reports, office and field samples, and items of similar nature which are normally submitted for the Engineer's review for conformance with the design concept and compliance with the Contract Documents.

1.04 GENERAL CONDITIONS

Review by the Engineer of shop drawings or submittals of material and equipment shall not relieve the Contractor from the responsibilities of furnishing same of proper dimension, size, quantity, materials and all performance characteristics to efficiently perform the requirements and intent of the Contract Documents. Review shall not relieve the Contractor from responsibility for errors of any kind on the shop drawings.

Review is intended only to assure conformance with the design concept of the Project and compliance with the information given in the Contract Documents. Review of shop drawings shall not be construed as releasing the Contractor from the responsibility of complying with the Specifications.

1.05 GENERAL REQUIREMENTS FOR SUBMITTALS

- A. Shop drawings shall be prepared by a qualified detailer. Details shall be identified by reference to sheet and detail numbers shown on Contract Documents. Where applicable, show fabrication, layout, setting and erection details. Shop drawings are defined as original drawings prepared by the Contractor, subcontractors, suppliers, or distributors performing work under this Contract. Shop drawings illustrate some portion of the work and show fabrication, layout, setting or erection details of equipment, materials and components. The Contractor shall, except as otherwise noted, have prepared the number of reviewed copies required for his distribution plus three (3) which will be retained by the Engineer and Owner. Shop drawings shall be folded to an approximate size of 8-1/2 inch x 11 inch and in such manner that the title block will be located in the lower righthand corner of the exposed surface.
- B. Project data shall include manufacturer's standard schematic drawings modified to delete information which is not applicable to the Project, and shall be supplemented to provide additional information applicable to the Project. Each copy of descriptive literature shall be clearly marked to identify pertinent information as it applies to the Project.
- C. Where samples are required, they shall be adequate to illustrate materials, equipment or workmanship, and to establish standards by which completed work is judged. Provide sufficient size and quantity to clearly illustrate functional characteristics of product and material, with integrally related parts and attachment devices, along with a full range of color samples.
- D. All submittals shall be referenced to the applicable item, section and division of the Specifications, and to the applicable Drawing(s) or Drawing schedule(s) and shall be with transmittal forms and format provided by the Engineer.
- E. The Contractor shall review and check submittals, and indicate his review by initials and date.
- F. If the submittals deviate from the Contract Drawings and/or Specifications, the Contractor shall advise the Engineer, in letter of transmittal of the deviation and the reasons therefor. All changes shall be clearly marked on the submittal with a bold mark other than red. Any additional costs for modifications shall be borne by the Contractor.
- G. In the event the Engineer does not specifically reject the use of material or equipment at variance to that which is shown on the Drawings or specified, the Contractor shall, at no additional expense to the Owner, and using methods reviewed by the Engineer, make any changes to structures, piping, controls, electrical work, mechanical work, etc., that may be necessary to accommodate this equipment or material. Should

equipment other than that on which design drawings are based be accepted by the Engineer, shop drawings shall be submitted detailing all modification work and equipment changes made necessary by the substituted item.

- H. Additional information on particular items, such as special drawings, schedules, calculations, performance curves, and material details, shall be provided when specifically requested in the technical Specifications.
- I. Submittals for all electrically operated items (including instrumentation and controls) shall include complete wiring diagrams showing lead, runs, number of wires, wire size, color coding, all terminations and connections, and coordination with related equipment.
- J. Equipment shop drawings shall indicate all factory or shop paint coatings applied by suppliers, manufacturers and fabricators; the Contractor shall be responsible for insuring the compatibility of such coatings with the field-applied paint products and systems.
- K. Fastener specifications of manufacturer shall be indicated on equipment shop drawings.
- L. Where manufacturer's brand names are given in the Specifications for building and construction materials and products, such as grout, bonding compounds, curing compounds, masonry cleaners, waterproofing solutions and similar products, the Contractor shall submit names and descriptive literature of such materials and products he proposes to use in this Contract.
- M. No material shall be fabricated or shipped unless the applicable drawings or submittals have been reviewed by the Engineer and returned to the Contractor.
- N. All bulletins, brochures, instructions, parts lists, and warranties packaged with and accompanying materials and products delivered to and installed in the Project shall be saved and transmitted to the Owner through the Engineer.
- O. All submittals shall be made by the use of a multi-copy transmittal form supplied by the Engineer. All applicable blanks on the form shall be filled in with the appropriate data.

1.06 CONTRACTOR RESPONSIBILITIES

- A. Verify field measurements, field construction criteria, catalog numbers and similar data.
- B. Coordinate each submittal with requirements of Work and Contact Documents.

- C. Notify Engineer, in writing at time of submission, of deviations in submittals from requirements of Contract Documents.
- D. Begin no work, and have no material or products fabricated or shipped which required submittals until return of submittals with Engineer's stamp and initials or signature indicating review.

END OF SECTION 01300

SECTION 01380 - CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. During the construction period through completion, provide photographic documentation of construction progress and at selected milestones including electronic indexing, navigation, storage and remote access to the documentation, as per these specifications. The commercial photographer or the subcontractor used for this work shall meet the following qualifications:
 - 1. Experienced 3rd party company with references/examples of similar construction documentation. Demonstrable minimum experience of three (3) years in operation providing documentation and advanced indexing/navigation systems including a representative portfolio of construction projects of similar type, size, duration and complexity as the Project.
 - 2. Demonstrable ability to service projects throughout North America, which shall be demonstrated by a representative portfolio of active projects of similar type, size, duration and complexity as the Project.
- B. Photographic documentation elements:
 - 1. Each digital image shall be taken with a professional grade camera with minimum size of 6 megapixels (MP) capable of producing 200x250mm (8 x 10 inch) prints with a minimum of 2272 x 1704 pixels and 400x500mm (16 x 20 inch) prints with a minimum 2592 x 1944 pixels.
 - 2. Indexing and navigation system shall utilize actual AUTOCAD construction drawings, making such drawings interactive on an on-line interface. For all documentation referenced herein, indexing and navigation must be organized by both time (date-stamped) and location throughout the project.
 - 3. Documentation shall combine indexing and navigation system with inspection-grade digital photography designed to capture actual conditions throughout construction and at critical milestones. Documentation shall be accessible on-line through use of an internet connection. Documentation shall allow for secure multiple-user access, simultaneously, on-line.
 - 4. Before construction, the building pad, adjacent streets, roadways, parkways, driveways, curbs, sidewalks, landscaping, adjacent utilities and adjacent structures surrounding the building pad and site shall be documented.

Overlapping photographic techniques shall be used to insure maximum coverage. Indexing and navigation accomplished through interactive architectural drawings. If site work or pad preparation is extensive, this documentation may be required immediately before construction and at several pre-determined intervals before building work commences.

5. Post Construction, the building pad, adjacent streets, roadways, parkways, driveways, curbs, sidewalks, landscaping, adjacent utilities and adjacent structures surrounding the building pad and site shall be documented. Overlapping photographic techniques shall be used to insure maximum coverage. Indexing and navigation accomplished through interactive architectural drawings. If site work or pad preparation is extensive, this documentation may be required immediately before construction and at several pre-determined intervals before building work commences.
6. Construction progress for all trades shall be tracked at pre-determined intervals, but not less than once every thirty (30) calendar days ("Progressions"). Progression documentation shall track both the exterior and interior construction of each structure. Exterior Progressions shall track 360 degrees around the site and each building. Interior Progressions shall track interior improvements beginning once each structure is enclosed and continuing until each structure is completed.

END OF SECTION 01380

SECTION 01400 - QUALITY CONTROL

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Work of all crafts and trades shall be laid out to lines and elevations as established by the Contractor from the Drawings or from instructions by the Engineer.
- B. Unless otherwise shown, all work shall be plumb and level, in straight lines and true planes, parallel or square to the established lines and levels. The Work shall be accurately measured and fitted to tolerance as established by the best practices of the crafts and trades involved, and shall be as required to fit all parts of the Work carefully and neatly together.
- C. All equipment, materials and articles incorporated into the Work shall be new and of comparable quality as specified. All workmanship shall be first-class and shall be performed by mechanics skilled and regularly employed in their respective trades.
- D. The Contractor shall determine that the equipment he proposes to furnish can be brought into the facility and installed in the space available. Equipment shall be installed so that all parts are readily accessible for inspection and maintenance.

1.02 WORKMANSHIP

Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.

1.03 MANUFACTURERS' INSTRUCTION

Comply with manufacturer's instructions in full detail as to shipping, handling, storing, installing, start-up and operation.

1.04 MANUFACTURERS' FIELD SERVICES

- A. The Contractor shall arrange for the services of qualified service representatives from the companies manufacturing or supplying each type of equipment required in the Specification sections and/or in Section 01450.
- B. The manufacturer or supplier shall provide sufficient engineering and technician manhours to satisfactorily complete Supervision of Installation, Equipment Check-out, Field Acceptance Tests, Pre-startup Operator Training, and Post-startup Services (see Section 01450).

1.05 TESTING SERVICES

- A. Tests, inspections and certifications of materials, equipment, subcontractors or completed work, as required by the various sections of the Specifications shall be provided by the Contractor and all costs shall be included in the Contract Price.
- B. The Contractor shall submit to the Owner the name of testing laboratory to be employed.
- C. Contractor shall deliver written notice to the Engineer at least two (2) work days in advance of any inspections or tests to be made at the Project site. All inspections or tests to be conducted in the field shall be done in the presence of the Owner or his representative.
- D. Certifications by independent testing laboratories may be by properly attested copies of the data including scientific procedures and results of tests.

END OF SECTION 01400

SECTION 01450 - SERVICES OF MANUFACTURER'S REPRESENTATIVE

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. General: The Contractor shall provide a qualified service representative from each company manufacturing or supplying certain equipment to perform the duties herein described and as required by the various sections of the Specifications. All costs shall be included in the Contract price.
 - 1. The service representative shall notify the Engineer each time he intends to be at the project site, and define the purpose of this visit. There will be no acknowledgment by the Owner of on-site visits by service representative unless such visits are properly logged by the Engineer.
- B. Supervision of Installation: Supervision of the workers and advice to the Owner to insure that proper procedures are followed during equipment installation.
- C. Equipment Check-out:
 - 1. After installation of the listed equipment has been completed and the equipment is presumably ready for operation but before it is operated by others, the representative shall inspect, operate, test and adjust the equipment. The inspection shall include but shall not be limited to, the following points as applicable:
 - a. Soundness (without cracked or otherwise damaged parts).
 - b. Completeness in all details as specified.
 - c. Correctness of setting, alignment and relative arrangement of various parts.
 - d. Adequacy and correctness of packing, sealing and lubricants.
 - 2. The operation, testing and adjustment shall be as required to prove that the equipment has been installed properly and is capable of satisfactory operation under the conditions specified. On completion of his work, the manufacturer's or supplier's representative shall submit in triplicate to the Engineer a complete signed report of the result of his inspection, operation, adjustments and tests. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results obtained if such are specified and suggestions for precautions to be taken to ensure proper maintenance. The report also shall include a certificate that the equipment conforms to the requirements of the Contract and is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.

- D. Field Acceptance Tests: After the Engineer has reviewed the reports from the manufacturer's representatives, the Contractor shall make arrangements to have qualified manufacturers' representatives present when the field acceptance tests are performed for a minimum of one (1) day for each piece of control equipment and one (1) day for each piece of process equipment. Costs to provide qualified manufacturers' representatives for field acceptance tests shall be included in the Contract price. Refer to control and/or equipment specifications for additional requirements.
- E. Pre-startup Operator Training: Provision of classroom and hands-on training to maintenance personnel in the operation and maintenance of the equipment prior to placing the equipment in full operation. The Contractor shall make arrangements to have qualified manufacturers' representatives present during pre-startup operator training for a minimum of one (1) day for each piece of control equipment and one (1) day for each piece of process equipment. Costs to provide qualified manufacturers' representatives for pre-startup operator training shall be included in the Contract price. Refer to control and/or equipment specifications for additional requirements.
- F. Post-startup Services: Provision of assistance to the Owner in the calibration, tuning and troubleshooting, plus any additional training which may be required during the year after the equipment is accepted by the Owner. The Contractor shall make arrangements to have qualified manufacturers' representatives present during post-startup services for a minimum of one (1) day for each piece of control equipment and one (1) day for each piece of process equipment. Costs to provide qualified manufacturers' representatives for post-startup services shall be included in the Contract price. Refer to control and/or equipment specifications for additional requirements.

END OF SECTION 01450

SECTION 01510 - TEMPORARY UTILITIES

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The Contractor shall maintain strict supervision of use of temporary utility services:
 - 1. Enforce compliance with applicable standards.
 - 2. Enforce safety practices.
 - 3. Prevent abuse of services.

1.02 RELATED REQUIREMENTS

Section 01590 - Field Offices.

1.03 REQUIREMENTS OF REGULATORY AGENCIES

- A. Obtain and pay for all permits as required by governing authorities.
- B. Obtain and pay for temporary easements required across property other than that of Owner.
- C. Comply with applicable codes.

1.04 REMOVAL

- A. Completely remove temporary materials, equipment, and miscellaneous items upon completion of construction and approval of the Engineer.
- B. Repair damage caused by installation and restore to specified or original condition.

1.05 TEMPORARY ELECTRICITY

Electrical services for construction needs and for lighting and heating the work area will be provided by the Contractor.

1.06 TEMPORARY LIGHTING

- A. Furnish and install temporary lighting required for:
 - 1. Construction needs.
 - 2. Safe and adequate working conditions.
 - 3. Public safety.
 - 4. Security lighting.
 - 5. Temporary office and storage area lighting.

- B. Service periods:
 - 1. Security lighting: All hours of darkness.
 - 2. Safety lighting:
 - a. Within construction area: All times that authorized personnel are present.
 - b. Public areas: At all times.
- C. Costs of Installation and Preparation: Contractor shall pay all installation, maintenance and removal costs of temporary lighting.
- D. Maintenance of temporary lighting service (replacement of bulbs, etc.) shall be the sole responsibility of the Contractor.

1.07 TEMPORARY HEATING AND VENTILATING

- A. Furnish and install temporary heat and ventilation in work areas throughout construction period to provide proper conditions required to:
 - 1. Facilitate progress of work.
 - 2. Protect work and products against dampness and cold.
 - 3. Prevent moisture condensation on surfaces.
 - 4. Provide adequate ventilation to meet health regulations for safe working environment.
- B. Temperatures required in building:
 - 1. Generally, 24 hours a day: minimum 40 degrees F (4.5 degrees C).
 - 2. 24 hours a day during placing, setting and curing of cementitious materials: as required by Specification section for each product.
 - 3. Storage areas: as required by Specification section for each product.
- C. Ventilation required:
 - 1. General: Prevent hazardous accumulations of dusts, fumes, mists, vapors or gases occupied during construction.
 - a. Provide local exhaust ventilation to prevent harmful dispersal of hazardous substances into atmosphere of occupied areas.
 - b. Dispose of exhaust materials in manner that will not result in harmful exposure to persons.
 - c. Ventilate storage spaces containing hazardous or volatile materials. 2. Provide adequate ventilation for:
 - a. Curing installed materials.
 - b. Dispersal of humidity.
 - c. Ventilation of temporary sanitary facilities.
 - 3. Duration of operation:
 - a. For personnel:
 - (1) At all times personnel occupies an area subject to hazardous accumulations of harmful elements.

- (2) Continue operation of ventilation and exhaust system for time after cessation of work process to assure removal of harmful elements.
 - b. For curing installed materials: as required by Specification section for respective materials.
 - c. For humidity dispersal: As needed to provide suitable ambient conditions for work.
 - D. Pay costs of installation, operation, maintenance and removal of temporary heat and ventilation.
- 1.08 TEMPORARY TELEPHONE SERVICE (Contractor and Engineer's Resident Representative if required).
- A. Furnish and install temporary telephone services for construction needs throughout construction periods.
 - B. Pay costs for temporary telephone services, including installation, maintenance, and removal.
 - C. Pay service costs for all local telephone services.
 - D. Pay costs of toll charges related to construction of the Project for the Contractor's office and the Engineer's office.
 - E. The Contractor and the Engineer shall have different phone numbers and instruments.

1.09 TEMPORARY WATER

The Contractor will provide the water necessary for construction and testing.

END OF SECTION 01510

SECTION 01530 - BARRIERS

PART 1 - GENERAL

1.01 WORK INCLUDED

The Contractor shall provide all temporary barriers in conformance with local, state, and federal codes for the protection of personnel and property; and as determined by the Contractor to fully comply with these Contract Documents.

END OF SECTION 01530

SECTION 01535 - PROTECTION OF INSTALLED WORK

PART 1 - GENERAL

1.01 WORK INCLUDED

Protection for products, including Owner-provided products, after installation.

1.02 RELATED REQUIREMENTS

Division 1 - General Requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 PROTECTION AFTER INSTALLATION

- A. Protect installed products and control traffic in immediate area to prevent damage from subsequent operations.
- B. Restrict traffic of any kind across planted lawn and landscape areas.

END OF SECTION 01535

SECTION 01540 - SECURITY

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The Project area has to remain safely accessible to Owner's personnel; however, the Contractor will provide any non-interfering security he deems necessary to protect his work, equipment, etc.
- B. Provide an adequate system to secure the Project area at all times, especially during non-construction periods; the Contractor shall be solely responsible for taking proper security measures.

1.02 COSTS

Contractor shall pay for all costs for protection and security systems.

END OF SECTION 01540

SECTION 01550 - ACCESS ROADS AND PARKING AREAS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Access roads.
- B. Temporary parking.
- C. Existing pavements and parking areas.
- D. Permanent pavements and parking areas.
- E. Maintenance.
- F. Removal and repair.

1.02 RELATED REQUIREMENTS

- A. Section 01045 - Cutting and Patching.

PART 2 - PRODUCTS

2.01 MATERIALS

For temporary construction: Contractor's option but must be approved by the Owner.

PART 3 - EXECUTION

3.01 PREPARATION

Clear areas, provide proper surface and storm drainage of premises and adjacent areas.
Install erosion protection.

3.02 ACCESS ROADS

- A. Construct temporary all-weather access roads from public thoroughfares to serve construction area, of a width and load-bearing capacity to provide unimpeded traffic for construction purposes.
- B. Construct temporary bridges and/or culverts to span low areas and allow unimpeded

drainage.

- C. Extend and relocate as work progress requires, and provide detours as necessary for unimpeded traffic flow.
- D. Locate temporary access roads as approved by the Owner and/or the Engineer.
- E. Provide and maintain access to all Owner facilities.

3.03 TEMPORARY PARKING

Construct temporary parking areas to accommodate use of construction personnel in an area acceptable to the Owner and/or the Engineer. Pay all costs relating to temporary parking.

3.04 MAINTENANCE

- A. Maintain traffic and parking areas in a sound condition, free of excavated material, construction equipment, products, mud, snow and ice. Use whatever dust control measures required to prevent airborne particles.
- B. Maintain existing paved areas used for construction; promptly repair breaks, potholes, low areas, standing water and other deficiencies to maintain paving and drainage in original and/or specified condition.

3.05 REMOVAL AND REPAIR

- A. Remove temporary materials and construction when permanent facilities are usable as directed by the Engineer.
- B. Remove underground work and compacted materials to a depth of two (2) feet; fill and grade site as specified.
- C. Repair existing permanent facilities damaged by usage to original and/or specified condition.

END OF SECTION 01550

SECTION 01560 - TEMPORARY CONTROLS

PART 1 - GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Dust control.
- B. Erosion and sediment control.

1.02 RELATED REQUIREMENTS

- A. Section 01565 - Erosion and Sediment Control.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 DUST CONTROL

Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere. Provide spraying of dust with water so no dust leaves the site.

3.02 EROSION AND SEDIMENT CONTROL

- A. Plan and execute construction by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.
- B. Minimize amount of bare soil exposed at one time.
- C. Provide temporary measures such as berms, dikes, drains, hay bales, gabions, etc., as directed by the Engineer so as to minimize siltation due to runoff.
- D. Construct fill and waste areas by selective placement to avoid erosive exposed surface of silts or clays.
- E. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.

END OF SECTION 01560

SECTION 01565 - EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The Contractor shall do all Work and take all measures necessary to control soil erosion resulting from construction operations, shall prevent the flow of sediment from the construction site, and shall contain construction materials (including excavation and backfill) within his protected working area so as to prevent damage to the adjacent wetlands and water courses.
- B. The Contractor shall not employ any construction method that violates a rule, regulation, guideline or procedure established by Federal, State or local agencies having jurisdiction over the environmental effects of construction.
- C. Pollutants such as chemicals, fuels, lubricants, bitumen, raw sewage and other harmful waste shall not be discharged into or alongside of any body of water or into natural or man-made channels leading thereto.

PART 2 - PRODUCTS

2.01 MATERIALS

Bales may be hay or straw, and shall be reasonably clean and free of noxious weeds and deleterious materials. Filter fabric for sediment traps shall be of suitable materials acceptable to the Engineer.

PART 3 - EXECUTION

3.01 METHODS OF CONSTRUCTION

- A. The Contractor shall use any of the acceptable methods necessary to control soil erosion and prevent the flow of sediment to the maximum extent possible. These methods shall include, but not be limited to, the use of water diversion structures, diversion ditches and settling basins.
- B. Construction operations shall be restricted to the areas of work indicated on the Drawings and to the area which must be entered for the construction of temporary or permanent facilities. The Engineer has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and fill operations and to direct the Contractor to provide immediate permanent or temporary pollution control measures to prevent contamination of the wetlands and adjacent watercourses. Such work may involve the construction of temporary berms, dikes,

dams, sediment basins, slope drains, and use of temporary mulches, mats, or other control devices or methods as necessary to control erosion.

- C. Excavated soil material shall not be placed adjacent to the wetlands or watercourses in a manner that will cause it to be washed away by high water or runoff. Earth berms or diversions shall be constructed to intercept and divert runoff water away from critical areas. Diversion outlets shall be stable or shall be stabilized by means acceptable to the Engineer. If for any reason construction materials are washed away during the course of construction, the Contractor shall remove those materials from the fouled areas as directed by the Engineer.
- D. For Work within easements or rights-of-way, all materials used in construction such as excavation, backfill, roadway, and pipe bedding and equipment shall be kept within the limits of these easements or rights-of-way.
- E. The Contractor shall not pump silt-laden water from trenches or other excavation into the wetlands, or adjacent watercourses. Instead, silt-laden water from his excavations shall be discharged within areas surrounded by baled hay or into sediment traps or ensure that only sediment-free water is returned to the watercourses. Damage to vegetation by excessive watering or silt accumulation in the discharge area shall be avoided.
- F. Prohibited construction procedures include, but are not limited to the following:
 - 1. Dumping of spoil material into any streams, wetlands, surface waters, or unspecified locations.
 - 2. Indiscriminate, arbitrary, or capricious operation of equipment in wetlands or surface waters.
 - 3. Pumping of silt-laden water from trenches or excavations into surface waters, or wetlands.
 - 4. Damaging vegetation adjacent to or outside of the construction area limits.
 - 5. Disposal of trees, brush, debris, paints, chemicals, asphalt products, concrete curing compounds, fuels, lubricants, insecticides, washwater from concrete trucks or hydroseeders, or any other pollutant in wetlands, surface waters, or unspecified locations.
 - 6. Permanent or unauthorized alteration of the flow line of any stream.
 - 7. Open burning of debris from the construction work.
- G. Any temporary working roadways required shall be clean fill approved by the Engineer. In the event fill is used, the Contractor shall take every precaution to prevent the fill from mixing with native materials of the site. All such foreign fill materials shall be removed from the site following construction.

3.02 EROSION CHECKS

The Contractor shall furnish and install baled hay or straw erosion checks surrounding the base of all deposits of stored excavated material outside of the disturbed area, and where indicated by the Engineer. Checks located surrounding stored material shall be located approximately 6 feet from that material. Bales shall be held in place with two 2 inch by 2 inch by 3 feet wooden stakes. Each bale shall be butted tightly against the adjoining bale to preclude short circuiting of the erosion check.

END OF SECTION 01565

SECTION 01580 - PROJECT IDENTIFICATION SIGNS

PART 1 - GENERAL

1.01 SCOPE OF WORK

The Contractor shall provide signs near the site of the Work. The sign shall set forth the description of the Work and the names of the Owner, Engineer, and Contractor.

PART 2 - PRODUCTS

2.01 IDENTIFICATION SIGN (4-feet x 8-feet)

- A. The Contractor shall provide sign(s), as detailed hereinafter, near the site of the work. The sign(s) shall set forth the description of the work and the names of the Owner, Engineer, and Contractor, and other information as required.

The sign shall be constructed of 3/4-inch thick APA A-B Exterior grade or marine plywood. Posts shall be 4" x 4" of fencing type material. Prime all wood with white primer.

The sign shall be maintained in good condition until completion of the project.

- B. Colors shall be as required by the sign detail or as selected by the Engineer.

- C. Number Required: Two (2).

PART 3 - EXECUTION

3.01 INSTALLATIONS

Signs shall be installed at locations specified by the Engineer.

3.02 MAINTENANCE

The signs shall be maintained in good condition until the completion of the Project.

END OF SECTION 01580

SECTION 01600 - MATERIAL AND EQUIPMENT

PART 1 - GENERAL

1.01 STORAGE OF MATERIALS AND EQUIPMENT

All excavated materials and equipment to be incorporated in the Work shall be placed so as not to damage any part of the Work or existing facilities and so that free access can be had at all times to all parts of the Work and to all public utility installations in the vicinity of the Work. Materials and equipment shall be kept neatly piled and compactly stored in such locations as will cause a minimum of inconvenience to public travel and adjoining owners, tenants and occupants.

1.02 HANDLING AND DISTRIBUTION

- A. The Contractor shall handle, haul, and distribute all materials and all surplus materials on the different portions of the Work, as necessary or required; shall provide suitable and adequate storage room for materials and equipment during the progress of the Work, and be responsible for the protection, loss of, or damage to materials and equipment furnished by him, until final completion and acceptance of the Work.
- B. Storage and demurrage charges by transportation companies and vendors shall be borne by the Contractor.

1.03 MATERIALS, SAMPLES, INSPECTION

- A. Unless otherwise expressly provided on the Drawings or in any of the other Contract Documents, only new materials and equipment shall be incorporated in the Work. All materials and equipment furnished by the Contractor to be incorporated in the Work shall be subject to the inspection of the Engineer. No material shall be processed or fabricated for the Work or delivered to the Work site without prior concurrence of the Engineer.
- B. As soon as possible after execution of the Agreement, the Contractor shall submit to the Engineer the names and addresses of the manufacturers and suppliers of all materials and equipment he proposes to incorporate into the Work. When shop and working drawings are required as specified below, the Contractor shall submit prior to the submission of such drawings, data in sufficient detail to enable the Engineer to determine whether the manufacturer and/or the supplier have the ability to furnish a product meeting the Specifications. As requested, the Contractor shall also submit data relating to the materials and equipment he proposes to incorporate into the Work in sufficient detail to enable the Engineer to identify and evaluate the particular product

and to determine whether it conforms to the Contract requirements. Such data shall be submitted in a manner similar to that specified for submission of shop and working drawings.

- C. Facilities and labor for the storage, handling, and inspection of all materials and equipment shall be furnished by the Contractor. Defective materials and equipment shall be removed immediately from the site of the Work.
- D. If the Engineer so requires, either prior to or after commencement of the Work, the Contractor shall submit samples of materials for such special tests as the Engineer deems necessary to demonstrate that they conform to the Specifications. Such samples, including concrete test cylinders, shall be furnished, taken, stored, packed, and shipped by the Contractor as directed. The Contractor shall furnish suitable molds for and make the concrete test cylinders. Except as otherwise expressly specified, the Contractor shall make arrangements for, and pay for, the tests.
- E. All samples shall be packed so as to reach their destination in good condition, and shall be labeled to indicate the material represented, the name of the building or work and location for which the material is intended, and the name of the Contractor submitting the sample. To ensure consideration of samples, the Contractor shall notify the Engineer by letter that the samples have been shipped and shall properly describe the samples in the letter. The letter of notification shall be sent separate from and should not be enclosed with the samples.
- F. The Contractor shall submit data and samples, or place his orders, sufficiently early to permit consideration, inspection and testing before the materials and equipment are needed for incorporation in the Work. The consequences of his failure to do so shall be the Contractor's sole responsibility.
- G. In order to demonstrate the proficiency of workmen, or to facilitate the choice among several textures, types, finishes, surfaces, etc., the Contractor shall provide such samples of workmanship of wall, floor, finish, etc., as may be required.
- H. When required, the Contractor shall furnish to the Engineer triplicate sworn copies of manufacturer's shop or mill tests (or reports from independent testing laboratories) relative to materials, equipment performance ratings, and concrete data.
- I. After review of the samples, data, etc., the materials and equipment used on the Work shall in all respects conform therewith.

END OF SECTION 01600

SECTION 01620 - STORAGE AND PROTECTION

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. General storage.
- B. Enclosed storage.
- C. Exterior storage.
- D. Maintenance of storage.

1.02 RELATED REQUIREMENTS

Division 1 - General Requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL STORAGE

- A. Store products, immediately on delivery, in accordance with manufacturer's instructions, with seals and labels intact. Protect until installed.
- B. Arrange storage in a manner to provide access for maintenance of stored items and for inspection.

3.02 ENCLOSED STORAGE

- A. Store products, subject to damage by the elements, in substantial weathertight enclosures.
- B. Maintain temperature and humidity within ranges stated in manufacturer's instructions.
- C. Provide humidity control and ventilation for sensitive products as required by manufacturer's instructions.
- D. Store unpacked and loose products on shelves, in bins, or in neat groups of like items.

3.03 EXTERIOR STORAGE

- A. Provide substantial platforms, blocking, or skids, to support fabricated products above ground; slope to provide drainage. Protect products from soiling and staining.
- B. For products subject to discoloration or deterioration from exposure to the elements, cover with impervious sheet material. Provide ventilation to avoid condensation.
- C. Store loose granular materials on clean, solid surfaces such pavement, or on rigid sheet materials, to prevent mixing with foreign matter.
- D. Provide surface drainage to prevent erosion and ponding of water.
- E. Prevent mixing of refuse or chemically injurious materials.

3.04 MAINTENANCE OF STORAGE

- A. Periodically, inspect stored products on a scheduled basis. Maintain a log of inspections, make available to Engineer on request.
- B. Verify that storage facilities comply with manufacturer's product storage requirements.
- C. Verify that manufacturer required environmental conditions are maintained continually.
- D. Verify that surfaces of products exposed to the elements are not adversely affected; that any weathering of finishes in acceptable under requirements of Contract Documents.

3.05 MAINTENANCE OF EQUIPMENT STORAGE

- A. For mechanical and electrical equipment in long-term storage, provide manufacturer's service instructions to accompany each item, with notice of enclosed instructions shown on exterior of package.
- B. Service equipment on a regularly scheduled basis, in accordance with the manufacturer's recommendations, maintaining a log of services; submit as a record document.

END OF SECTION 01620

SECTION 01700 - PROJECT CLOSEOUT

PART 1 - GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 00700 - General Conditions.
- B. Section 01710 - Final Cleaning.
- C. Section 01720 - Project Record Documents.

1.02 SUBSTANTIAL COMPLETION

- A. Contractor:
 - 1. Submit written certification to Engineer that project is substantially complete.
 - 2. Submit list of major items to be completed or corrected.
- B. Engineer will make an inspection within seven days after receipt of certification, together with the Owner's representative.
- C. Should Engineer consider that work is substantially complete:
 - 1. Contractor shall prepare, and submit to Engineer, a list of the items to be completed or corrected, as determined by on-site observation.
 - 2. Engineer will prepare and issue a Certificate of Substantial Completion, containing:
 - a. Date of Substantial Completion.
 - b. Contractor's list of items to be completed or corrected, verified and amended by Engineer.
 - c. The time within which Contractor shall complete or correct work of listed items.
 - d. Time and date Owner will assume possession of work or designated portion thereof.
 - e. Responsibilities of Owner and Contractor for:
 - (1) Insurance.
 - (2) Utilities.
 - (3) Operation of mechanical, electrical and other systems.
 - (4) Maintenance and cleaning.
 - (5) Security.

- f. Signatures of:
 - (1) Engineer.
 - (2) Contractor.
 - (3) Owner.
 - 3. Contractor: Complete work listed for completion or correction, within designated time.
- D. Should Engineer consider that work is not substantially complete:
- 1. He shall immediately notify Contractor, in writing, stating reasons.
 - 2. Contractor: Complete work, and send second written notice to Engineer, certifying that Project, or designated portion of project is substantially complete.
 - 3. Engineer will re-review work.

1.03 FINAL INSPECTION

- A. Contractor shall submit written certification that:
- 1. Contract Documents have been reviewed.
 - 2. Project has been inspected for compliance with Contract Documents.
 - 3. Work has been completed in accordance with Contract Documents.
 - 4. Equipment and systems have been tested in presence of Owner's representative and are operational.
 - 5. Project is completed and ready for final inspection.
- B. Engineer will make final on-site observation/review within seven (7) days after receipt of certification.
- C. Should Engineer consider that work is finally complete in accordance with requirements of Contract Documents, he shall request Contractor to make Project Closeout submittals.
- D. Should Engineer consider that work is not finally complete:
- 1. He shall notify Contractor, in writing, stating reasons.
 - 2. Contractor shall take immediate steps to remedy the stated deficiencies, and send second written notice to Engineer certifying that work is complete.
 - 3. Engineer will re-review the work.

1.04 FINAL CLEANING UP

The work will not be considered as completed and final payment made until all final cleaning up has been done by the Contractor in a manner satisfactory to the Engineer. See Section 01710 for detailed requirements.

1.05 CLOSEOUT SUBMITTALS

- A. Project Record Documents: to requirements of Section 01720.

- B. Operating and Maintenance Data: to requirements of particular technical specifications and Section 01730.
- C. Warranties and Bonds: to requirements of particular technical specifications and Section 01740.

1.06 INSTRUCTION

Instruct Owner's personnel in operation of all systems, mechanical, electrical and other equipment.

1.07 FINAL APPLICATION FOR PAYMENT

Contractor shall submit final applications in accordance with requirements of General Conditions.

1.08 FINAL CERTIFICATE FOR PAYMENT

- A. Engineer will issue final certificate in accordance with provisions of General Conditions.
- B. Should final completion be materially delayed through no fault of Contractor, Engineer may issue a Semi-final Certificate for payment.

END OF SECTION 01700

SECTION 01710 - CLEANING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. On a continuous basis, maintain premises free from accumulations of waste, debris, and rubbish, caused by operations.
- B. At completion of Work, remove waste materials, rubbish, tools, equipment, machinery and surplus materials, and clean all sight-exposed surfaces; leave Project clean and ready for occupancy.

1.02 RELATED REQUIREMENTS

- A. Section 01045 - Cutting and Patching.
- B. Section 01700 - Project Closeout.
- C. Cleaning for Specific Products or Work: Specification Section for that work.

1.03 SAFETY REQUIREMENTS

- A. Hazards control:
 - 1. Store volatile wastes in covered metal containers, and remove from premises daily.
 - 2. Prevent accumulation of wastes which create hazardous conditions.
 - 3. Provide adequate ventilation during use of volatile or noxious substances.
- B. Conduct cleaning and disposal operations to comply with local ordinances and anti-pollution laws.
 - 1. Do not burn or bury rubbish and waste materials on Project site without written permission from the Owner.
 - 2. Do not dispose of volatile wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains.
 - 3. Do not dispose of wastes into streams or waterways.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Use only cleaning materials recommended by manufacturer of surface to be cleaned.
- B. Use cleaning materials only on surfaces recommended by cleaning material

manufacturer.

PART 3 - EXECUTION

3.01 DURING CONSTRUCTION

- A. Execute cleaning to ensure that building, grounds and public properties are maintained free from accumulations of waste materials and rubbish.
- B. Wet down dry materials and rubbish to lay dust and prevent blowing dust.
- C. At reasonable intervals during progress of Work, clean site and public properties, and dispose of waste materials, debris and rubbish.
- D. Provide on-site containers for collection of waste materials, debris and rubbish.
- E. Remove waste materials, debris and rubbish from site and legally dispose of at public or private dumping areas off Owner's property.
- F. Handle materials in a controlled manner with as few handlings as possible; do not drop or throw materials from heights.
- G. The Contractor shall thoroughly clean all materials and equipment installed.

3.02 FINAL CLEANING

- A. Employ experienced workmen, or professional cleaners, for final cleaning.
- B. In preparation for substantial completion, conduct final inspection of sight-exposed interior and exterior surface, and of concealed spaces.
- C. Repair, patch and touch up marred surfaces to specified finish, to match adjacent surfaces.
- D. Broom clean paved surfaces; rake clean other surfaces of grounds.
- E. Maintain cleaning until Project, or portion thereof, is occupied by Owner.
- F. The Contractor shall restore or replace existing property or structures as promptly and practicable as work progresses.

END OF SECTION 01710

SECTION 01720 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 00700 - General Conditions.
- B. Section 01300 - Submittals.

1.02 MAINTENANCE OF DOCUMENTS

- A. Maintain at job site, one copy of:
 - 1. Contract Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Reviewed Shop Drawings.
 - 5. Change Orders.
 - 6. Other Modifications to Contract.
- B. Store documents in approved location, apart from documents used for construction.
- C. Provide files and racks for storage of documents.
- D. Maintain documents in clean, dry legible condition.
- E. Do not use record documents for construction purposes.
- F. Make documents available at all times for inspection by Engineer and Owner.

1.03 MARKING DEVICES

Provide colored pencil or felt-tip marking pen for all marking.

1.04 RECORDING

- A. Label each document "RECORD DRAWING" in 2-inch high printed letters.
- B. Keep record documents current.
- C. Do not permanently conceal any work until required information has been recorded.

- D. Contract Drawings: Legibly mark to record actual construction:
 - 1. Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvements.
 - 2. Location of internal utilities and appurtenances concealed in construction referenced to visible and accessible features of structure.
 - 3. Field changes of dimension and detail.
 - 4. Changes made by Change Order or Field Order.
 - 5. Details not on original Contract Drawings.
- E. Specifications and Addenda: Legibly mark up each Section to record:
 - 1. Manufacturer, trade name, catalog number, and Supplier of each product and item of equipment actually installed.
 - 2. Changes made by Change Order or Field Order.
 - 3. Other matters not originally specified.
- F. Shop Drawings: Maintain as record documents; legibly annotate Shop Drawings to record changes made after review.

1.05 SUBMITTAL

- A. At completion of project, deliver record documents to Engineer.
- B. Accompany submittal with transmittal letter, in duplicate, containing:
 - 1. Date.
 - 2. Project title and number.
 - 3. Contractor's name and address.
 - 4. Title and number of each record document.
 - 5. Certification that each document as submitted is complete and accurate.
 - 6. Signature of Contractor or his authorized representative.

END OF SECTION 01720

SECTION 01730 - OPERATING AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Compile product data and related information appropriate for Owner's maintenance and operation of equipment furnished under the contract. Prepare operating and maintenance data as specified.
- B. Instruct Owner's personnel in the maintenance and operation of equipment and systems as outlined herein.
- C. In addition to maintenance and operations data, the manufacturer's printed recommended installation practice shall also be included. If not part of the operations and maintenance manual, separate written installation instructions shall be provided, serving to assist the Contractor in equipment installation.

1.02 RELATED REQUIREMENTS

- A. Section 00700 - General Conditions.
- B. Section 01300 - Submittals.
- C. Section 01720 - Project Record Documents.
- D. Section 01740 - Warranties and Bonds.

1.03 MAINTENANCE AND OPERATIONS MANUAL

Every piece of equipment furnished and installed shall be provided with two (2) complete maintenance and operations manuals. These shall be detailed in instructions to the Owner's personnel. They shall be attractively bound for the Owner's records.

The manuals shall be submitted to the Engineer for review as to adequacy and completeness. After approval the Contractor shall store all manuals until the completion of the project or until requested by the Engineer. The manuals will be stored and delivered to the Engineer in an organized format.

1.04 FORM OF SUBMITTALS

- A. Prepare data in the form of an instructional manual for use by Owner's personnel.

B. Format:

1. Size: 8-1/2 x 11 in.
2. Paper: 20 pound minimum, white, for typed pages.
3. Text: Manufacturer's printed data, or neatly typewritten.
4. Drawings:
 - a. Provide reinforced punched binder tab, bind with text.
 - b. Fold large drawings to the size of the text pages where feasible.
 - c. For all drawings included within manuals, furnish a 8 mil mylar copy in standard size drawings 36" x 24", 8" x 16" or 8-1/2" x 11".
 - d. For flow or piping diagrams that cannot be detailed on the standard size drawings, a larger, appropriate size drawing may be submitted.
5. Provide fly-leaf for each separate product, or each piece of operating equipment.
 - a. Provide typed description of product, and major component parts of equipment.
 - b. Provide indexed tabs.
6. Cover: Identify each volume with types or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS". List:
 - a. Title of Project.
 - b. Identity of separate structure as applicable.
 - c. Identity of general subject matter covered in the manual.
7. Digital: Two (2) copies of the entire O&M Manual shall be submitted on CD. All documents shall be in PDF format.

C. Binders:

1. Commercial quality, durable and cleanable, 3-hole, 3" or 4" post type binders, with oil and moisture resistant hard covers.
2. When multiple binders are used, correlate the data into related consistent grouping.
3. Labeled on the front cover and side of each binder shall be the name of the Contract, the Contract Number and Volume Number.

1.05 CONTENT OF MANUAL

A. Neatly typewritten table of contents for each volume, arranged in systematic order.

1. Contractor, name of responsible principal, address and telephone number.
2. A list of each product required to be included, indexed to the content of the volume.
3. List, with each product, the name, address and telephone number of:
 - a. Subcontractor or installer.
 - b. Maintenance contractor, as appropriate.
 - c. Identify the area of responsibility of each.
 - d. Local source of supply for parts and replacement.
4. Identify each product by product name and other identifying symbols as set forth in Contract Documents.

- B. Product Data:
1. Include only those sheets which are pertinent to the specific product. References to other sizes and types or models of similar equipment shall be deleted or lined out.
 2. Annotate each sheet to:
 - a. Clearly identify the specific product or part installed.
 - b. Clearly identify the data applicable to the installation.
 - c. Provide a parts list for all new equipment items, with catalog numbers and other data necessary for ordering replacement parts.
 - d. Delete references to inapplicable information.
 3. Clear and concise instructions for the operation, adjustment, lubrication, and other maintenance of the equipment including a lubrication chart.
- C. Drawings:
1. Supplement product data with drawings as necessary to clearly illustrate:
 - a. Relations of component parts of equipment and systems.
 - b. Control and flow diagrams.
 2. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.
 3. Do not use Project Record Documents as maintenance drawings.
- D. Written text, as required to supplement product data for the particular installation:
1. Organize in a consistent format under separate headings for different procedures.
 2. Provide a logical sequence of instructions for each procedure.
- E. Copy of each warranty, bond and service contract issued: Provide information sheet for Owner's personnel.
1. Proper procedures in the event of failure.
 2. Instances which might affect the validity of warranties or bonds.
- F. These manuals shall be submitted to the Engineer for review at the same time that the equipment to which it pertains is delivered at the site. The manuals must be approved by the Engineer before final payment on the equipment is made.

END OF SECTION 01730

SECTION 01740 - WARRANTIES AND BONDS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Compile specified warranties and bonds.
- B. Compile specified service and maintenance contracts.
- C. Co-execute submittals when required.
- D. Review submittals to verify compliance with Contract Documents.

1.02 RELATED REQUIREMENTS

- A. Bid Bond.
- B. Performance and Payment Bonds.
- C. Guaranty.
- D. General Warranty of Construction.
- E. Warranties and Bonds required for specific products: As listed in other Specification sections.

1.03 (NOT USED)

1.04 SUBMITTALS REQUIREMENTS

- A. Assemble warranties, bonds and service and maintenance contracts, executed by each of the respective manufacturers, suppliers and subcontractors.
- B. Furnish two (2) original signed copies.
- C. Table of Contents: Neatly typed, in orderly sequence. Provide complete information for each item.
 - 1. Product, equipment or work item.
 - 2. Firm name, address and telephone number.
 - 3. Scope.
 - 4. Date of beginning of warranty, bond or service and maintenance contract.
 - 5. Duration of warranty, bond or service and 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 or bond.
7. Contractor name, address and telephone number.

1.05 FORM OF SUBMITTALS

- A. Prepare in duplicate packets.
- B. Format:
 1. Size 8 1/2-inch x 11 inches, punch sheets for 3-ring binder: Fold larger sheets to fit into binders.
 2. Cover: Identify each packet with typed or printed title "WARRANTIES AND BONDS". List:
 - a. Title of Project.
 - b. Name of Contractor.
- C. Binders: Commercial quality, three-ring, with durable and cleanable plastic covers.

1.06 TIME OF SUBMITTALS

- A. For equipment or component parts of equipment put into service during progress of construction: Submit documents within ten (10) days after inspection and acceptance.
- B. Otherwise, make submittals within ten (10) days after date of substantial completion, prior to final request for payment.
- C. For items of work, where acceptance is delayed materially beyond the Date of Substantial Completion, provide updated submittal within 10 days after acceptance, listing the date of acceptance as the start of the warranty period.

1.07 SUBMITTALS REQUIRED

Submit warranties, bonds, service and maintenance contracts as specified in the respective sections of the Specifications. Additionally, the Contractor shall warrant the entire contract, including all concrete, paving, building, plumbing, HVAC, mechanical and electrical equipment to be free from defects in design and installation for one (1) year from the date of startup. In the event a component fails to perform as specified or is proven defective in service during the warranty period, the Contractor shall repair the defect without cost to the Owner.

END OF SECTION 01740

Division 2 – Site Work

02110 - SITE CLEARING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Clear site within construction limits of plant life and grass.
- B. Remove root system of trees and shrubs.
- C. Remove surface debris.

1.02 REGULATORY REQUIREMENTS

Conform to applicable local codes and ordinances for disposal of debris.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 EXISTING TREES AND OTHER VEGETATION

- A. The Contractor shall not cut or injure any trees or other vegetation outside right-of-way or easement lines and outside areas to be cleared, as indicated on the Drawings, without written permission from the Engineer. The Contractor shall be responsible for all damage done outside these lines.
- B. The Engineer shall designate which trees are to be removed within permanent and temporary easement lines or right-of-way lines.

3.02 CLEARING

- A. From areas to be cleared, the Contractor shall cut or otherwise remove all trees, brush, and other vegetable matter such as snags, bark and refuse. The ground shall be cleared to the width of the permanent easement or right-of-way unless otherwise directed by the Engineer.
- B. Except where clearing is done by uprooting with machinery, trees, stumps, and stubs to be cleared shall be cut as close to the ground surface as practicable, but no more than 6-inches above the ground surface for small trees and 12-inches for larger trees.
- C. Elm bark shall be either buried at least 1 foot deep or burned in suitable incinerators off site with satisfactory antipollution controls and fire prevention controls, to prevent the spread of Dutch Elm disease and as required by applicable laws.

3.03 GRUBBING

From areas to be grubbed, the Contractor shall remove completely all stumps, remove to a depth of 12-inches all roots larger than 3-inch diameter, and remove to a depth of 6-inches all roots larger than 1/2-inch diameter. Such depths shall be measured from the existing ground surface or the proposed finished grade, whichever is lower.

3.04 STRIPPING OF TOPSOIL

Prior to starting general excavation, strip topsoil to a depth of 6-inches or to depths required by the Engineer. Do not strip topsoil in a muddy condition and avoid mixture of subsoil. Stockpile the stripped topsoil within easement or right-of-way lines for use in finish grading and site restoration. Topsoil stockpiled shall be free from trash, brush, stones over 2-inches in diameter and other extraneous material.

3.05 PROTECTION

- A. Protect plant growth and features remaining as final landscaping.
- B. Protect bench marks and existing work from damage or displacement.
- C. Maintain designated site access for vehicle and pedestrian traffic.

3.06 REMOVAL

- A. All material resulting from clearing and grubbing and not scheduled for reuse shall become the property of the Contractor and shall be suitably disposed of off-site, unless otherwise directed by the Engineer, in accordance with all applicable laws, ordinances, rules and regulations.
- B. Such disposal shall be performed as soon as possible after removal of the material and shall not be left until the final period of cleaning up.

END OF SECTION 02110

SECTION 02150 - SHORING AND BRACING

PART 1 - GENERAL

1.01 SUMMARY

- A. Shore and brace sidewalls in deep excavations with steel sheet, soldier piles or timber lagging as required to protect existing buildings, utilities, roadways, and improvements. Prevent cave-ins, loss of ground, or damage to people and property.
- B. Maintain shoring and bracing during construction activities, and remove shoring and bracing if practical when construction and filling is complete.

1.02 SUBMITTALS

Submit for approval shop drawings and information on methods proposed for use.

1.03 QUALITY ASSURANCE

Comply with governing codes and regulations. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Sheet Steel: Heavy-gauge steel sheet suitable for service.
- B. Soldier Piles: Steel H-beams in serviceable condition.
- C. Timber Lagging: Heavy timber pressure treated with wood preservative.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in proper relation with adjacent construction. Coordinate with work of other sections.
- B. Locate shoring and bracing to avoid permanent construction. Anchor and brace to prevent collapse.

END OF SECTION 02150

SECTION 02211 - ROUGH GRADING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Remove topsoil and stockpile for later reuse.
- B. Excavate subsoil to bedrock and stockpile for later reuse as directed in Section 02223, Embankments.
- C. Grade and rough contour site.

1.02 RELATED REQUIREMENTS

- A. Section 02221 - Rock Removal.
- B. Section 02222 - Excavation.
- C. Section 02223 - Embankments.
- D. Section 02225 - Excavation, Backfilling and Compacting for Utilities.
- E. Section 02900 - Landscaping

1.03 PROJECT RECORD DOCUMENTS

- A. Submit documents under provisions of Section 01720.
- B. Accurately record location of utilities remaining, rerouted utilities, new utilities by horizontal dimensions, elevations or inverts, and slope gradients.

1.04 PROTECTION

- A. Protect trees and other features remaining as portion of final landscaping.
- B. Protect benchmarks, existing structures, fences, roads, sidewalks and other features not designated for demolition.
- C. Protect above or below grade utilities which are to remain.
- D. Contractor shall be responsible for repairing any damage to those items not designated for demolition or removal in a manner satisfactory to the Owner at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Topsoil: Excavated material, graded free of roots, rocks larger than 1-inch, subsoil, debris, and large weeds.
- B. Subsoil: Excavated material, graded free of lumps larger than 12-inches, rocks larger than 12-inches, and debris.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Identify known below grade utilities. Stake and flag utility locations.
- C. Identify and flag above grade utilities.
- D. Maintain and protect existing utilities remaining which pass through work area.
- E. Upon discovery of unknown utility or concealed conditions, discontinue affected work; notify Engineer.

3.02 TOPSOIL EXCAVATION

- A. Excavate topsoil from areas to be further excavated, and stockpile in area designated on-site by the Engineer.
- B. Do not excavate wet topsoil.
- C. Stockpile topsoil to depth not exceeding 8 feet.

3.03 SUBSOIL EXCAVATION

- A. Excavate subsoil from indicated areas and stockpile in area designated on site. Excess subsoil may be reused according to Section 02223 - Embankments and Backfill.
- B. Do not excavate wet subsoil.
- C. Stockpile subsoil to depth not exceeding 8 feet.
- D. When excavation through roots is necessary, perform work by hand and cut roots with a sharp axe.

3.04 TOLERANCES

Top Surface of Subgrade: Plus or minus 3-inches.

END OF SECTION 02211

SECTION 02221 - ROCK REMOVAL

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The Contractor shall excavate rock, if encountered, as required to perform the required work, and shall dispose of the excavated material or stockpile for later use in non-structural areas. Contractor shall furnish acceptable material for backfill in place of the excavated rock.
- B. In general, rock in pipe trenches shall be excavated so as to be not less than 6-inches from the pipe (bottom and sides) after pipe has been laid.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Rock Definition: Solid mineral material that cannot be removed by heavy excavating equipment with ripping tools.

PART 3 - EXECUTION

3.01 MEANS OF REMOVAL

- A. No blasting will be allowed in this Contract.
- B. The Contractor shall be solely responsible for rock removal operations. The Contractor shall not hold the Owner and/or the Engineer liable for any damages resulting from rock removal operations on this project.

3.02 PAYMENT

Rock excavation shall be bid as unclassified and will not be paid for separately.

END OF SECTION 02221

SECTION 02222 - EXCAVATION

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Structure excavation.
- B. Shoring excavations.

1.02 RELATED REQUIREMENTS

- A. Section 02221 - Rock Removal.
- B. Section 02223 – Embankments and Backfill.
- C. Section 02225 - Excavating, Backfilling and Compacting for Utilities.

1.03 PROTECTION

- A. Protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent cave-in or loose soil from falling into excavation.
- B. Underpin adjacent structures which may be damaged by excavation work, including service utilities and pipe chases.
- C. Notify Engineer of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
- D. Protect bottom of excavations and soil adjacent to and beneath foundations from frost.
- E. Grade excavation top perimeter to prevent surface water run-off into excavation.
- F. Contractor shall provide ample means and devices with which to intercept any water entering the excavation area.

1.04 ROCK EXCAVATION

Any rock encountered within foundation excavations for recommended soil bearing elements should be removed to a depth sufficient to provide a minimum 24 inch cushion between the bottom of the footing and the top of rock. The cushion should be constructed of properly compacted KY DOT #610 stone or DGA free of organics and deleterious materials. See Section 02223, Embankments and Backfill.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Subsoil: Excavated material, graded free of lumps larger than 12-inches, rocks larger than 12-inches, and debris.

PART 3 - EXECUTION

3.01 PREPARATION

Identify required lines, levels, contours, and datum.

3.02 EXCAVATION

- A. Excavate subsoil required for structure foundations, construction operations, and other work.
- B. Contractor is responsible to adequately brace open cuts and protect workmen and equipment from cave-in.
- C. Remove lumped subsoil, boulders, and rock up to 1/3 cu. yd., measured by volume.
- D. Correct unauthorized excavation at no cost to Owner.
- E. Fill over-excavated areas under structure bearing surfaces in accordance with direction by Engineer.
- F. Stockpile excavated material in area designated on site.

3.03 EXCAVATION FOR STRUCTURES

- A. For structures, excavate to elevations and dimensions indicated, plus ample space for construction operations and inspection of foundations.
 - 1. Unless otherwise shown on drawings, excavate for foundation bearing a minimum of 24-inches below existing grade. Structure foundations shall bear entirely on rock, or entirely on compacted granular fill. Where structures are not to be supported on rock and rock is encountered, under cut rock 24-inches and backfill with granular material, as directed.
 - 2. Structure foundations shall be installed immediately after excavation is completed, or if this cannot be done, the last 4 to 6-inches of material should not be removed until preparations for installing the foundation are complete. In no case should foundations be installed in excavations that contain water. Any soft, saturated areas in the bottom of excavations shall be removed or stabilized using

granular material.

3. Make no excavation to the full depth indicated when freezing temperatures may be expected unless foundations can be installed after the excavation has been completed. Bottom of excavation shall be protected from frost if foundation installation is delayed.

3.04 REMOVAL OF WATER

- A. The Contractor, at his own expense, shall provide adequate facilities for promptly and continuously removing water from all excavation.
- B. To ensure proper conditions at all times during construction, the Contractor shall provide and maintain ample means and devices (including spare units kept ready for immediate use in case of breakdowns) with which to remove promptly and dispose properly of all water entering trenches and other excavations. Such excavation shall be kept dry until the structures, pipes, and appurtenances to be built therein have been completed to such extent that they will not be floated or otherwise damaged.
- C. All water pumped or drained from the Work shall be disposed of in a suitable manner without undue interference with other work, damage to pavements, other surfaces, or property. Suitable temporary pipes, flumes, or channels shall be provided for water that may flow along or across the site of the Work.
- D. If necessary, the Contractor shall dewater the excavations by means of an efficient drainage wellpoint system that will drain the soil and prevent saturated soil from flowing into the excavation. The wellpoints shall be designed especially for this type of service. The pumping unit shall be designed for use with the wellpoints, and shall be capable of maintaining a high vacuum and of handling large volumes of air and water at the same time.
- E. The installation of the wellpoints and pump shall be done under the supervision of a competent representative of the manufacturer. The Contractor shall do all special work such as surrounding the wellpoints with sand or gravel or other work which is necessary for the wellpoint system to operate for the successful dewatering of the excavation.

3.05 UNAUTHORIZED EXCAVATION

If the bottom of any excavation is taken out beyond the limits indicated or prescribed, the resulting void shall be backfilled at the Contractor's expense with thoroughly compacted KY DOT #610 stone or DGA free of organics and deleterious materials in accordance with Section 02223, Embankment and Backfill, or with Class A concrete, if the excavation was for a structure.

3.06 ELIMINATION OF UNSUITABLE MATERIAL

- A. If material unsuitable for foundation (in the opinion of the Engineer) is found at or below the grade to which excavation would normally be carried in accordance with the Drawings and/or Specifications, the Contractor shall remove such material to the required width and depth and replace it with thoroughly compacted, KY DOT #610 stone or DGA free of organics and deleterious materials or Controlled Low Strength Material.
- B. No excavated materials shall be removed from the site of the work or disposed of by the Contractor except as directed or permitted.
- C. Surplus excavated materials suitable for backfill shall be used to backfill normal excavations in rock or to replace other materials unacceptable for use as backfill; shall be neatly deposited and graded so as to make or widen fills, flatten side slopes, or fill depressions. All work shall be as directed or permitted and without additional compensation.
- D. Surplus excavated materials not needed as specified above shall be hauled away and dumped by the Contractor, at his expense, at appropriate on-site locations as designated by the Owner, and in accordance with arrangements made by the Contractor.

3.07 EXCESS MATERIAL

Disposal of excess material shall be the responsibility of the Contractor. The Contractor shall determine the best method and area for disposal and obtain all permits and required permission. On-site areas have been designated by the Owner.

3.08 EXISTING UTILITIES AND OTHER OBSTRUCTIONS

Prior to the commencement of construction on the project, the Contractor shall contact the utility companies whose lines, above and below ground, may be affected during construction and verify the locations of the utilities as shown on the Contract Drawings. The Contractor shall ascertain from said companies if he will be allowed to displace or alter, by necessity, those lines encountered or replace those lines disturbed by accident during construction, or if the companies themselves are only permitted by policy to perform such work. If the Contractor is permitted to perform such work, he shall leave the lines in as good condition as were originally encountered and complete the Work as quickly as possible. All such lines or underground structures damaged or molested in the construction shall be replaced at the Contractor's expense, unless in the opinion of the Engineer, such damage was caused through no fault of the Contractor.

3.09 FIELD QUALITY CONTROL

Provide for visual inspection of rock surfaces under provisions of Section 01400.

END OF SECTION 02222

SECTION 02223 – EMBANKMENTS AND BACKFILL

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Structure perimeter backfilling to subgrade elevations.
- B. Site backfilling.
- C. Compaction requirements.
- D. Access road subgrade preparation.

1.02 RELATED WORK

- A. Section 00700 - Submittals (General Conditions).
- B. Section 01400 - Quality Control: Compaction requirements of backfill.
- C. Section 02222 - Excavation.
- D. Section 02225 - Excavation, Backfilling and Compacting for Utilities.

1.03 REFERENCES

- A. Commonwealth of Kentucky, Standard Specifications for Road and Bridge Construction.
- B. ANSI/ASTM D698 - Moisture-Density Relations of Soils and Soil-Aggregate Mixture Using 5.5 lb Rammer and 12 inch Drop.
- C. ANSI/ASTM D1556 - Density of Soil in Place by the Sand-Cone Method.
- D. ASTM 2922 - Density of Soil and Soil-Aggregate in Place by Nuclear Methods.
- E. ASTM 3017 - Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.04 TESTS

- A. Tests and analysis of fill materials will be performed in accordance with ANSI/ASTM D698 and under provisions of Section 01400. Tests shall include but not be limited to gradation analysis and moisture/density relationships.

- B. Test will be performed by an approved independent testing laboratory and shall be the responsibility of the Contractor at no additional cost to the Owner.
- C. Density test shall be performed in sufficient number to insure the specified densities are being obtained.
- D. When ASTM D2922 is used, the calibration curves shall be checked and adjusted if necessary by the procedure described in ASTM D2922, paragraph ADJUSTING CALIBRATION CURVE. ASTM D2922 results in a wet unit weight of soil; and when using this method, ASTM D3017 shall be used to determine moisture content of the soil. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed by the testing laboratory.

1.05 SUBMITTALS

Results of soil moisture and density tests by an approved testing laboratory shall be submitted to the Engineer for review.

1.06 DEFINITIONS

Structural Areas: All locations under concrete foundations, floor slabs, footers, buildings, concrete structures, bridges, etc.

Non-structural Areas: Locations such as landscaped areas, sidewalks, roadways, etc.

PART 2 - PRODUCTS

2.01 SELECT FILL MATERIALS

- A. The on-site residual soils are considered suitable for use as compacted fill in non-structural areas. A minimum of 95 percent of the maximum dry density and plus or minus 2 percent of optimum moisture content should be obtained for fill soils supporting non-structural areas. Field density tests should be performed on each lift placed to determine if proper compaction is being achieved. If sufficient suitable material is not available from the excavations, the backfill material in non-structural areas shall be screened gravel, crushed stone or selected borrow as directed. Backfill material in structural areas shall be KY DOT #610, DGA, or Controlled Low Strength Material.
- B. Frozen material shall not be placed in the backfill nor shall backfill be placed upon frozen material. Previously frozen material shall be removed or shall be otherwise treated as required before new backfill is placed.

- C. All material, whether from the excavations or from borrow, shall be of such nature that after it has been placed and properly compacted, it will make a dense, suitable fill. It shall not contain vegetation, masses of roots, individual roots more than 18-inches long or more than 1/2-inch in diameter, stones over 6-inches in diameter, or porous matter.

2.02 COMPACTED FILL

- A. Soil used for compacted fill in non-structural areas should be inorganic clayey soils free of deleterious debris or rocks whose largest dimension is no larger than 3-inches. The soil should have a liquid limit (LL) of less than 50, a plasticity index (PI) of less than 30, and a maximum dry density according to the standard Proctor compaction test of at least 100 pcf. The fill should be compacted to at least 95 percent of the SPMDD. The top foot of structural fill shall be compacted to 100 percent of the SPMDD.
- B. The moisture content of the compacted fill material shall be within 2% of the optimum moisture content as determined by ASTM-D-698.

2.03 STRUCTURAL BACKFILL

- A. An underdrain system shall be provided for the soil bearing structures. The underdrain should be constructed of 12-inches of #57 crushed stone and designed in a manner that would promote positive drainage away from the foundation elements. Final site grading should be accomplished in such a manner as to divert surface runoff and roof drains away from all foundation elements.
- B. All structures, unless otherwise noted on the Drawings, shall be supported entirely by bedrock or well compacted crushed stone consisting of Kentucky No. 610 size aggregate, DGA, or Controlled Low Strength Material. Structures that have pressure relief valves shall have a 12-inch blanket of #57 stone to allow for proper drainage around the PRV's. Any building supported by stone should have a minimum of 12-inches of compacted crushed stone beneath the bottom of the slab (i.e. foundation elements). Structures should not be supported on a combination of crushed stone and bedrock.
- C. Crushed stone used as a bearing medium should be placed in uniform, loose lifts not exceeding 8-inches in thickness. It is recommended that each lift be compacted by a minimum of five (5) passes of a smooth drum vibratory roller having a total static weight of not less than 20,000 pounds. The diameter of the drum should be between 5.0 and 5.5 feet and 6.0 and 6.5 feet wide.
- D. Walls below final grade should be backfilled with a minimum 12-inch thick layer of free draining material up to two feet below final grade. The two feet above this free draining material should be backfilled with an impervious material that would retard surface water infiltration. The free draining material should extend down to a rock

blanket beneath the bottom slab. Areas within five (5) feet horizontally from vertical walls, the Contractor shall use a hand compactor.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify foundation perimeter drainage installation has been inspected.
- B. Verify areas to be backfilled are free of debris, snow, ice, or water, and ground surfaces are not frozen.

3.02 PREPARATION

- A. When necessary, compact subgrade surfaces to density requirements for the backfill material and prepare subgrade or previous layer of compacted fill prior to placement of additional fill by scarifying or disking.
- B. Cut out soft areas of subgrade not readily capable of in-situ compaction. Backfill with subsoil and compact to density equal to requirements for subsequent backfill material.

3.03 BACKFILLING - GENERAL

- A. Backfill areas to contours and elevations. Use unfrozen materials. The Contractor shall keep the foundation and subgrade free from water or unacceptable materials after the fill operations have started.
- B. Backfill systematically, as early as possible, to allow maximum time for natural settlement. Do not backfill over porous, wet, or spongy subgrade surfaces.
- C. Place and compact fill materials in continuous layers not exceeding 8-inches loose depth. Field density tests shall be performed on each lift.
- D. Employ a placement method so not to disturb or damage foundation drainage.
- E. Maintain optimum moisture content of backfill material to attain required compaction density as specified. Material deposited on the fill that is too wet shall be removed or spread and permitted to dry, assisted by disking or blading, if necessary, until the moisture content is reduced to the specified limits.
- F. All crushed stone fill and crushed stone backfill under structures and pavements adjacent to structures shall be DGA or #610 crushed stone per Kentucky Highway Department Standard Specifications for Road and Bridge Construction, unless indicated otherwise. Fill and backfill materials shall be placed in layers not exceeding

eight (8) inches in thickness and compacted to 95 percent of maximum dry density.

- G. Backfill shall not be placed against or on structures until they have attained sufficient strength to support all loads to which subjected without distortion, cracking, or damage. Deposit soil evenly around the structure.
- H. Slope grade away from structures minimum 2-inches in 10-feet, unless noted otherwise.
- I. Make changes in grade gradual. Blend slopes into level areas.
- J. Remove surplus excavation materials to designated areas.

3.04 TOLERANCES

Top Surface of Backfilling: Plus or minus 1-inch.

3.05 FIELD QUALITY CONTROL

- A. Compaction testing will be performed in accordance with ASTM D1556 or ASTM D2922 and under provisions of Sections 01400.
- B. If tests indicate work does not meet specified requirements, remove work, replace and retest at no cost to Owner.

END OF SECTION 02223

SECTION 02225 - EXCAVATING, BACKFILLING, AND COMPACTING FOR UTILITIES

PART 1 - GENERAL

1.01 WORK INCLUDED

The Contractor shall make excavations in such widths and depths as will give suitable room for below grade vaults, pump stations, etc., laying pipe to the lines, grades and elevations, furnish, place and compact all backfill materials specified herein or denoted on the Drawings. The materials, equipment, labor, etc., required herein are to be considered as part of the requirements and costs for installing the various pipes, structures and other items they are incidental to.

1.02 RELATED WORK

- A. Section 02221 - Rock Removal.
- B. Section 02731 – Gravity Sewers.
- C. Section 02732 – Sewage Force Mains.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Crushed stone material shall conform with the requirements of the applicable sections of the Kentucky Bureau of Highways Standard Specifications and shall consist of clean, hard, and durable particles or fragments, free from dirt, vegetation or objectionable materials.
- B. Two classes of crushed stone material are used in this Section. The type of material in each class is as follows:
 - 1. Class I - No. 9 Aggregate.
 - 2. Class II - Dense Graded Aggregate (DGA).

PART 3 - EXECUTION

3.01 EXCAVATION OF TRENCHES

- A. Unless otherwise directed by the Engineer, trenches are to be excavated in open cuts.
 - 1. Where pipe is to be laid in gravel bedding or concrete cradle, the trench may be

excavated by machinery to, or just below, the designated subgrade, provided that the material remaining at the bottom of the trench is no more than slightly disturbed.

2. Where pipe is to be laid directly on the trench bottom, the lower part of trenches in earth shall not be excavated to subgrade by machinery. However, just before the pipe is to be placed, the last of the material to be excavated shall be removed by means of hand tools to form a flat or shaped bottom, true to grade, so that the pipe will have a uniform and continuous bearing and support on firm and undisturbed material between joints except for limited areas where the use of pipe slings may have disturbed the bottom.
- B. Trenches shall be sufficient width to provide working space on each side of the pipe and to permit proper backfilling around the pipe.
 1. The Contractor shall remove only as much of any existing pavement as is necessary for the prosecution of the Work. The pavement shall be cut with pneumatic tools, without extra compensation to the Contractor, to prevent damage to the remaining road surface. Where pavement is removed in large pieces, it shall be disposed of before proceeding with the excavation.
 - C. All excavated materials shall be placed a safe distance back from the edge of the trench.
 - D. Unless specifically directed otherwise by the Engineer, not more than 500 feet of trench shall be opened ahead of the pipe laying work of any one crew, and not more than 500 feet of open ditch shall be left behind the pipe laying work of any one crew. Watchmen or barricades, lanterns and other such signs and signals as may be necessary to warn the public of the dangers in connection with open trenches, excavations and other obstructions, shall be provided by and at the expense of the Contractor.
 - E. When so required, or when directed by the Engineer, only one-half of street crossings and road crossings shall be excavated before placing temporary bridges over the side excavated, for the convenience of the traveling public. All backfilled ditches shall be maintained in such manner that they will offer no hazard to the passage of traffic. The convenience of the traveling public and the property owners abutting the improvements shall be taken into consideration. All public or private drives shall be promptly backfilled or bridged at the direction of the Engineer.
 - F. Trench excavation shall include the removal of earth, rock, or other materials encountered in the excavating to the depth and extent shown or indicated on the Drawings.

3.02 WATER PIPE BEDDING

- A. Piping for water mains shall be supported as follows:
 1. The trench bottom for water main piping shall be stable, continuous, relatively

smooth and free of frozen material, clodded dirt, foreign material and rock or granular material larger than 1/2 inch in diameter. The foundation for water main piping shall be prepared so that the entire load of the backfill on top of the pipe will be carried uniformly on the barrel of the pipe. Any uneven areas in the trench bottom shall be shaved-off or filled-in with Class I granular bedding. When the trench is made through rock, the bottom shall be lowered to provide 6-inches of clearance around the pipe. Class I granular bedding or earth material free of rocks shall be used to bring the trench bottom to grade.

- B. After each pipe has been brought to grade, aligned, and placed in final position, earth material for water main piping shall be deposited and densified under the pipe haunches and on each side of the pipe up to the spring line of the pipe to prevent lateral displacement and hold the pipe in proper position during subsequent pipe jointing, bedding, and backfilling operations.
- C. In wet, yielding and mucky locations where pipe is in danger of sinking below grade or floating out of grade or line, or where backfill materials are of such a fluid nature that such movements of pipe might take place during the placing of the backfill, the pipe must be weighted or secured permanently in place by such means as will prove effective.
- D. Where an unstable (i.e., water, mud, etc.) trench bottom is encountered, stabilization of the trench bottom is required. This is to be accomplished by undercutting the trench depth and replacing to grade with a foundation of crushed stone aggregate.
- E. The depth of the foundation is dependent upon the severity of the trench bottom. The size of stone aggregate used in the foundation will be determined by the condition of the unstable material. Once the trench bottom has been stabilized, the required Class I bedding material can be placed.
- F. It should be noted that no pipe shall be laid on solid or blasted rock.
- G. Pipe bedding as required in Paragraphs A, B, and D of this Section is **not** considered a separate pay item.

3.03 WATER PIPE BACKFILLING

- A. Initial Backfill:
 - 1. This backfill is defined as that material which is placed over the pipe from the spring line to a point 12-inches above the top of the pipe. For water main piping, initial backfill material shall be earth material free of rocks, acceptable to the Engineer or with Class I material when a condition exists mentioned in Paragraph A, 3. below.
 - 2. Material used, whether earth or Class I, in the initial backfilling is **not** a separate pay item. Payment for the material is included in the unit price per linear foot of

water main.

3. In areas where large quantities of rock are excavated and the available excavated earth in the immediate vicinity is insufficient for placing the required amount of backfill over the top of the pipe as set forth in Paragraph A.1, the Contractor shall either haul in earth or order Class I material for backfilling over the pipe. Neither the hauling and placement of earth nor the ordering and placement of Class I material to fulfill the backfill requirements set forth herein is considered a separate pay item.
- B. Final Backfill:
1. There are two cases where the method of final backfilling varies. The various cases and their trench situations are as follows:
 - a. Case I - Areas not subject to vehicular traffic.
 - b. Case II - Paved areas including streets, drives, parking areas, and walks.
 2. In all cases, walking or working on the completed pipelines, except as may be necessary in backfilling, will not be permitted until the trench has been backfilled to a point 12-inches above the top of the pipe. The method of final backfilling for each of the above cases is as follows:
 - a. Case I - The trench shall be backfilled from a point 12-inches above the top of the pipe to a point 8-inches below the surface of the ground with earth material free from large rock (over one-half cubic foot in volume), acceptable to the Engineer. The remainder of the trench shall be backfilled with earth material reasonably free of any rocks.
 - b. Case II - The trench shall be backfilled from a point 12-inches above the top of the pipe to a point 12-inches below the existing pavement surface with Class I (No. 9 crushed stone aggregate) material. The backfill shall be mechanically tamped in approximately 6-inch layers to obtain the maximum possible compaction. The remaining backfill shall be Class II (dense graded aggregate) material mechanically tamped to maximum possible compaction. The trench may be left with a slight mound if permitted by the Engineer. Where required by state or local regulations, a bituminous binder coarse detailed on the Drawings and specified in Section 02510 shall be incorporated in the final backfill.
 3. Earth and Class I material used in final backfill is not a separate pay item. Payment shall be included in the price of water main.
 4. Class II material used in final backfill shall be included in the unit price of the pipe.
- C. A sufficient amount of Class II material shall be stockpiled to insure immediate replacement by the Contractor of any settled areas. No extra payment will be made for the filling in of settled or washed areas by the Contractor.
- D. Excavated materials from trenches, in excess of quantity required for trench backfill, shall be disposed of by the Contractor. It shall be the responsibility of the Contractor

to obtain location or permits for its disposal, unless specific waste areas have been designated on the Drawings or noted in these Specifications. The cost of disposal of excess excavated materials, as set forth herein, no additional compensation being allowed for hauling or overhaul.

3.04 GRAVITY SEWER AND FORCE MAIN PIPE BEDDING

- A. Piping for gravity sewers and force mains shall be supported as follows:
 - 1. All gravity sewer piping shall be laid on a bed of granular material except when a concrete encasement situation occurs. All pipe bedding material shall be Class I (No. 9 crushed stone aggregate) and shall be placed to a depth of 6-inches in an earth trench and 6-inches in a rock trench. Aggregate bedding shall be graded to provide for a uniform and continuous support beneath the pipe at all points.
 - 2. The trench bottom for force main piping shall be stable, continuous, relatively smooth and free of frozen material, clodded dirt, foreign material and rock or granular material larger than 1/2 inch in diameter. The foundation for force main piping shall be prepared so that the entire load of the backfill on top of the pipe will be carried uniformly on the barrel of the pipe. Any uneven areas in the trench bottom shall be shaved-off or filled-in with Class I granular bedding. When the trench is made through rock, the bottom shall be lowered to provide 6-inches of clearance around the pipe. Class I granular bedding shall be used to bring the trench bottom to grade.
- B. After each pipe has been brought to grade, aligned, and placed in final position, Class I material for gravity sewer piping and earth material for force main piping shall be deposited and densified under the pipe haunches and on each side of the pipe up to the spring line of the pipe to prevent lateral displacement and hold the pipe in proper position during subsequent pipe jointing, bedding, and backfilling operations.
- C. In wet, yielding and mucky locations where pipe is in danger of sinking below grade or floating out of grade or line, or where backfill materials are of such a fluid nature that such movements of pipe might take place during the placing of the backfill, the pipe must be weighted or secured permanently in place by such means as will prove effective.
- D. Where an unstable (i.e., water, mud, etc.) trench bottom is encountered, stabilization of the trench bottom is required. This is to be accomplished by undercutting the trench depth and replacing to grade with a foundation of crushed stone aggregate.
- E. The depth of the foundation is dependent upon the severity of the trench bottom. The size of stone aggregate used in the foundation will be determined by the condition of the unstable material. Once the trench bottom has been stabilized, the required Class I bedding material can be placed.
- F. It should be noted that no pipe shall be laid on solid or blasted rock.

- G. Pipe bedding as required in Paragraphs A, B, and D of this Section is **not** considered a separate pay item.

3.05 GRAVITY SEWER AND FORCE MAIN BACKFILL

A. Initial Backfill:

1. This backfill is defined as that material which is placed over the pipe from the spring line to a point 12-inches above the top of the pipe. For gravity sewer piping the material shall be Class I (No. 9 crushed stone aggregate) and may be machine placed without compaction. Uneven places in the backfill shall be leveled by hand. For force main piping, initial backfill material shall be earth material free of rocks, acceptable to the Engineer or with Class I material when a condition exists mentioned in Paragraph A, 3. below.
2. Material used, whether earth or Class I, in the initial backfilling is **not** a separate pay item. Payment for the material is included in the unit price per linear foot of gravity sewer or force main.
3. In areas where large quantities of rock are excavated and the available excavated earth in the immediate vicinity is insufficient for placing the required amount of backfill over the top of the pipe as set forth in Paragraph A.1, the Contractor shall either haul in earth or order Class I material for backfilling over the pipe. Neither the hauling and placement of earth nor the ordering and placement of Class I material to fulfill the backfill requirements set forth herein is considered a separate pay item.

B. Final Backfill:

1. There are two cases where the method of final backfilling varies. The various cases and their trench situations are as follows:
 - a. Case I - Areas not subject to vehicular traffic.
 - b. Case II - Paved areas including streets, drives, parking areas, and walks.
2. In all cases, walking or working on the completed pipelines, except as may be necessary in backfilling, will not be permitted until the trench has been backfilled to a point 12-inches above the top of the pipe. The method of final backfilling for each of the above cases is as follows:
 - a. Case I - The trench shall be backfilled from a point 12-inches above the top of the pipe to a point 8-inches below the surface of the ground with earth material free from large rock (over one-half cubic foot in volume), acceptable to the Engineer. The remainder of the trench shall be backfilled with earth material reasonably free of any rocks.
 - b. Case II - The trench shall be backfilled from a point 12-inches above the top of the pipe to a point 12-inches below the existing pavement surface with Class I (No. 9 crushed stone aggregate) material. The backfill shall be mechanically tamped in approximately 6-inch layers to obtain a compaction of 95 percent density as measured by the modified Procter Test. The remaining backfill shall be Class II (dense graded aggregate)

material mechanically tamped to the compaction as required above for Class I material. The trench may be left with a slight mound if permitted by the Engineer. Where required by state or local regulations, a bituminous binder coarse detailed on the Drawings and specified in Section 02510 shall be incorporated in the final backfill.

3. Earth and Class I material used in final backfill is not a separate pay item. Payment shall be included in the price of gravity sewer and force main.
 4. Class II material used in final backfill shall be included in the unit price for gravity sewer and force main.
- C. A sufficient amount of Class II material shall be stockpiled to insure immediate replacement by the Contractor of any settled areas. No extra payment will be made for the filling in of settled or washed areas by the Contractor.
- D. Excavated materials from trenches, in excess of quantity required for trench backfill, shall be disposed of by the Contractor. It shall be the responsibility of the Contractor to obtain location or permits for its disposal, unless specific waste areas have been designated on the Drawings or noted in these Specifications. The cost of disposal of excess excavated materials, as set forth herein, no additional compensation being allowed for hauling or overhaul.

3.06 PLACEMENT OF IDENTIFICATION TAPE

- A. The placement of detectable mylar underground marking tape shall be installed over all utility lines. Care shall be taken to insure that the buried marking tape is not broken when installed and shall be Lineguard brand encased aluminum foil, Type III. The identification tape is manufactured by Lineguard, Inc., P.O. Box 426, Wheaton, IL 60187.
- B. The identification tape shall bear the printed identification of the utility line below it, such as "Caution - Buried Below". Tape shall be reverse printed; surface printing will not be acceptable. The tape shall be visible in all types and colors of soil and provide maximum color contrast to the soil. The tape shall meet the APWA color code, and shall be 2-inches in width. Colors are: yellow - gas, green - sewer, red - electric, blue - water, orange - telephone, brown - force main.
- C. The tape shall be the last equipment installed in the trench so as to be first out. The tape shall be buried 18-inches below top of grade. After trench backfilling, the tape shall be placed in the backfill and allowed to settle into place with the backfill. The tape may be plowed in after final settlement, installed with a tool during the trench backfilling process, unrolled before final restoration or installed in any other way acceptable to the Owner or Engineer.

3.07 COPPER TRACING WIRE

No. 12 solid copper wire shall be laid in top 12 inches of trench over all plastic pipe. The copper tracing wire shall be wrapped around a line marker at least three (3) times and tied one (1) foot above grade.

END OF SECTION 02225

SECTION 02510 - ASPHALT CONCRETE PAVING

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide asphalt concrete paving for following applications and prepared subbase and compacted base.
 - 1. Roads.
 - 2. Parking areas.
 - 3. Driveways.
 - 4. Walkways.
 - 5. Curbs.
- B. Provide striping for parking, roadway, and handicapped markings.

1.02 SUBMITTALS

Submit for approval product data, test reports.

1.03 QUALITY ASSURANCE

Comply with governing codes and regulations. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Prime coat: Cut-back asphalt.
- B. Tack coat: Emulsified asphalt.
- C. Asphalt cement: AASHTO M226 and as required by local authorities.
- D. Aggregate: Crushed stone or crushed gravel.
- E. Traffic paint: Quick-drying chlorinated-rubber alkyd type, color as approved.
- F. Wheelstops: Precast concrete of uniform color and texture with steel stakes.

PART 3 - EXECUTION

3.01 NEW PAVEMENT INSTALLATION

- A. Asphalt/aggregate Mixture: Comply with local DPW Standard Specifications for Highways and Bridges. Class as required by loading and use.
- B. Remove loose material from compacted subbase. Proof roll and check for areas requiring additional compaction. Report unsatisfactory conditions in writing. Beginning of work means acceptance of subbase.
- C. Apply tack coat to previous laid work and adjacent in-place concrete surfaces.
- D. Place asphalt concrete at minimum temperature of 225 degrees F in strips not less than 10' wide overlapping previous strips. Complete entire base course before beginning surface course.
- E. Construct curbs to dimensions indicated or if not indicated to standard shapes. Provide tack coat between curb and pavement.
- F. Begin rolling when pavement can withstand weight of roller. Roll while still hot to obtain maximum density and to eliminate roller marks.
- G. Provide 4" lane and striping paint in uniform, straight lines. Provide wheelstops where indicated and securely dowel into pavement. Protect work from traffic and damage.
- H. Test in-place asphalt work for thickness and smoothness. Remove and replace defective work and patch to eliminate evidence of patching. Provide the following minimum thickness and smoothness unless otherwise greater thickness is required on the Drawings:
 - 1. Subbase course: 4-inch No. 2 stone and 4-inch DGA.
 - 2. Base course: 2-1/2-inch.
 - 3. Surface course: 1-1/2-inch plus or minus 1/4-inch at drives and parking; 1-inch plus or minus 1/4-inch at walks.
 - 4. Surface course smoothness: Plus or minus 1/8-inch in 10 feet. No ponding of water is acceptable.

3.02 REPLACEMENT PAVEMENT FOR UTILITIES

- A. Sections of pavement shall be replaced as required to install the pipelines. Disturbed pavement shall be reconstructed to original lines and grades with bituminous binder as detailed on the Drawings and in such manner as to leave all such surfaces in fully as good or better condition than that which existed prior to these operations.

- B. Prior to trenching, the pavement shall be scored or cut to straight edges along each side of the proposed trench to avoid unnecessary damage to the remainder of the paving. Edges of the existing pavement shall be recut and trimmed as necessary to square, straight edges after the pipe has been installed and prior to placement of the binder course or concrete.
- C. Backfilling of trenches shall be in accordance with the applicable portions of Section 02225.
- D. Bituminous concrete binder shall be one course construction in accordance with applicable provisions of the Kentucky Department of Highways Standard Specifications, Section 402.
 - 1. Placement and compaction of binder courses shall be in accordance with Section 402 of the Kentucky Department of Highways Standard Specifications. Minimum thickness after compaction shall be 2-inches for driveways and 5 ½ inches for roads.
- E. Pavement restoration shall be in accordance with the above unless shown otherwise on the plans.

END OF SECTION 02510

SECTION 02605 - VALVE VAULT

PART 1 - GENERAL

1.01 WORK INCLUDED

The Contractor shall provide all materials and labor to install valve vaults as shown on the Drawings and specified herein.

1.02 RELATED WORK

- A. Section 02225 - Excavating, Backfilling, and Compacting for Utilities.
- B. Section 02610 - Water Pipe and Fittings.
- C. Section 02642 - Sewage Valves and Gates.

PART 2 - PRODUCTS

2.01 PRECAST VALVE VAULTS

- A. Precast Concrete Sections:
 - 1. Valve Vaults shall be constructed of precast concrete manhole sections.
 - 2. Precast concrete sections and appurtenances shall conform to the ASTM Standard Specifications for Precast Reinforced Concrete Manhole Sections, Designation C478, latest revision, with the following exceptions and additional requirements.
 - 3. The wall sections shall be not less than 5 inches thick.
 - 4. Type II cement shall be used except as otherwise permitted.
 - 5. Joints between sections shall be made watertight through the use of rubber O-ring gaskets or a 1 – ¼ inch diameter flexible joint sealer or No. 2 kent-seal as manufactured by Hamilton Kent, or equal. Gaskets shall conform to the ASTM Standard C-443, latest revision.
- B. Mortar for Precast Concrete Rings
 - 1. The mortar shall be composed of one part Portland cement and two parts of sand by volume with sufficient water to form a workable mixture. Cement and sand shall be as specified for mortar for brickwork.
- C. Manhole Frames and Covers:
 - 1. The Contractor shall furnish all cast-iron manhole frames and covers conforming to the details shown on the Drawings, or as hereinbefore specified.
 - 2. The castings shall be of good quality, strong, tough, evengrained cast iron, smooth, free from scale, lumps, blisters, sandholes, and defects of every nature

which would render them unfit for the service for which they are intended. Contact surfaces of covers and frame seats shall be machined to prevent rocking of covers.

3. All casting shall be thoroughly cleaned and subject to a careful hammer inspection.
4. Castings shall be at least Class 25 conforming to the ASTM Standard Specifications for Gray Iron Casting, Designation A48, latest revision.
5. Unless otherwise specified, manhole covers shall be 22-3/4 inches in diameter, weighing not less than 350 pounds per frame and cover. Manhole covers shall set neatly in the rings, with contact edges machined for even bearings and tops flush with ring edge. They shall have sufficient corrugations to prevent slipperiness. The covers shall have two (2) pick holes about 1-1/4 inches wide and 1/2 inches deep with 3/8 inch undercut all around. Covers shall not be perforated. Frames and covers shall be J.R. Hoe and Sons, Mc-350, or equal.
6. All covers shall be appropriately marked in large letters either "WATER" or "SEWER" in the center.

D. Pre-molded Elastomeric-sealed Joints:

All holes for pipe connections in concrete barrels and bases shall have a factory-installed flexible rubber gasket to prevent infiltration. The gasket shall conform to the latest revision of ASTM-433. The gasket shall be Contour Seal or Kor-N-Seal made by National Pollution Control Systems, Inc., Nashua, NH; A-Lok Manhole Pipe Seal made by A-Lok Corporation, Trenton, NJ; or equal.

2.02 PRECAST CONCRETE VAULTS

- A. General: Concrete valve vaults shall be furnished and installed in accordance with the details and dimensions as shown on the Plans. Concrete for the vault shall be Type I, 4,500 psi at 28 days, and shall conform to the applicable requirements of ACI 301-72 in all respects. Reinforcement shall conform to the requirements of ASTM A-615, A-616, or A-617. Minimum yield strength of the reinforcement shall be 60,000 psi.
- B. Access Hatch: Access hatch assemblies shall be installed in the top slab of the valve pit at the location shown on the Drawings. Frames and covers shall be fabricated of aluminum. Frame shall be securely mounted over the valves. Covers shall be provided with lifting handle and safety latch to hold the cover in the 90 degrees open position. Locking hasps shall be provided. Covers shall be of the checkered plate design. Access frame and cover shall be sized in accordance with the Drawings. Access frame and cover shall be Model KD-2 as manufactured by the Bilco Company, New Haven, CT, or equal.

2.03 VALVES

Valves are specified in Section 02642.

PART 3 - EXECUTION

3.01 FABRICATION - PRECAST SECTIONS

- A. Manhole sections shall contain manhole steps accurately positioned and embedded in the concrete when the section is cast.
- B. Sections shall be cured in an enclosed curing area and shall attain strength of 4,000 psi prior to shipment.
- C. No more than two (2) lift holes or inserts may be cast or drilled in each section.
- D. Flat slab tops shall have a minimum thickness of 6 inches and reinforcement in accordance with ASTM C478.
- E. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the precast sections.
- F. Acceptance of the sections will be on the basis of material tests and inspection of the completed product and test cylinders if requested by the Engineer.
- G. Cones shall be precast sections of similar construction.

3.02 SETTING PRECAST MANHOLE SECTIONS

- A. Precast-reinforced concrete manhole sections shall be set so as to be vertical and with sections and steps in true alignment.
- B. Rubber gaskets shall be installed in all manhole joints in accordance with the manufacturer's recommendations.
- C. All holes in sections used for their handling shall be thoroughly plugged with rubber plugs made specifically for this purpose.

3.03 ADJUSTING MANHOLE FRAMES AND COVERS TO GRADE

- A. Except where shown on the Drawings, the top of the precast concrete eccentric cone of a standard manhole or the top of the flat slab of a shallow manhole shall terminate 4 inches below existing grade in an unpaved non-traffic area except in a residential yard and 13 inches below existing grade in a paved or unpaved traffic area and in a residential yard. The remainder of the manhole shall be adjusted to the required grade as described hereinafter in paragraphs B and C of this article.
- B. When a manhole is located in an unpaved non-traffic area other than in a residential yard, the frame and cover shall be adjusted to an elevation 3 inches to 5 inches above

the existing grade at the center of the cover. If field changes have resulted in the installed manhole invert elevation to be lower than the invert elevation shown on the Drawings, the adjustment to an elevation of 3 inches to 5 inches above existing grade shall be accomplished by the use of precast concrete rings. If field changes have resulted in the completed manhole invert to be greater than the invert shown on the Drawings and the cover higher than 5 inches above existing grade, then the top of the eccentric cone, when used, or the top of the barrel section, when used, shall be trimmed down so that the manhole cover, after installation, is no greater than 5 inches above existing grade at the center of the cover. The area around the adjusted frame and cover shall be filled with the required material, sloping it away from the cover at a grade of 1 inch per foot.

- C. When a manhole is located in a bituminous, concrete, or crushed stone traffic area, or in a residential yard, the frame and cover shall be adjusted to the grade of the surrounding area by the use of precast concrete rings. The adjusted cover shall conform to the elevation and slope of the surrounding area. If field changes have resulted in the installed manhole invert elevation to be so much higher than the invert elevation shown on the Drawings that the top of the eccentric cone, when used, or the top of the flat slab, when used, is less than the thickness of the frame and cover 7 inches from the grade of the surrounding area, then the top of the cone or barrel section shall be trimmed down enough to permit the cover, after installation, to conform to the elevation and slope of the surrounding area. After installation, the inside and outside surfaces of the brick shall receive a waterproofing bitumastic coating.
 - 1. The Contractor shall coordinate elevations of manhole covers in paved streets with the Owner. If resurfacing of the street in which sewers are laid is expected within twelve (12) months, covers shall be set 1-1/2 inches above the existing pavement surface in anticipation of the resurfacing operations.

3.04 ADJUSTING SECTIONS

Only clean adjusting sections shall be used. Each adjusting section shall be laid in a bead butyl mastic sealant and shall be thoroughly bonded.

3.05 SETTING MANHOLE FRAMES AND COVERS

- A. Manhole frames shall be set with the tops conforming to the required elevations set forth hereinbefore. Frames shall be set concentric with the top of the concrete and in a full bead of butyl mastic sealant so that the space between the top of the masonry and the bottom flange of the frame shall be completely watertight.
- B. Manhole covers shall be left in place in the frames on completion of other work at the manholes.

END OF SECTION 02605

SECTION 02610 – WATER PIPE AND FITTINGS

PART 1 - GENERAL

1.01 WORK INCLUDED

The Contractor shall furnish all labor, material, and equipment necessary to install water main piping together with all appurtenances as shown and detailed on the Drawings and specified herein.

1.02 RELATED WORK

- A. Section 02222 - Excavation.
- B. Section 02223 – Embankments.
- C. Section 02225 - Excavating, Backfilling and Compacting for Utilities.
- D. Section 02640 - Water Valves and Gates.
- E. Section 02642 – Sewage Valves and Gates.
- F. Section 02675 - Disinfection of Potable Water Pipe.

1.03 REFERENCES

- A. AWWA C104.
- AWWA C110.
- AWWA C111.
- AWWA C115.
- AWWA C150.
- AWWA C151.
- AWWA C153.
- ASTM C443.
- ASTM C478.

ASTM D1785.

ASTM D2467.

ASTM D2564.

PART 2 - PRODUCTS

2.01 DUCTILE IRON PIPE (DIP) AND FITTINGS

- A. Ductile iron pipe (DIP) shall conform to ANSI/AWWA C150/A21.50, ANSI/AWWA C151/A21.51 Standard. The pipe shall conform to pressure class 350 minimum unless noted otherwise. All pipe, fittings and joints must be capable of accommodating pressure up to 350 psi. The ductile iron pipe shall be as manufactured by Clow Corp., U.S. Pipe & Foundry Co., American Cast Iron Pipe Co., or equal.
- B. Fittings shall be restrained mechanical joint or push-on joint ductile iron in accordance with AWWA C153 and have a body thickness and radii of curvature conforming to ANSI A21.10 or ANSI A21.53 for compact fittings. Fittings and joints shall be supplied with all accessories.
 - 1. Restrained mechanical joint fittings shall have joints in accordance with ANSI/AWWA C111/A21.11. Fitting restraint shall be by set screw retainer rings such as Mega Lugs as manufactured by EBBA Iron, Inc., or equal.
 - 2. Push-on type joints shall be single rubber gasket, with cast gasket socket and recessed bell with a tapered annular opening and flared socket. Plain spigot ends shall be suitably beveled to permit easy entry into the bell, centering and compressing the gasket. Push-on joints shall be equal to the "Fastite" joint as manufactured by American Cast Iron Pipe Company, or "Tyton Joint" as manufactured by US Pipe & Foundry Company, or approved equal. Push-on fittings shall have a restraint system as per paragraph 2.01.I of this section.
- C. Ductile iron flanged joint pipe shall conform to ANSI/AWWA C115/A 21.15 Standard and have a thickness Class of 53. The pipe shall have a rated working pressure of 250 psi with Class 125 flanges. Gaskets shall be ring gaskets with a thickness of 1/8 inch. Flange bolts shall conform to ANSI B 16.1.
- D. Flanged fittings shall meet all requirements of ANSI/AWWA C110/A21.10 (or A21.53 for compact fittings) and have Class 125 flanges. Fittings shall accommodate a working pressure up to 250 psi and be supplied with all accessories.
- E. All pipe and fittings shall be asphaltic coated outside and shall receive a standard cement lining with asphaltic seal coat on the inside in accordance with ANSI/AWWA C104/A21.4.

- F. Cement mortar lining and seal coating for pipe and fittings, where applicable shall be in accordance with ANSI/AWWA C104/A21.4. Asphaltic outside coating shall be in accordance with ANSI/AWWA C151/A21.51 for pipe and ANSI/AWWA C110/A21.10 for fittings.
- G. All ductile fittings shall be rated at 250 psi water working pressure plus water hammer. Ductile iron fittings shall be ductile cast-iron grade 70-50-05 per ANSI/AWWA C110/A21.10.
- H. No separate pay item has been established for fittings and no determination of the number of fittings required on the job has been made. The Contractor, during the bidding phase, shall determine the number of fittings required on the job and include the cost of the fittings and installation in the unit price for pipe.
- I. Restrained joint pipe and push-on fittings shall be a boltless system equal to "Fast-Grip" restraining gaskets or "Flex-Ring" joint as manufactured by American Cast Iron Pipe Company, or "Field-Lok" restraining gaskets or "TRFLEX Joint" as manufactured by US Pipe & Foundry Company, or equal.
- J. Ball and socket restrained joint pipe and fittings shall be a boltless system equal to USIFLEX manufactured by U.S. Pipe and Foundry Company or FLEX-LOK manufactured by American Cast Iron Pipe Company, or equal. Pipe shall have a working pressure rating of 250 psi and have a maximum joint deflection of 15 degrees. Nominal laying lengths shall be in the range of 18-feet 6-inches to 20-feet 6-inches.
- K. Pipe shall be as manufactured by U.S. Pipe & Foundry Company, American Cast Iron Pipe Company, or equal.

2.02 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

- A. Polyvinyl chloride (PVC) pipe for buried water mains smaller than 4-inches in diameter shall be Class 250 (SDR 17) PVC pressure rated pipe with either twin gasket joints or integral bell joints with rubber O-ring seals. All Class 250 pipe shall meet the requirement of SDR 17.
- B. All PVC pipe shall conform to the latest revisions of ASTM D-1784 (PVC Compounds), ASTM D-2241 (PVC Plastic Pipe, SDR), and ASTM D-2672 (Bell-end PVC Pipe). PVC pipe shall have a minimum cell classification of 12454B or 12454C as defined in ASTM D-1784. Rubber gasketed joints shall conform to ASTM D-3139. The gaskets for the PVC pipe joint shall conform to ASTM F-477 and D-1869.
- C. Rubber gasket joints shall provide adequate expansion to allow for a 50 degree change in temperature on one length of pipe. Lubrication for rubber connected couplings shall be water soluble, non-toxic, be non-objectionable in taste and odor and have no

deteriorating affect on the PVC or rubber gaskets and shall be as supplied by the pipe manufacturer.

- D. All pipe and couplings shall bear identification markings that will remain legible during normal handling, storage and installation, which have been applied in a manner what will not reduce the strength of the pipe or the coupling or otherwise damage them. Pipe and coupling markings shall include the nominal size and OD base, material code designation, dimension ratio number, ASTM Pressure Class, ASTM designation number for this standard, manufacturer's name or trademark, seal (mark) of the testing agency that verified the suitability of the pipe material for potable-water service. Each marking shall be applied at intervals of not more than 5 feet for the pipe and shall be marked on each coupling.

PART 3 - EXECUTION

3.01 LAYING DEPTHS

In general, water mains shall be laid with a minimum cover of 36-inches, except as otherwise indicated on the Drawings.

3.02 UTILITY CROSSING CONCRETE ENCASEMENT

- A. At locations shown on the Contract Drawings, required by the Specifications, or as directed by the Engineer, concrete encasement shall be used when the clearance between the proposed water pipe and any existing utility pipe is 18-inches or less. Utility pipe includes underground sewer, gas, telephone, and electrical conduit, storm sewers, and any other pipe as determined by the Engineer.
- B. There are two cases of utility crossing encasement. Case I is applicable when the proposed water line is **above** the existing utility line. Case II is applicable when the proposed water line is laid **below** the utility line. In either case, the concrete shall extend to at least the spring line of each pipe involved.
- C. Concrete shall be 3000 psi and shall be mixed sufficiently wet to permit it to flow between the pipes to form a continuous bridge. In tamping the concrete, care shall be taken not to disturb the grade or line of either pipe or damage the joints.
- D. Concrete for this Work is not a separate pay item and will be considered incidental to utility pipe installation.

3.03 PIPE LAYING

- A. All pipe shall be laid with ends abutting and true to the lines and grades indicated on the plans. Pipe shall be fitted and matched so that when laid in the Work, it will

provide a smooth and uniform invert. Supporting of pipe shall be as set out in Section 02225 and in no case shall the supporting of pipe on blocks be permitted.

- B. Before each piece of pipe is lowered into the trench, it shall be thoroughly swabbed out to insure it is clean. Any piece of pipe or fitting which is known to be defective shall not be laid or placed in the lines. If any defective pipe or fittings shall be discovered after the pipe is laid, it shall be removed and replaced with a satisfactory pipe or fitting without additional charge. In case a length of pipe is cut to fit in a line, it shall be so cut as to leave a smooth end at right angles to the longitudinal axis of the pipe. Bevel can be made with hand or power tools.
- C. The interior of the pipe, as the Work progresses, shall be cleaned of dirt, jointing materials, and superfluous materials of every description. When laying of pipe is stopped for any reason, the exposed end of such pipe shall be closed with a plywood plug fitted so as to exclude earth or other material and precautions taken to prevent floatation of pipe by runoff into trench.
- D. Anchorage of Bends:
 - 1. At all tees, plugs, caps and bends of 11 ¼ degrees and over, and at reducers or in fittings where changes in pipe diameter occur, movement shall be prevented by using suitable harness, thrust blocks or ballast. Thrust blocks shall be as shown on the Drawings, with sufficient volumes of concrete being provided; however, care shall be taken to leave weep holes unobstructed and allow for future tightening of all nearby joints. Unless otherwise directed by the Engineer, thrust blocks shall be placed so that pipe and fitting joints will be accessible for repair.
 - 2. Bridles, harness or pipe ballasting shall meet with the approval of the Engineer. Steel rods and clamps shall be stainless steel. No extra pay shall be allowed for work to provide proper anchorage of pipe, fittings or other appurtenances. Such items shall be included in the price bid for the supported item.
- E. No backfilling (except for securing pipe in place) over pipe will be allowed until the Engineer has the opportunity to make an inspection of the joints, alignment and grade in the section laid, but such inspection shall not relieve the Contractor of further liability in case of defective joints, misalignment caused by backfilling and other such deficiencies that are noted later.

3.04 JOINTING

All joint surfaces shall be cleaned immediately before jointing the pipe. The bell or groove shall be lubricated in accordance with the pipe manufacturer's recommendations. Each pipe unit shall then be carefully pushed into place without damage to pipe or gasket. All pipe shall be provided with home marks to insure proper gasket seating. Details of gasket installation and joint assembly shall follow the

direction of the manufacturer's of the joint material and of the pipe. The resulting joints shall be watertight and flexible.

3.05 TESTING OF WATER PIPE

- A. The completed work shall comply with the provisions listed herein, or similar requirements which will insure equal or better results. Suitable test plugs, water pump or other equipment and apparatus, and all labor required to properly conduct the tests shall be furnished by the Contractor at no expense to the Owner.
- B. Water main piping shall be pressure tested to a minimum of 150 pounds per square inch (psi). At no time shall the test pressure exceed 150 percent of the pipe's rated working pressure. A pipe section shall be accepted if the test pressure does not fall more than 5 psi during the minimum 2-hour test period. The pipe shall be tested for allowable leakage according to AWWA C-600 (latest revision) concurrently with the pressure test.
- C. Where practicable, pipelines shall be tested between line valves or plugs in lengths of not more than 6,000 feet. Testing shall proceed from the source of water toward the termination of the line. The line shall be tested upon the completion of the first 6,000 feet. After the completion of two (2) consecutive tests without failure, the Contractor, at his option and with the Engineer's approval, may discontinue testing until the system is complete.
- D. All pipe, fittings and other materials found to be defective under test shall be removed and replaced at the Contractor's expense.
- E. Before applying the specified test pressure, air shall be expelled completely from the pipe, valves and hydrants. If permanent air vents are not located at high points within the test section, the Contractor shall install corporation cocks at such points so that the air can be expelled as the line is filled with water.
- F. All piping shall be tested for leakage at a pressure no less than that specified for the pressure test. The leakage shall be defined as the quantity of water that must be supplied to the tested section to maintain pressure within 5 psi of the specified test pressure after the air in the pipeline has been expelled and the pipe has been filled with water. The leakage shall be less than an allowable amount determined by guidelines listed in AWWA Manual of Water Supply Practices "PVC PIPE--DESIGN AND INSTALLATION", or appropriate guidelines for other pipe materials. For PVC pipe, the following equation applies:

$$L = \frac{N * D * P^{0.5}}{7400}$$

Where:

L = allowable leakage (gallons/hour)

N = number of joints in the length of pipelines

D = nominal diameter of pipe (inches)

P = average pressure during the leakage test (psig)

- G. Should the sections under test fail to meet the requirements, the Contractor shall do all work of locating and repairing the leaks and retesting as the Engineer may require without additional compensation. All visible leaks are to be repaired regardless of the amount of leakage.
- H. If in the judgement of the Engineer, it is impracticable to follow the foregoing procedures for any reason, modifications in the procedures shall be made as required and as acceptable to the Engineer, but in any event, the Contractor shall be responsible for the ultimate tightness of the line within the above test requirements.

3.06 PLACEMENT OF IDENTIFICATION TAPE

The placement of detectable underground mylar marking tape shall be installed over all water mains as specified in Section 02225.

END OF SECTION 02610

SECTION 02615 – CHEMICAL PIPING, VALVES AND APPURTENANCES

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. The Contractor shall furnish, install, and test all chemical piping, hoses, valves, fittings and appurtenances as herein specified. The locations where various types of pipe shall be used shall be as indicated on the drawings and herein specified.
- B. The Contractor, at no additional cost to the Owner, shall do all work required by and in accordance with applicable State and local codes; shall arrange for all permits, inspections and tests required by these codes; and shall do everything necessary to provide complete systems which will be ready for use without further expense to the Owner.
- C. The Contractor shall thoroughly familiarize himself, his workmen and his subcontractors with the hazards associated with the chemicals specified herein and used at the water pollution control plant, and he shall take all necessary safety precautions.
- D. Chemical drain piping shown on Plumbing sheets is specified under Section 15400 – PLUMBING.

1.02 RELATED WORK

PART 2 – PRODUCTS

2.01 PIPE AND FITTING

- A. Insofar as possible, all materials shall conform, and all piping shall be fabricated, installed and tested in accordance with the provisions of the “American Standard Code for Pressure Piping, Chemical Plant Petroleum Refinery Piping,” ANSI B31.3-1976 and Addenda B31.3a-1978, as published by the American Society of Mechanical Engineers, New York, New York 10017.
- B. All bolting shall be cadmium plated carbon steel in accordance with the hereinafter listed ASTM A307, Grade B, and nuts shall be cadmium plated carbon steel in accordance with the hereinafter-listed ASTM A194, Grade 2.
- C. All pipe and fittings shall conform to the following Specifications and Standards as applicable, unless otherwise indicated or specified.

1. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- a. A53-79 Specifications for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- b. A182-70A Specifications for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
- c. A194-79 Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High Temperature Service
- d. A307-78 Specification for Carbon Steel Externally and Internally Threaded Standard Fasteners
- e. A312-79a Specification for Seamless and Welded Austenitic Stainless Steel Pipe
- f. A403-79 Specification for Wrought Austenitic Stainless Steel Piping Fittings
- g. D1785 Specifications for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedules 40 and 80
- h. D2464-76 Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
- i. D2467-76a Socket Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
- j. F439-77 Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) CPVC) Plastic Pipe, Schedules 40 And 80
- k. F441-77 Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
- l. F493-79 Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

2. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- a. B16.5-199 AN Standard for Steel Pipe Flanges and Flanged Fittings
- b. B16.9-1978 An Standard for Factory-Made Wrought Steel Buttwelding Fittings
- c. B16.11-1973 AN Standard for Forged Steel Fittings, Socket-Welding and Threaded

3. MANUFACTURER'S STANDARDIZATION SOCIETY OF THE VALVES AND FITTINGS INDUSTRY (MSS)

- a. MSS Standard Practice SP-43 (Fitting Dimensions)
- b. MSS Standard Practice SP-56 (Hangers and Supports)
- c. MSS Standard Practice SP-69 (Selection of Hangers and Supports)

2.02 CHEMICAL FEEDING SYSTEMS

- A. Pipe and Fittings: Insofar as possible, all fittings shall be solvent socket weld type CPVC Schedule 80. Schedule 40 fittings shall not be used.
- B. Screwed Connections: Screwed connections are permissible only where system components are not available in socket weld or flanged configurations, and only as follows:
 - 1. All threaded plastic connections and threaded plastic to metal transition connections shall be made with Spears Stainless Steel Reinforced (SR) Fittings, or equal. All fittings shall be Schedule 80 CPVC, conforming to ASTM F 439.
 - 2. All plastic components requiring screwed connections shall be made using Spears Stainless Steel Reinforced or approved equal, (SR) CPVC Fittings, Unions or Flanges.
 - 3. The Contractor shall take every precaution not to over-tighten or crack plastic threaded components. Threaded joints shall be made using either Teflon® tape or Spears Blue 75™ thread sealant, or equal. Threaded joints shall first be assembled "finger tight" and then no more than one to two turns past "finger tight". Only strap wrenches should be used to tighten plastic.

- C. Gaskets: CPVC flanges shall be jointed with full-face Viton or hypalon gaskets, of 50 or 60 Shore "A" Durometer, and shall be 1/8-inch thick. All gaskets shall be machine made or die stamped and shall have inside and outside edges concentric. Bolt holes shall be oversized to prevent crimping of the gasket when installed. Gaskets shall be resistant to deterioration for piping chemical use.
- D. Use of Other Plastic Components:
1. In the event that certain system components are composed of plastics other than CPVC, and are not available in flanged configuration, if acceptable to the Engineer, they shall be provided in screwed configuration and fitted with threaded CPVC nipples, and then connected to the system with socket weld CPVC unions or flanges.
 2. All such other plastics shall have strength and heat distortion resistance equal to or greater than CPVC at 150°F.
- E. Valves:
1. CPVC valves shall be made from chlorinated poly vinyl chloride, Type IV Cell Classification 23447, PVC valves shall be made from polyvinyl chloride Type I Cell classification 12454. All ½" through 2" valves shall be pressure rated at 235 psi and all 2-1/2" through 6" valves shall be rated at 150 psi, non-shock service at 73°F as manufactured by Spears Manufacturing Company, or equal.
 2. Valves shall have socket or flanged ends to suit the pipe connections herein before specified and shall be of the types indicated on the drawings.
 3. Valves shall be anchored as specified herein after and within the manufacturers recommendations to prevent torque stress on the pipe when opening and closing valves.
 4. CPVC & PVC ball valves shall have double True Union ends to permit removal of the valve without disconnecting the pipeline. All valves shall have Safe-T-Blocked® seal carriers, or equal, that will not leak when the downstream union end is disconnected. Genuine Viton® "O" ring seals, or equal, shall be used with PTFE Teflon seats. Ball valves shall be installed with the flow arrow pointed in the direction of the downstream piping. During installation, the valve handle shall be oriented for ease of operation by rotating the valve body about its axis prior to tightening the ends.
 5. Buried valves shall be provided with either Stem Extension Kits or 2" Square / T-Style Operator Nuts. Extension Handles or Rods shall be installed in valve boxes.

6. CPVC Check Valves shall have double True Union ends to permit removal of the valve without disconnecting the pipeline. All valves shall have Safe-T-Blocked® seal carriers that will not leak when the downstream union end is disconnected and Genuine Viton® “O” rings. All ½” through 2” valves shall be pressure rated at 235 psi and all 2-1/2” through 6” valves shall be rated at 150 psi, non-shock service at 73°F as manufactured by Spears Manufacturing Company, or equal.
7. Diaphragm valves shall be Saunders Patent weir type valves with Hypalon diaphragm, rising stem and CPVC body, or equal. Diaphragm valves shall have sealed bonnets to prevent leakage if damage to the diaphragm should occur.

F. Miscellaneous Fittings and Valves:

1. Union fittings shall be CPVC, Schedule 80, with socket weld ends, pressure rated at 235 psi, non-shock service at 73°F as manufactured by Spears Manufacturing Company or approved equal. Adequate unions shall be provided to allow for the removal and replacement of individual pieces of equipment.
2. All sample and blowdown valves shall be furnished with outlet piping, which shall terminate 6-in. above the floor slab, but in no event shall such piping be less than a 2-in. long nipple.
3. Vacuum breakers shall be designed to seal against pressure and to vent when under vacuum. Vacuum breakers shall have CPVC bodies and molded normally closed diaphragm seals.
4. Pressure relief valves shall be constructed of Type 1, Grade 1 CPVC with a solid Teflon Shaft. Three seals shall be constructed of Viton. Relief pressure shall be able to be manually set and shall be from 5 to 100 psig. Valve shall be Plast-O-Matic, model RVT or equal.
5. Quick disconnect hose fittings and all hoses shall be as specified hereinafter under “Chemical Hose”.

- G. All underground plastic piping shall have a colored metallic tape laid 2 feet above the pipe. The tape shall have the word “Caution” printed on it and shall identify the pipe use. Product shall be Seton Name Plate Corp., New Haven, CT, No. 210, or equal.

2.03 CHEMICAL HOSE

- A. Hose for carrying chemical solutions and slurries shall be 2-ply, with helical steel wire, 3/16-inch Hypalon tube and rubber cover, suction and discharge hose, sizes

as indicated on the drawings, suitable for 100 psi service. Hoses shall be made by Gates Rubber Co., Denver, Colorado; B.F. Goodrich, Akron, Ohio; or equal.

- B. Hoses shall be reasonably flexible and lightweight, therefore 4-ply hoses will not be acceptable.
- C. Hose sections shall not exceed twenty feet in length and shall be as necessary for the hose lines indicated on the drawings. Hose ends shall be fitted with shank type, polypropylene quick disconnect couplings. Coupling shall be of the cam and groove type, sized the same as the lines to which they are connected. All couplings furnished shall be compatible with all other couplings of equal line size. Coupling shall be Viton or Hypalon gaskets.

2.04 HANGERS, SUPPORTS AND WALL SLEEVES

- A. All piping shall be provided with necessary hangers, anchors, and supports as specified herein and as indicated on the drawings. Piping shall not be supported by the equipment to which it is connected.
- B. The pipe supports shall be complete with all accessories such as clamps, bolts, nuts, washers, rods, intermediate structural steel members when necessary, etc.
- C. All piping hanger components shall be designed for the maximum pressures and temperatures developed under all operating and test conditions as indicated.
- D. Pipe hanger and support designs and construction shall conform to the Manufacturers Standardization Society (MSS) of the Valve and Fitting Industry, Standard practice SP –58, and where details are not provided on the drawings or in the specifications, the selection and applications shall conform to the MSS Standard Practice SP-69. Where hangers and supports are identified on the drawings or in the specifications by a Type number, this number refers to units identified in the above Standard Practice bulletins.
- E. Anchors for CPVC shall have compressible rubber gaskets between the pipe and metal anchor to prevent damage to the pipe.
- F. Wall sleeve seals for pipes passing through structure walls below grade shall be compressions type units consisting of molded rubber links with bolt holes, elongated backup washers, nuts and bolts. When assembled around the pipes and inserted in the wall sleeve, tightening the bolts shall expand the rubber against the pipe and sleeve.

2.05 PRESSURE GAUGES

- A. Pressure gauges shall be provided as specified and as indicated on the drawings. They shall have a black turret-type case and shall be 4-1/2 inch nominal diameter

with stainless steel or phosphor bronze Bourdon tubes, 1/2-in. NPT male bottom connection, stainless steel rack and pinion movement, microadjustment for calibration, white dials and black figures, threaded ring case with an integral wall separating the dial face from the Bourdon tube, with blowout plug in the rear of the case and clear acrylic plastic lens.

- B. Gauges specified to have diaphragm seals shall have phosphor bronze Bourdon tubes. All other gauges shall have Type 316 stainless steel Bourdon tubes.
- C. Where specified, gauges shall be provided with protective diaphragm attachment, factory mounted. Diaphragm housings shall be constructed such that the diaphragm is held between to halves of the housing and the assembly is secured by four through-bolts with nuts. Diaphragms shall be Viton fluoroelastomer. Diaphragm housings for lime slurry services shall be 1-1/2 inch screwed end; all other diaphragm housings shall be 1/2inch screwed end; all lower housings shall be of the same materials as the piping system to which they are connected. Diaphragms shall be fitted with the manufacturer's standard fluid. For systems in contact with chemicals used to treat potable water supplies, the diaphragms shall be filled with propylene glycol or other FDA approved fluid. All diaphragm housings shall be equipped with 1/4-inch. NPT flushings connections, suitably plugged. Plugs shall be same material as the lower housing.
- D. All gauges shall be installed with nipples no shorter than 2 inch and equipped with a shutoff valve of the type indicated on the drawings. Nipples and valves shall be of the same materials as the piping system to which they are connected. Gauges shall be support as specified herein.
- E. All gauges that do not have diaphragm seals shall be equipped with the manufacturer's standard pressure snubbers.
- F. The ranges of the gauges shall be suitable for the range of pressure that can occur during operation

2.06 WATER PRESSURE REGULATORS

- A. Water pressure regulators shall be installed where and as indicated on the drawings. Sizes and flows shall be as indicated on the drawings.
- B. Regulators shall be self-contained units operated by internal spring loaded diaphragms or pistons. Regulators shall have bronze bodies and spring chambers, bronze or brass trim, stainless steel or bronze body seat, Buna-N seat disk, and Buna-N reinforced diaphragms. Large size regulators shall have spring-opposed bronze piston where not available in the diaphragm configuration.

- C. Regulators shall be constructed such that all repairs may be performed with the valve in-line. A top adjusting screw shall be provided to set the downstream pressure.
- D. Regulators shall be sized for the required flows with an inlet pressure of 85 psig and an outlet pressure of 50 psig. Pressure variation at the outlet shall not be greater than 15 psig at maximum required flows.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPING AND HOSES

Unless otherwise specified, installation of piping and hose shall be as follows:

A. General:

1. All piping and hoses shall be installed in a neat and workmanlike manner. Piping shall be installed to accurate lines and grades, and shall be supported by hangers of the type and spacing hereinafter specified.
2. Wherever possible, piping shall be installed parallel to the other building walls. The exact location of each pipe shall be determined in the field in respect to piping and equipment installed.
3. Pipes shall not run through, directly over, or in front of electrical switchboards, power panels, etc.
4. All piping shall be free to expand and contract with an allowance of at least 3/4 inch per 100 ft.
5. Piping shall be installed to provide not less than 3-inch clearance from walls, ceilings, floors and other piping systems of electric conduits, etc. This clearance shall be the outside surface of pipe or flange, whichever is greater.
6. All piping shall pitch toward low points.

B. Joints, Connections, and Fittings:

1. Before assembly, all dirt and chips shall be removed from inside the pipe and fittings and from the threads.
2. After being cut to final lengths, the ends of pipe shall be reamed to remove burrs.
3. Threads of all screwed joints shall be clean cut and of proper taper. Screwed joints shall be made up with Teflon tape applied to the male threads only.
4. All valves shall be installed and oriented such that valve handles are easily accessible for operation.
5. All valves, fitting and appurtenances shall be installed such that flow arrows cast into the bodies or painted thereon facing in the direction of flow and easily visible when operating.

6. Sockets in CPVC pipe and fitting shall be tried for fit before application of the primer or solvent cement.
7. Materials shall be used, mixed, applied, cured and installed in strict accordance with the manufacturer's current printed recommendations.
8. The Contractor shall conform to the manufacturer's recommendations concerning the cleanliness and temperature to be maintained before, during and after the application of CPVC primer and cement, and amount to be applied, and the set time required.
9. The Contractor shall use CPVC cement and primer in the smallest containers available from the manufacturer in order to avoid drying out and evaporation of the solvent systems used.
10. The Contractor shall conform to the manufacturer's recommendations for square smooth pipe cuts and the need to protect the pipe from nicks, scratches and cracking. Tapered plugs shall be inserted into the pipe when threading to prevent the die from distorting or gouging the pipe wall. Pipe strap wrenches shall be used for tightening. Stillson-type wrenches shall not be used. If any CPVC pipe is damaged, the damaged section shall be cut out. Manufacturer's recommendations shall be closely followed regarding the length of tapered pipe threads.
11. Flanged joints shall be made with bolts, or studs with nuts where the flange is tapped. The number and size of bolts shall conform to the same AN Standard as the flanges. Bolts and nuts shall be Grade B, conforming to ASTM A307. Bolts studs and studs shall be of the same quality as machine bolts. Before the flanges pieces are assembled, rust-resistant coating shall be removed from machined surfaces, gaskets shall be thoroughly cleaned, and all brush and other defects shall be carefully smoothed. Flanged joints shall be made up tight, care being taken to prevent undue strain upon valves or other pieces of equipment.
12. Final connections to all equipment shall be made with flanges.
13. Cleanouts shall be installed in piping at ends of branches, at points where direction of flow changes, and at convenient points in long runs of pipe.
14. All automatic devices shall be adjusted for proper operation.
15. Isolation or service valves shall be provided in all branch, subbranch and equipment connections whether or not indicated on the drawings.
16. Joints which are required to be backed off shall be entirely disjointed, the threads of both the pipe and fittings wiped clean, new Teflon tape applied, and the connection reassembled.

G. Hangers and Supports:

1. The drawings do not generally indicate locations or types of hangers; however, the Contractor shall provide complete support systems as necessary to allow satisfactory operation of each system. Where piping supports or accessories are indicated, the information is supplied to indicate typical provisions for systems involving more critical consideration due to expansion, thrust or other conditions. The Contractor

shall adapt the indicated typical conditions as necessary to suit the actual system requirements.

2. All necessary piping supports shall be provided to install the piping at the lines and grades indicated on the drawings or specified. The supports shall be secured to the building structure so as to provide for expansion and contraction, prevent vibration and to prevent transmitting forces to equipment from the piping systems which are in excess of the allowable limits of the equipment.
3. Where several pipes are parallel, multiple or trapeze hangers may be used.
4. Hangers shall be secured to the building structure with expansion type anchors.
5. Except as otherwise permitted, all hangers shall have provisions for vertical adjustment after installation.
6. Hanger shall be located on all systems so as to provide at least one hanger immediately adjacent to each change of direction, offset, and additional hangers shall be provided wherever concentrated loads occur in the piping system from the installation of in-line equipment.
7. All pressure gages equipped with diaphragms or supported by shutoff valves shall be supported by brackets clamped to the pipeline. In-line equipment of substantial weight shall be supported independently of the pipeline.
8. Additional guided or supports shall be provided at offsets in piping as necessary to prevent deflection of pipe axis due to expansion or pressure forces except where right angle bends are utilized to compensate for expansion.
9. Hangers and support spacing for steel pipe shall not exceed 6 ft. Horizontal runs of PVC pipe and hose shall be continuously supported in light-weight epoxy-coated steel angle or channel shapes except where otherwise indicated on the drawings.
10. For all pipe and hose, vertical runs shall be supported with clamps at a maximum spacing of 6ft. on centers. Where hoses are hung vertically from CVPC piping, such hoses shall be independently supported. Hangers shall be of a type to give broad support to the pipe and permit free axial movement. Where temporary supports are used, they shall be sufficiently rigid to prevent shifting or distortion of the pipe. Where necessary, and particularly for CPVC piping, suitable provisions shall be made for expansion.

3.02 EXTERIOR PIPING INSTALLATION

Section 3.01 – Yard Piping Installation specification 02610 applies.

3.03 TESTING

- A. After installation, and in the presence of the Engineer, all pipelines shall be tested for watertightness in an acceptable manner. For these tests, the Contractor shall

furnish suitable testing plugs or caps, all necessary pressure pumps, pipe connections, test fluids, gages, other equipment and all labor required.

- B. Gauges shall be recently calibrated. All instrumentation and appurtenant equipment that is incapable of withstanding the test pressures shall be removed from the lines, or shall be valved off.
- C. All equipment and property damaged by the testing procedure shall be cleaned, repaired to the satisfaction of the engineer or replaced by the Contractor, all at no additional cost to the Owner.
- D. All piping shall be cleaned in a manner acceptable to the engineer prior to testing. Generally, compressed air shall not be used for this testing procedure. Water at ambient temperatures shall be used for testing all lines.
- E. Prior to testing, the Contractor shall walk the line to be tested to visually inspect the lines for obviously improper valve settings, loose fittings, disconnected equipment, etc., and he shall correct these items before beginning the test procedures.
- F. The Contractor shall take proper provisions to assure complete venting of all entrapped air when filling the system with the water used for testing. Special care shall be taken with plastic piping systems to insure removing all air from the system. If a slow buildup or fluctuation of pressure in a completely liquid-filled system is noted, the pressure shall be immediately released and the line re-bled to remove the entrapped air.
- G. All piping to be so tested shall be purged of air and water-filled, and the liquid shall be pressurized using a hand-operated hydraulic pump unless other suitable means are submitted to the Engineer for review and accepted. Upon reaching the test pressure, the piping system with test gauges shall be valved off and disconnected from the pressure source, and pressure shall be observed for a period of 2 hours. No leakage or pressure decay shall be permitted during the test period.
- H. Where feasible, the test pressure shall be at least 100 psi or 1-1/2 times the normal operating pressure, whichever is greater.
- I. Should leaks be found, faulty joints shall be repaired, even to the extent of disassembling and remaking the joint, and all defective pipe and fittings shall be removed and replaced in a manner satisfactory to the Engineer.
- J. Chemical sealants, tape or cements shall not be used to repair leaks. Leaks in CPVC piping shall be repaired as specified and conforming to the manufacturer's current printed recommendations. Cemented CPVC socket weld fittings and screwed nipples with improperly cut thread shall not be reused, nor shall threaded

CPVC pipe and fittings be overtightened or sealed with chemical sealants. Leaks shall not be repaired by backwelding.

- K. Wherever possible each piping system shall be tested as it is completed in order to uncover faulty materials or workmanship.
- L. Lines shall not be painted until satisfactorily passing their leakage tests.
- M. The Contractor shall pass through all gravity flow CPVC pipe related a less than 200 psi and installed underground, under its own momentum, a wooden ball of a diameter one inch less than the nominal diameter of the pipe. All pipes that do not pass the wooden ball shall be replaced or repaired so that they do not pass the ball, a no cost to the Owner.

END OF SECTION 02615

SECTION 02640 - WATER VALVES AND GATES

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The Contractor shall furnish all labor, material, and equipment necessary to install valves together with all appurtenances as shown and detailed on the Drawings and specified herein.
- B. The Drawings and Specifications direct attention to certain features of the equipment, but do not purport to cover all the details of their design. The equipment furnished shall be designed and constructed equal to the high quality equipment manufactured by such firms as are mentioned hereinafter, or as permitted by the Engineer. The Contractor shall furnish and install the equipment complete in all details and ready for operation.
- C. Valves for use in the following services are specified under their appropriate sections:
 - 1. Disinfection equipment
 - 2. Heating and air conditioning
 - 3. Plumbing
 - 4. Instrumentation
- D. Electrical work and equipment specified herein shall conform to the requirements of the applicable electrical sections.
- E. Enclosures shall be of a suitable type for the atmospheres in which they are installed.
- F. Sizes and capacities not specified herein are indicated on the Drawings.

1.02 RELATED WORK

- A. Section 02225 - Excavating, Backfilling and Compacting for Utilities.
- B. Section 02610 - Water Pipe and Fittings.
- C. Section 02647 - Non-Potable (Yard) Hydrants.

1.03 SUBMITTALS

- A. Complete shop drawings of all valves and appurtenances shall be submitted to the Engineer in accordance with the requirements of Section 01300.

- B. The manufacturer shall furnish the Engineer two (2) copies of an affidavit stating that the valve and all materials used in its construction conform to the applicable requirements of the latest revision of the applicable AWWA Standard, and that all tests specified therein have been performed and that all test requirements have been met.
- C. The Engineer shall be furnished two (2) copies of affidavit that the "Valve Protection Testing" has been done and that all test requirements have been met.
- D. The Engineer shall be furnished with two (2) copies of affidavit that inspection, testing and rejection are in accordance with the latest revision of the applicable AWWA Standard.

PART 2 - PRODUCTS

2.01 GATE VALVES

- A. All gate valves shall be of the resilient seat type in accordance with the latest revision of AWWA C509 Standard. The valve body, bonnet and gate castings shall be ductile iron or cast iron. The valve shall have a non-rising stem (NRS), fully bronze mounted with o-ring seals. Valve body and bonnet, inside and out, shall be fully coated with fusion bonded epoxy coating in accordance with AWWA C550 Standard. Valves shall have a rated working pressure of 200 psi.
- B. Gate valves for buried service shall be furnished with mechanical joint end connections, unless otherwise shown on the Drawings or specified herein. The end connection shall be suitable to receive ductile iron or PVC pipe.
- C. Gate valves for meter pits, pump stations, or other installations as shown on the Drawings shall be furnished with flanged joint and connections, outside screw and yoke and handwheel operator. The gate valve shall have the direction of opening cast on the rim of the handwheel and provided with chain and lock.
- D. All gate valves shall have the name or monogram of the manufacturer, the year the valve casting was made, the size of the valve, and the working pressure cast on the body of the valve.
- E. Buried service gate valves shall be provided with a 2-inch square operating nut and shall be opened by turning to the left (counterclockwise).
- F. Buried service gate valves shall be installed in a vertical position with valve box as detailed on the Drawings. They shall be set vertically and properly adjusted so that the cover will be in the same plane as the finished surface of the ground or street.

- G. Valves 4-inch and larger shall be model A-2630 as manufactured by Mueller, or equal. Valves smaller than 4-inch shall be model A-2630-8 (threaded) as manufactured by Mueller, or equal.

2.02 BUTTERFLY VALVES

- A. Resilient seated butterfly valves shall meet or exceed the requirements of AWWA C504 for flanged end valves and AWWA C506 mechanical-joint end (buried) valves. Flanged-end valves shall be short body style suitable for use with ANSI 125 or 150 pound flanges. Valves shall be fully tested and certified for seat leakage and body leakage per AWWA C504.
- B. Valve bodies shall be cast iron (ASTM A126, Class B) or ductile iron (ASTM A536 Grade 65/45/12). Valves shall be rated 150 psi and provided drip-tight shutoff at differentials up to 150 psi.
- C. Short body valves shall have a retained seat and shall provide tight shutoff up to the full valve rating on dead-end or isolation service without the use of downstream flanges.
- D. All valves shall be furnished with permanently self-lubricated 316 stainless steel bearings or TFE fabric coated stainless steel. Shaft seals shall be provided to prevent leakage and to protect bearings from internal or external corrosion. Stem seals shall be Nylatron.
- E. Seats shall be of the reinforced resilient type and shall be field replaceable. Body seats shall be recessed. Seats shall have flange sealing lips to provide a positive seal without use of flange gaskets. Seats shall be of Neoprene or Hycar.
- F. Shafts shall be one piece and shall be of 316 or 304 stainless steel. Shaft diameter shall meet the 150B standard from AWWA specification C504 for butterfly valves. Shafts shall be finish ground and polished to minimize bearing and shaft seal wear. Shafts of 8 inches and larger valves shall have a non-adjustable thrust collar.
- G. Disc material shall be cast/ductile iron or aluminum bronze. Disc edge shall be 316 stainless steel, the disc-to-shaft connections shall be type 316 stainless steel. Pins, shaft and disc of all valves shall be individually machined and completely interchangeable.
- H. Butterfly valves shall be as manufactured by DeZurik, Pratt, or equal.

2.04 BALL VALVES

- A. Ball valves shall have double union ends to permit removal of the valve without

disconnecting the pipeline and shall be of the type that will not leak when the downstream union end is disconnected.

- B. Viton "O" ring seals shall be used with Teflon seats. Ball valves shall be installed with the flow arrow pointed in the direction of flow to permit disconnection of downstream piping.
- C. During installation, the valve handle shall be oriented for ease of operation by rotating the valve body about its axis prior to tightening the ends.
- D. Where indicated on the Drawings, the valve shall be equipped with a pointer and scale plate which will indicate the position of the valve at all times.

2.05 MUD VALVES

- A. Mud valves shall be located and sized as indicated on the Drawings and as specified herein. Mud valves shall be designed for basin drain applications, and shall be of the nonrising stem type. The valve body shall be constructed of cast iron with the stem, stem nut, disc ring, and seat ring of bronze. All bolts and nuts shall be rustproofed steel.
- B. The valves shall be furnished with operating nuts to be located at the positions shown on the Drawings. They shall also be furnished with extension stems, stem guides if required, and bench stands.
- C. The mud valves shall be as manufactured by Clow Corporation, or an approved equivalent product.

2.06 SLIDE GATES

- A. Self-contained slide gates shall be rising stem, fabricated gates complete with frames and anchor rods, plate disk, stem, and bench stand. All metal parts except the stem and bench stand shall be of aluminum. Stems shall be made of stainless steel. Bench stands are described hereinafter.
- B. Side frame shall be made of extruded aluminum members having a slot in which the disk shall be guided. The bottom frame members shall be an aluminum tee or an angle to serve as a flat seat for the rubber seat on the bottom frame section.
- C. The disk shall be reinforced as necessary to prevent buckling and to support the attachment for the stem.
- D. The top frame member or concrete structure shall support the bench stand as indicated on the Drawings.

- E. The slide gates shall be flush bottom fabricated metal gates made by Waco, Waterman, Golden Harvest, or equal.
- F. Manually lifted slide gates shall have embedded or surface mounted frames and shall be as indicated on the Drawings and as herein specified.
- G. Disk and frame shall be 6061-T6 aluminum alloy and temper designation of the Aluminum Association. Disk shall be formed from aluminum plate and frames for the disk shall be of extruded aluminum. The handle shall be of the same material as the gates.
- H. Frame shall be set into the concrete as the concrete is being placed. The frame shall be straight and true, and shall permit the gates to be moved easily and to seat tight without binding.

2.07 PLUG VALVES

- A. Plug valves shall conform to the latest revision of AWWA C517 and shall be of the non-lubricated eccentric type with resilient plugs faced with natural or synthetic rubber suitable for service in sewage and sludge piping.
- B. Port areas shall be unobstructed when open and have smoothly shaped waterways of not less than 80 percent (80%) of full pipe area except that valves 30 inch and larger shall have only 70 percent (70%) area. Plug valves 12-inch and smaller shall have 100% full pipe area. Valve shall have a round ported design.
- C. Bodies shall be of semisteel, suitable for 125-pound working water pressure and shall have raised seats.
- D. Valves 3 inches and larger shall have seats of a welded in overlay of not less than 90 percent (90%) pure nickel or other acceptable material.
- E. Valves less than 3 inches shall have plastic-covered seats.
- F. Valves shall have permanently lubricated upper and lower stainless steel bushings on plug journal ends.
- G. Valves shall have bolted bonnets. Valves 4-inch and larger shall be designed so they can be repacked without removing the bonnet from the valve. Packing shall be adjustable to self-adjusting.
- H. Valves 6 inches and larger shall be gear-operated with handwheels and valves smaller than 6 inches shall be wrench operated, except as hereinafter specified or indicated on the Drawings.

- I. Where there is a lack of space for the valve wrench to operate gear operators, handwheels shall be provided in lieu of the wrench.
- J. Chain operators, consisting of sprocket wheels, chain guides and operating chains shall be provided for all valves with operator centerlines located more than 6 feet 6 inches above the operating level. Operating chain shall be galvanized and shall extend within 3 feet of the operating level.
- K. Gear operators shall be totally enclosed, worm gear type, permanently lubricated, and shall be watertight and dust tight.
- L. Gear operators shall be provided with adjustable stops for the open and closed position to prevent overtravel, and shall have a valve disk position indicator.
- M. A suitable lever or wrench shall be provided for each six wrench operated valves but at least on wrench for each operating station. Wrenches or wheels and chains shall be of suitable size and sufficient length for easy operation of the valves at their rated working pressure.
- N. Plug valves 2-1/2 inches and smaller shall have screwed ends.
- O. Plug valves 3 inches and larger shall have mechanical joint or flanged ends faced and drilled in accordance with 125-pound ANSI Standard.
- P. Plug valves shall be those manufactured by DeZurik, Pratt, or equal.

2.08 HEAVY-DUTY OUTSIDE LEVER AND WEIGHT SWING CHECK VALVE

- A. The valve shall exceed the minimum requirements of AWWA C508 with a heavy-duty body of high-strength cast iron conforming to ASTM A126 Class with integral flanges, faced and dilled per ANSI B16.1 Class 125, suitable for horizontal or vertical installation.
- B. The valve body shall be the full waterway type, designed to provide a net flow area not less than the nominal inlet pipe size when swung open no more than 25 degrees. The valve shall have a replaceable stainless steel body seat, a cast iron disc faced with a renewable resilient seat ring of rubber or other suitable material and held in place by stainless steel screws.
- C. The disc arm shall be ductile iron or steel, suspended from a keyed to an austenitic stainless steel shaft which is completely above the waterway and supported at each end by heavy bronze bushings. The shaft shall rotate freely without the need for external lubrication. The shaft shall be sealed where it passes though the body by means of a stuffing box and adjustable packing. Simple O-ring shaft seals are not acceptable.

- D. For air cushioned check valves (where required on the plans), the valve shall be supplied with an outside lever with counterweight and non-pivoting bronze air-cushion chamber that is rigidly mounted on machined pads on the side of the body without the need for brackets. Commercial air cylinders which pivot and/or are attached with fabricated brackets are not acceptable. The counterweight position and the amount of cushioning shall be adjustable.
- E. Unless shown otherwise on the plans, the lever, counterweight and cushion chamber shall be on the right hand side of the valve (looking at the inlet) but shall be field convertible to the left hand side without additional parts.
- F. The Check valves shall be GA. Industries Fig NO. 220-DS/250-D (for air cushioned check valve) with lever and weights, or approved equal.

2.09 SILENT CHECK VALVES

- A. Silent check valves 3 inches and larger shall be iron body, bronze mounted with a stainless steel spring. Flanges shall be faced and filled in accordance with the 125-lb. AN Standard. The valve plug shall be center guided at both ends with a through integral shaft and spring loaded.
- B. Valves shall be designed for a water working pressure of 150 psi.
- C. The seat and plug shall be replaceable manually in the field.
- D. The flow area through the valve body shall be equal to or greater than the cross-sectional area of the equivalent pipe length.
- E. Valves shall be capable of operating in either a horizontal or vertical position.

2.10 SOLENOID VALVES

- A. Solenoid valves shall be bronze body, screwed-end, single integral seat, full pipe area glove type valves, with renewable composition disk seats.
- B. Solenoid enclosures shall meet NEMA Type 4X requirements with coils epoxy encapsulated and suitable for high ambient temperatures (140 degrees F).
- C. Valves shall be suitable for operation on 120 volt, single-phase, 60 Hz current, and designed to open when energized.
- D. The solenoid valves shall be manufactured by Automatic Valve Co., Inc., Indianapolis, IN; J.D. Gould Co., Indianapolis, IN; Automatic Switch Co., Florham Park, NJ; Magnatrol Valve Corp., Hawthorne, NJ; or be acceptable equivalent product.

2.11 PRESSURE REDUCING VALVES

- A. The valve shall automatically reduce a higher inlet pressure to a steady lower downstream pressure regardless of changing flow rate and/or varying inlet pressure. The main valve and pilot valve shall close drip-tight when downstream pressure exceeds the pressure setting of the control point.
- B. The valve shall include a check feature that will close the valve when pressure reversal occurs. The closing of the valve shall be accomplished by transmitting downstream pressure to the main valve cover chamber.
- C. The valve shall be a hydraulically operated, piston-actuated, globe pattern valve. It shall contain a resilient seated piston. The piston assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. Packing glands and/or stuffing boxes are not permitted, and there shall be no diaphragm operating the valve. All necessary repairs shall be possible without removing valve from the line.
- D. The pressure reducing pilot control shall be a direct-acting, adjustable, spring-loaded, normally open diaphragm valve, which closes when downstream pressure exceeds the spring setting.
- E. Valve shall have a cast iron body with bronze trim.
- F. Upstream inlet range shall be up to 180 psi.
- G. The valve shall be similar to a Model Series 4900 Pressure Reducing Valve (globe style) as manufactured by GA Industries, or approved equal.

2.12 SURGE RELIEF VALVES

- A. Construction: Surge Relief Valve shall consist of a main valve assembly and a pilot system, completely assembled and tested as a unit and ready for field installation.
- B. Main Valve
 - 1. Main valve body shall be globe style, constructed of high-strength cast iron conforming to ASTM A126 Class B with integral flanges, faced and drilled per ANSI B16.1 Class 125. The valve shall be “full-ported” with a flow area through the valve no less than the area of its nominal pipe size. Valve shall have an integral bottom pad or feet permitting support directly under the valve body.
 - 2. The main valve shall operate on the differential piston principle such that the area

on the underside of the piston is no less than the pipe area and the area on the upper surface is greater than that of the underside. There shall be no diaphragms or springs in the main valve.

3. The valve piston shall be fully guided on its outside diameter and all guiding and sealing surfaces shall be bronze. To minimize the consequences of throttling, throttling shall be by long, stationary V-ports located downstream of the seat and not by the seat itself. Sawtooth attachments or other add-on devices are not permitted.
4. The valve shall be fully capable of operating in any position without the need of springs and shall not incorporate stems, stem guides or spokes in the waterway. A visual position indicator shall be provided.
5. The main valve shall be serviceable in the line through a single flanged cover which provides easy access to all internal components.

C. Pilot System

1. Provide a system of pilots and controls to enable the valve to perform the function listed below. All controls and control piping shall be non-corrosive and suitable for the working pressure.
2. System shall include a normally closed, direct-acting, diaphragm operated, spring loaded bronze pressure relief pilot. Pilot shall be easily field adjustable from near zero to a minimum of 10% above the factory setting. Controls shall include adjustable closing speed control, y-strainer and pilot isolating valves.

D. Function

1. The valve shall open when system pressure exceeds its pressure setting and throttle as necessary to limit system pressure to a pre-set maximum pressure. When pressure subsides below the pre-set maximum the valve shall close tight.

E. The valve shall be manufactured by GA Industries, Inc. Figure 6600-D, or equal.

2.13 AIR RELEASE AND AIR/VACUUM VALVES

- A. The air/vacuum valves shall be APCO Series 140 DAT as manufactured by Valve and Primer Corp., or equal.
- B. The air release valves shall be APCO Series 140 C as manufactured by Valve and Primer Corp., or equal.

- C. The Combination air/vacuum valves shall be APCO Series 140 C as manufactured by Valve and Primer Corp., or equal.
- D. The valves shall be of the type that automatically exhausts large quantities of air during the filling of a system and allows air to re-enter during draining or when a vacuum occurs. The over-all height less back wash accessories shall not exceed 21 inches. Valves shall be constructed of cast iron body and cover, stainless trim and float with Buna-N seat for positive seating.
- E. The baffle shall be ductile iron and shall protect float from direct impact of air and water. The seat shall slip fit into the baffle or cover and lock in place without any distortion. The float and baffle assembly shall be shrouded with a water diffuser. The float shall be stainless steel center guided for positive seating and be rated at 1000 psi non-shock service.
- F. The discharge orifice shall be fitted with a double-acting throttle device to regulate and restrict air venting.
- G. All parts of the valves and the opening mechanisms shall be made of non-corrodible materials.

2.14 TAPPING VALVES AND TAPPING SLEEVES AND CROSSES

A. Tapping Valves

- 1. Tapping valves for use with tapping sleeve and crosses shall be in accordance with the specifications for gate valves, except that one end shall have a flanged connection and the other end either a hub or mechanical joint connection.
- 2. Valves shall be rated for 250 psi in sizes 2 inch thru 24-inch.
- 3. Valves shall open by turning counterclockwise.
- 4. Inlet flanges of valves shall meet ANSI B16.1, Class 125 standard.

B. Tapping Sleeves and Tapping Crosses

- 1. Tapping sleeves and tapping crosses shall have heavy cross sections to strengthen the existing water main at the point of installation.
- 2. Mainline end connections to existing pipeline shall be mechanical joint with large and small gaskets.
- 3. Mechanical joint tapping sleeves and crosses shall have a maximum working pressure of 250 psi.
- 4. Outlet end of tapping sleeves and crosses shall have ANSI B16.1, Class 125 flanges.

C. Quality Standard

- 1. For full body tapping valves, tapping sleeves and tapping crosses shall be model

- T-2360-16 with Tapping Sleeve H-615 as manufactured by Mueller Company, or equal.
2. Saddles for tapping branch lines smaller than 4-inch shall be Smith Blair Series 313 or Mueller BR 2 B Series.

D. Test and Certification

1. Tests on tapping valves shall be in accordance with these Specifications for gate valves.

E. Protection

1. Tapping Valves
 - a. Protection of tapping sleeves and valves shall be in accordance with these Specifications for gate valves.
2. Tapping Sleeves and Crosses
 - a. Protection for tapping sleeves and crosses shall be in accordance with these Specifications for ductile iron pipe fittings.

2.15 FIRE HYDRANTS

- A. All post-type dry barrel fire hydrants will have compression type valves, operating against pressure. They shall meet all requirements of ANSI/AWWA Specification C502-94.
- B. They shall have two 2-1/2 inch hose connection nozzles and one 4-1/2 inch steamer connection nozzle, all with caps and drains, and have national support threads.
- C. Main valve opening size shall be 5-1/4 inch, which must remain closed when the above ground breakable safety section of the hydrant barrel is broken off.
- D. All hydrants shall have 6 inch mechanical joint bell connection designed for 200 pounds working water pressure, in accordance with ANSI/AWWA C110/A21.10-98. Joint accessories are to be furnished with the hydrant.
- E. Finish paint color of the hydrant barrel above ground line shall be red.
- F. All hydrants shall have an automatic drain feature providing positive barrel drainage after hydrant use.
- G. The lowest outlet level of the hydrant shall be located sufficiently above the indicated ground level to permit a 360° swing of a 15 inch hydrant wrench. One standard hydrant wrench is to be provided. All hydrants shall open by turning counterclockwise. All hydrants shall be installed plumb and at proper bury depth.

OWNER may require concrete stabilizing collar (2.5' x 2.5' x 0.5') with rebar around hydrants.

H. Quality Standard

1. All post type fire hydrants shall have the features, and be equal to those of Kennedy, or equal.

2.16 FLOORSTANDS

- A. Floorstands shall be handwheel or crank operated as indicated on the Drawings or as required to suit the application.
- B. Handwheel operated type shall be without gear reduction and crank-operated type will have either single or double gear reduction depending upon the lifting capacity required. Each type shall be provided with a threaded cast bronze lift nut to engage the operating stem. Tapered roller bearings shall be provided above and below a flange on the operating nut to support both opening and closing thrusts. Floorstands shall develop their maximum capacity with not greater than a 40-pound pull on the crank or handwheel. Gears, where required, shall be steel with machined cut teeth designed for smooth operation. The pinion shafts on crank-operated floorstands, either single or double ratio, shall be supported on tapered roller bearings or other approved bearings. All components shall be totally enclosed in a cast iron case and cover. Positive mechanical seals will be provided on the operating nut and the pinion shafts to exclude moisture and dirt and prevent leakage of lubricant out of the hoist. Lubricating fittings shall be provided for the lubrication of all gears and bearings. Floorstands shall include a cast iron pedestal with the input shaft or handwheel approximately 36 in. above the operating floor. An arrow with the word OPEN shall be cast on the floorstand or handwheel indicating the direction of rotation to open.
- C. Floorstands for rising stem sluice gates shall have clear, transparent, rigid, plastic stem covers.
- D. Floorstands for non-rising stem sluice gates shall have stem indicators.
- E. Floorstands shall be provided by the valve or gate manufacturer with each valve or gate requiring floorstands.

2.17 VALVE BOXES

- A. Each buried stop and valve shall be provided with a suitable valve box equivalent to the OWNER'S standard valve box. Boxes shall be of the adjustable, telescoping, heavy-pattern type with the lower part of cast iron and the upper part of steel or cast iron. They shall be so designed and constructed as to prevent the direct transmission of traffic loads to the pipe or valve.

- B. The upper or sliding section of the box shall be provided with a flange having sufficient bearing area to prevent undue settling. The lower section of the box shall be designed to enclose the operating nut and stuffing box of the valve and rest on the valve bonnet.
- C. The boxes shall be adjustable through at least 6 inches vertically without reduction of the lap between sections to less than 4 inches.
- D. The inside diameter of boxes for valves shall be at least 4-1/2 inch, and the lengths shall be as necessary for the depths of the valves or stops with which the boxes are to be used.
- E. Covers for valves shall be close fitting and substantially dirt-tight.
- F. The top of the cover shall be close flush with the top of the box rim. An arrow and the word OPEN to indicate the direction of turning to open the valve shall be cast in the top of the valve covers.

2.18 T-HANDLE OPERATING WRENCHES

T-handle operating wrenches shall be provided in the number and lengths necessary to permit the operation of all valves by operators of average height working in normal positions (provide a minimum of five).

2.19 FLOOR BOXES

- A. The floor boxes shall be cast iron with a bronze bushing of the size necessary to accommodate the extension stem. The boxes shall be suitable for installation in a concrete floor of the thickness indicated on the Drawings.
- B. They shall be similar to those made by Mueller Co., Decatur, IL; Clow Corporation, Chicago, IL; Coldwell-Wilcox Co., Fairfield, CT; or be acceptable equivalent products.

2.20 MISCELLANEOUS STOPS AND SERVICE COUPLINGS

A. Corporation Stops

- 1. Corporation stops to be used with threaded pipe where connected into cast iron pipe, shall be brass ground joint type with AWWA CC or CS taper thread inlets. Stops shall be F1000-3-Q, as manufactured by Ford Meter Box Company, Inc., or equal.
- 2. Corporation stops to be used with copper pipe with compression type connections, where connected into cast iron or asbestos-cement pipe, shall be the same, except

with compression type outlet connections.

3. Corporation stops shall be factory tested to 250 psi to be compatible with the pipes in which they are installed.
4. Quick joint couplings for $\frac{3}{4}$ " copper or plastics tubing shall be C44-33Q as manufactured by Ford Meter Box Company, Inc., or equal.

2.21 PRESSURE GAUGES

- A. Pressure gauges shall have cast brass cases with bourdon tubes and precision rotary movements of bronze, nickel, or other material suitable to the environment in which they will be located. Dials shall be 6 inches in diameter with a pressure range of 0 to 100 psi. Provide female quick coupler for connection to corporation stop. Each gauge shall be provided with snuffer.
- B. Corporation stops shall be similar to Mueller and shall have iron pipe threads with pack joint connection outlets. Provide male quick coupler for attachment of pressure gauge.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Valves shall be installed as nearly as possible in the positions indicated on the Drawings consistent with conveniences of operating the handwheel or wrench. All valves shall be carefully erected and supported in their respective positions free from all distortion and strain on appurtenances during handling and installation.
- B. All material shall be carefully inspected for defects in workmanship and material, all debris and foreign material cleaned out of valve openings and seats, all operating mechanisms operated to check their proper functioning, and all nuts and bolts checked for tightness.
- C. Valves and other equipment that do not operate easily or are otherwise defective shall be repaired or replaced at the Contractor's expense.
- D. Valves shall be installed with stems in the vertical position unless an alternate position has been accepted by the Engineer.
- E. Valves shall be set plumb and supported adequately in conformance with the instructions of the manufacturer. Valves mounted on the face of concrete shall be shimmed vertically and grouted in place. Valves in the control piping shall be installed so as to be easily accessible.
- F. Where chain wheels are provided for remote operation of valves, two (2) S-shaped

hooks shall be provided for each valve to enable the chains to be hooked so as not to interfere with personnel traffic.

- G. Valves shall be provided with extension stems where required for convenience of operation. Extension stems shall be provided for valves installed underground and elsewhere so that the operating wrench does not exceed 6 feet in length.
- H. A permanent type gasket of uniform thickness shall be provided between flanges of valves and sluice gates and their wall thimble.
- I. Wall thimbles shall be accurately set in the concrete walls so that the gates can be mounted in their respective positions without distortion or strain.
- J. Floorstand operators and stem guides shall be set so that the stems shall run smoothly in true alignment. Guides shall be anchored firmly to the walls. Distances from the centerlines of gates to the operating level or base of floorstand shall be checked by the Contractor and adjusted if necessary to suit the actual conditions of installation.
- K. Plug valves in horizontal sewage and sludge piping shall be installed with the shaft horizontal such that when in the open position, the plug is located in the upper part of the valve body. Valves shall be oriented so that in the closed position, the plug is at the upstream end of the valve.

3.02 PAINTING

- A. Valves shall be factory primed and fully coated, inside and out, with fusion bonded epoxy in accordance with the latest revision of AWWA C550 Standard.
- B. Other painting (if required) is specified in Division 9.

END OF SECTION 02640

SECTION 02642 - SEWAGE VALVES AND GATES

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The Contractor shall furnish and install valves, gates, and miscellaneous piping appurtenances, as indicated on the Drawings and as herein specified.
- B. The Drawings and Specifications direct attention to certain features of the equipment, but do not purport to cover all the details of their design. The equipment furnished shall be designed and constructed equal to the high quality equipment manufactured by such firms as are mentioned hereinafter, or as permitted by the Engineer. The Contractor shall furnish and install the equipment complete in all details and ready for operation.
- C. Valves for use in the following services are specified under their appropriate sections:
 - 1. Chemical piping.
 - 2. Heating and air conditioning.
 - 3. Plumbing.
 - 4. Instrumentation.
 - 5. Electrical.
- D. Electrical work and equipment specified herein shall conform to the requirements of the applicable electrical sections.
- E. Enclosures shall be of a suitable type for the atmospheres in which they are installed.
- F. Sizes and capacities not specified herein are indicated on the Drawings.

1.02 RELATED WORK

- A. Section 02225 - Excavating, Backfilling and Compacting for Utilities.
- B. Section 02732 - Sewage Force Mains.

1.03 SUBMITTALS

- A. Complete shop drawings of all valves and appurtenances shall be submitted to the Engineer in accordance with the requirements of Section 01300.
- B. The manufacturer shall furnish the Engineer two (2) copies of an affidavit stating that the valve and all materials used in its construction conform to the applicable requirements of ANSI/AWWA valve, and that all tests specified therein have been performed and that all test requirements have been met.

- C. The Engineer shall be furnished two (2) copies of affidavit that the "valve protection testing" has been done and that all test requirements have been met.
- D. The Engineer shall be furnished with two (2) copies of affidavit that inspection, testing and rejection are in accordance with AWWA Standard.

PART 2 - PRODUCTS

2.01 BALL VALVES

- A. Ball valves shall have double union ends to permit removal of the valve without disconnecting the pipeline and shall be of the type which will not leak when the downstream union end is disconnected.
- B. Viton "O" ring seals shall be used with teflon seats. Ball valves shall be installed with the flow arrow pointed in the direction of flow to permit disconnection of downstream piping.
- C. During installation, the valve handle shall be oriented for ease of operation by rotating the valve body about its axis prior to tightening the ends.
- D. Where indicated on the Drawings, the valve shall be equipped with a pointer and scale plate which will indicate the position of the valve at all times.

2.02 CHECK VALVES

- A. Check valves 3 inches and larger shall be iron body, stainless mounted, full opening, swing type check valves with bolted covers and flanged ends. Flanges shall be faced and drilled in accordance with the 125-pound ANSI Standard. Valves shall comply with AWWA Standard C508 latest revision.
- B. Valves shall be equipped with double outside levers and weights and utilize oil-control bottom buffering as per APCO Series 6000B, or side mounted air cushioning as per Golden Anderson Industries Series 250-DS, or equal.
- C. Valves shall be designed for working pressures as follows:

<u>Valve Size (Diameter)</u>	<u>Pressure</u>
3 to 12 inches	175 psi
14 to 24 inches	150 psi
30 inches and larger	120 psi

- D. Check valves smaller than 3 inches in size shall be 200-pound WOG minimum bronze or all brass swing check valves. Valves shall have screw-on cap and renewable composition

disks. Valve body shall be as herein specified for gate valves.

- E. Check valves in pipelines carrying sewage or sludge shall be installed horizontally.

2.03 PLUG VALVES

- A. Plug valves shall conform to the latest revision of AWWA C507 and shall be of the non-lubricated eccentric type with resilient plugs faced with natural or synthetic rubber suitable for service in sewage and sludge piping. Plugs shall be one piece solid ductile iron, ASTM A536. All plugs shall have a cylindrical seating surface.
- B. Port areas shall be rectangular and unobstructed when open and have smoothly shaped waterways of one hundred percent (100%) of standard, full pipe area regardless of the CV values.
- C. Valve bodies shall be straight-through design with flushing port to maximize flow capacity and reduce headloss. Valve bodies shall be constructed of ASTM A126 class B cast iron, suitable for 125-pound working water pressure and shall have raised seats.
- D. Valves 3 inches and larger shall have seats of a welded in overlay of not less than 90 percent (90%) pure nickel or other acceptable material.
- E. Valves less than 3 inches shall have plastic-covered seats.
- F. Valves shall have permanently lubricated upper and lower stainless steel bushings on plug journal ends. Valve bodies shall be provided with grit excluders in the upper and lower journal areas.
- G. Valves shall have bolted bonnets. The valve stem packing shall be externally adjustable and provided with a spacer bonnet in order to allow visual inspection of the packing chamber. The packing shall be adjustable and replaceable without removing the bonnet of the valve and/or with the valve under pressure. Valves with non-adjustable packing shall not be acceptable.
- H. Valves 6 inches and larger shall be gear-operated with hand wheels and valves smaller than 6 inches shall be wrench operated, except as hereinafter specified or indicated on the Drawings. Gear operators shall have a stainless steel input shaft.
- I. Where there is a lack of space for the valve wrench to operate gear operators, hand wheels shall be provided in lieu of the wrench.
- J. Chain operators, consisting of sprocket wheels, chain guides and operating chains shall be provided for all valves with operator centerlines located more than 6 feet 6 inches above the operating level. Operating chain shall be galvanized and shall extend within 3 feet of the operating level.

- K. Gear operators shall be totally enclosed, worm gear type, permanently lubricated, and shall be watertight and dust tight.
- L. Gear operators shall be provided with adjustable stops for the open and closed position to prevent over travel, and shall have a valve disk position indicator.
- M. A suitable lever or wrench shall be provided for each six wrench operated valves but at least one wrench for each operating station. Wrenches or wheels and chains shall be of suitable size and sufficient length for easy operation of the valves at their rated working pressure.
- N. Plug valves 2-1/2 inches and smaller shall have screwed ends.
- O. Plug valves 3 inches and larger shall have mechanical joint or flanged ends faced and drilled in accordance with 125-pound ANSI Standard.
- P. Plug valves shall be PEF Series as manufactured by DeZurik, or equal.

2.04 GATE VALVES

- A. All gate valves shall be of the resilient wedge type, iron body, non-rising stem. Valves shall be of standard manufacture and of the highest quality both as to materials and workmanship and shall conform to the latest revisions of AWWA Specification C-509. Valves 2" through 12" shall have a rated working pressure of 250-psi and valves 12" through 24" shall have a rated working pressure of 200-psi.
- B. Gate valves for buried service shall be furnished with mechanical joint end connections, unless otherwise shown on the Drawings or specified herein. The end connection shall be suitable to receive ductile iron or PVC pipe.
- C. Gate valves for meter pits, pump stations, or other installations as shown on the Drawings shall be furnished with flanged joint end connections and hand wheel operator. The gate valve shall have the direction of opening cast on the rim of the hand wheel and provided with chain and lock.
- D. All gate valves shall have the name or monogram of the manufacturer, the year the valve casting was made, the size of the valve, and the working pressure cast on the body of the valve. Valves 18" and larger shall be provided with gear actuators.
- E. Buried service gate valves shall be provided with a 2-inch square operating nut and shall be opened by turning to the left (counterclockwise).
- F. Buried service gate valves shall be installed in a vertical position with valve box as detailed on the Drawings. They shall be set vertically and properly adjusted so that the

cover will be in the same plane as the finished surface of the ground or paved surface (concrete, bituminous, etc.).

- G. Valves shall be those manufactured by Mueller, M & H Valve Company, American, or equal.

2.05 SOLENOID VALVES

- A. Solenoid valves shall be bronze body, screwed-end, single integral seat, full pipe area, globe type valves, with renewable composition disk seats.
- B. Solenoid enclosures shall meet NEMA Type 4X requirements with coils epoxy encapsulated and suitable for high ambient temperatures (140 degrees F). NEMA 7 enclosures shall be provided in Class I or Class II hazardous areas.
- C. Valves shall be suitable for operation on 120 volt, single-phase, 60 Hz current, and designed to open when energized.
- D. The solenoid valves shall be manufactured by Automatic Valve Co., Inc., Indianapolis, IN; J.D. Gould Co., Indianapolis, IN; Automatic Switch Co., Florham Park, NJ; Magnatrol Valve Corp., Hawthorne, NJ; or equal.

2.06 TAPPING SLEEVES AND VALVES

- A. Tapping sleeves and valves shall consist of a split cast iron sleeve tee with mechanical joint ends on the main and a flange on the branch, and a tapping type gate valve with one flange end and one mechanical joint end.
- B. The valve shall, in general, conform to the requirements hereinbefore specified for gate valves and shall be furnished with a 2-inch square operating nut.
- C. The Contractor shall be responsible for verifying the outside diameter of the pipe to be correct. Sleeves and valves shall be manufactured by M&H Valve & Fittings, Div. of Dresser, Inc., Anniston, AL; Clow Corporation, Chicago, IL; Traverse City Iron Works, Traverse City, MI; or equal.

2.07 MUD VALVES

- A. Mud valves shall be located and sized as indicated on the Drawings and as specified herein. Mud valves shall be designed for basin drain applications, and shall be of the non-rising stem type. Mud valves shall be constructed entirely of stainless steel. All hardware shall be stainless steel. Valves shall have flanged end configurations.
- B. The valves shall be furnished with operating nuts to be located at the positions shown on the Drawings. They shall also be furnished with extension stems, stem guides if required,

and bench stands.

- C. The mud valves shall be as manufactured by H. Fontaine LTD., Quebec Canada, Clow Corporation, or equal.

2.08 TELESCOPING VALVES

Telescoping valves shall be equipped with hand wheel operated floorstands and shall be sized as indicated on the Drawings. Valves shall be as manufactured by Troy Valve, H. Fontaine LTD., Quebec Canada, or equal.

2.09 AIR RELEASE AND AIR/VACUUM VALVES

- A. The combination valve shall be of the type that automatically exhausts large quantities of air during the filling of a system and allows air to re-enter during draining or when a vacuum occurs. Valves shall also release small quantities of air as they gather in the valve body during normal operation. The over-all height less back wash accessories shall not exceed 21 inches. Valves shall be constructed of cast iron body and cover, stainless trim and float with a Buna-N seat for positive seating.
- B. All back wash accessories shall be furnished and assembled to the valve, consisting of an inlet shut-off valve clear water inlet valve, rubber supply hose and quick disconnect couplings.
- C. All parts of the valves and the operating mechanisms shall be made of non-corrodible materials.
- D. The following table may be used to determine air/vacuum valve sizing requirements. If the selection is unclear or if the selection of the valve appears critical to the operation of the system, contact the Engineer for assistance in the selection.

1. Sizing table:

Flow Rate (GPM)	0 to 1300	1301 to 3800	3801 to 7100
Valve Size (inch)	1	2	3

- E. On sewage or sludge lines, the combination air/vacuum valve shall be Figure 993 as manufactured by GA Industries, or equal.

2.10 SLIDE GATES

- A. Self-contained slide gates shall be rising stem, fabricated gates complete with frames and anchor rods, plate disk, stem, and bench stand. All metal parts, with the exception of the stem and bench stand shall be of aluminum. Stems shall be made of stainless steel. Bench stands are described hereinafter.

- B. Side frame shall be made of extruded aluminum members having a slot in which the disk shall be guided. The bottom frame members shall be an aluminum tee or an angle to serve as a flat seat for the rubber seat on the bottom edge of the disk.
- C. The disk shall be reinforced as necessary to prevent buckling and to support the attachment for the stem.
- D. The top frame member or concrete structure shall support the bench stand as indicated on the Drawings.
- E. The slide gates shall be flush bottom fabricated metal gates made by H. Fontaine LTD., Quebec, Canada; Rodney-Hunt Machine Co., Orange, MA; or equal.
- F. Manually lifted slide gates shall have embedded or surface mounted frames and shall be as indicated on the Drawings and as herein specified.
- G. Disk and frame shall be 6061-T6 aluminum alloy and temper designation of the Aluminum Association. Disk shall be formed from aluminum plate and frames for the disk shall be of extruded aluminum. The handle shall be of the same material as the gates.
- H. Frame shall be set into the concrete as the concrete is being placed. The frame shall be straight and true, and shall permit the gates to be moved easily and to seat tight without binding.

2.11 DOWNWARD OPENING WEIR GATES

- A. Weir gates shall be supplied with all the necessary parts and accessories required for a complete, properly operating installation. All parts except for the stem shall be manufactured from ASTM B-209 Alloy 6061-T6 Aluminum. Stem and guides shall be manufactured from ASTM A-276 type 304L stainless steel. Weir gates shall conform to the applicable requirements of AWWA C501's latest edition.
- B. The frame shall be of the frame back design welded to form a rigid one-piece frame suitable for mounting on a concrete wall. The guide slot shall be provided with an ASTM D-1248 ultra high molecular weight polyethylene (UHMWPE).
- C. The slide shall consist of a flat plate reinforced with additional structural members to limit deflection to 1/720 of the gate's span under the design loading conditions.
- D. The seals shall be made of UHMWPE of the self-adjusting type. A compression cord shall ensure contact in all positions providing a watertight seal. A watertight seal shall be maintained under design head conditions. Leakage shall not exceed 0.1 gallon per minute (gpm) per foot of seal periphery under seating head and 0.2 gpm per foot for the unseating head.

- E. Stems and couplings shall be manufactured of stainless steel designed to transmit in compression at least 2 times the rated output of the operating mechanism with a 40 pound effort on the crank. The stem shall have a slenderness ratio less than 200 and be provided with machined cut threads of the ACME type.
- F. For stems more than one-piece, individual sections shall be joined by solid couplings.
- G. Gates with widths equal to or greater than two times the height shall be provided with two lifting mechanisms connected by a tandem shaft.
- H. Weir gates shall be manufactured by H. Fontaine LTD., Quebec, Canada; Rodney-Hunt Co., Orange, MA; or equal. All weir gates shall be products of the same manufacturer.

2.12 SLUICE GATES

- A. Sluice gates shall conform to the AWWA Standard for sluice gates (C501-80) and as supplemented hereinafter. Sluice gates shall be manufactured by H. Fontaine LTD., Quebec Canada; Rodney-Hunt Co., Orange, MA; or equal. All sluice gates shall be products of the same manufacturer.
- B. The general equipment provided under this section shall be fabricated, assembled, erected and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer unless exceptions are noted by the engineer.
- C. Large rectangular thimbles shall be provided with holes in the invert to allow satisfactory concrete placement beneath the thimble, where required.
- D. Sluice gates shall be substantially watertight under the design head conditions. Under the design seating head, the leakage shall not exceed 0.05 gallon per minute per foot of seating perimeter. Under the design unseating head, the leakage for heads of 20 feet or less shall not exceed 0.1 gallon per minute per foot of perimeter. The sluice gates shall be designed to withstand the design head show in the schedule.
- E. The gates sealing system shall have been tested through a cycle test in an abrasive environment and should show that the leakage requirements are still obtained after 25,000 cycles. These documents shall be provided to the engineer and owner in the submittal package.
- F. All gates shall be self contained and of the non-rising stem type.
- G. The gate frame shall be constructed of structural members of formed plate welded to form a rigid one-piece frame and fabricated from 304L stainless steel. The frame shall be of the flange back design suitable for mounting on a concrete wall, wall thimble or standard pipe

flange as shown on the drawings. The frame configuration shall be of the flush-bottom type and shall allow the replacement of the top and side seals without removing the gate frame from the concrete or wall thimble. The yoke shall be 304L stainless steel.

- H. The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to $1/720$ of the gate's span under the design head. The slide shall be fabricated from 304L stainless steel.
- I. The guides shall be made of UHMWPE (ultra high molecular weight polyethylene) and shall be of such length as to retain and support at least two-thirds ($2/3$) of the vertical height of the slide in the fully open position. Side and top seals shall be made of UHMWPE of the self-adjusting type. A compression cord made of Nitrile shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and allow the water to flow only in the opened part of the gate. The bottom seal shall be made of resilient neoprene set into the bottom member of the frame and shall form a flush-bottom.
- J. The operating stem shall be of 303 MX stainless steel and designed to transmit in compression at least 2-times the rated output of the operating manual mechanism with a 40LB effort on the crank or hand wheel. The stem shall have a slenderness ratio less than 200. The threaded portion of the stem shall have machined cut threads of the Acme type. For stems in more than one piece and with a diameter of 1-3/4 inches and larger, the different sections shall be joined together by solid couplings. Stems with a diameter smaller than 1-3/4 inches shall be pinned to an extension tube. Gates having an equal to or greater than 2-times their height shall be provided with two lifting mechanisms connected by a tandem shaft. The lifting nut shall be bronze.
- K. If the gates are mounted directly to a concrete wall, an EPDM gasket shall be provided for mounting between the frame and the wall. Rising stem gates shall be provided with a clear stem tube cover.

2.13 VALVE BOXES

- A. Each buried stop and valve shall be provided with a suitable valve box. Boxes shall be of the adjustable, telescoping, heavy-pattern type with the lower part of cast iron and the upper part of steel or cast iron. They shall be so designed and constructed as to prevent the direct transmission of traffic loads to the pipe or valve.
- B. The upper or sliding section of the box shall be provided with a flange having sufficient bearing area to prevent undue settlement. The lower section of the box shall be designed to enclose the operating nut and stuffing box of the valve and rest on the valve bonnet.
- C. The boxes shall be adjustable through at least 6 inches vertically without reduction of the lap between sections to less than 4 inches.

- D. The inside diameter of boxes for valves shall be at least 4-1/2 inches, and the lengths shall be as necessary for the depths of the valves or stops with which the boxes are to be used.
- E. Covers for valves shall be close fitting and substantially dirt-tight.
- F. The top of the cover shall be flush with the top of the box rim. An arrow and the word OPEN to indicate the direction of turning to open the valve shall be cast in the top of the valve covers.

2.14 FLOORSTANDS

- A. Floorstands shall be hand wheel or crank operated as indicated on the Drawings or as required to suit the application.
- B. Hand wheel operated type shall be without gear reduction and crank-operated type will have either single or double gear reduction depending upon the lifting capacity required. Each type shall be provided with a threaded cast bronze lift nut to engage the operating stem. Tapered roller bearings shall be provided above and below a flange on the operating nut to support both opening and closing thrusts. Floor stands shall develop their maximum capacity with not greater than a 40-pound pull on the crank or hand wheel. Gears, where required, shall be steel with machined cut teeth designed for smooth operation. The pinion shafts on crank-operated floorstands, either single or double ratio, shall be supported on tapered roller bearings or other approved bearings. All components shall be totally enclosed in a cast iron case and cover. Positive mechanical seals will be provided on the operating nut and the pinion shafts to exclude moisture and dirt and prevent leakage of lubricant out of the hoist. Lubricating fittings shall be provided for the lubrication of all gears and bearings. Floorstands shall include a cast iron pedestal with the input shaft or hand wheel approximately 36 in. above the operating floor. An arrow with the word OPEN shall be cast on the floorstand or hand wheel indicating the direction of rotation to open.
- C. Floorstands for rising stem sluice gates shall have clear, transparent, rigid, plastic stem covers.
- D. Floorstands for non-rising stem sluice gates shall have stem indicators.
- E. Floorstands shall be provided by the valve or gate manufacturer with each valve or gate requiring floorstands.

2.15 T-HANDLE OPERATING WRENCHES

T-handle operating wrenches shall be provided in the number and lengths necessary to permit operation of all valves by operators of average height working in normal positions.

2.16 FLOOR BOXES

- A. The floor boxes shall be cast iron with a bronze bushing of the size necessary to accommodate the extension stem. The boxes shall be suitable for installation in a concrete floor of the thickness indicated on the Drawings.
- B. They shall be similar to those made by Mueller Co., Decatur, IL; Clow Corporation, Chicago, IL; or equal.

2.17 PRESSURE GAUGES

- A. Pressure gauges shall have cast brass cases with bourdon tubes and precision rotary movements of bronze, nickel, or other material suitable to the environment in which they will be located. Dials shall be 6 inches in diameter with a pressure range of 0 to 100 psi. Provide female quick coupler for connection to corporation stop.
- B. Corporation stops shall be similar to Mueller and shall have iron pipe threads with pack joint connection outlets. Provide male quick coupler for attachment of pressure gauge.
- C. Pressure gauges shall have a snuffer to prevent shock damage to gauges.

2.18 FIBERGLASS LINE MARKER

- A. General:
 - 1. Design: The continuous fiberglass reinforced composite line marker (CRM-375) shall be a single piece marker capable of simple, permanent installation by one person using a manual driving tool. The CRM-375 upon proper installation shall resist displacement from wind and vehicle impact forces. The CRM-375 shall be of a constant flat "T" cross sectional design with reinforcing support ribs incorporated longitudinally along each edge to provide sheeting protection and structural rigidity. The bottom end of the marker shall be pointed for ease of ground penetration.
 - 2. Material: The CRM-375 marker shall be constructed of a durable, UV resistant, continuous glass fiber and marble reinforced, thermosetting composite material which is resistant to impact, ozone, and hydrocarbons within a service temperature range of -40⁰ F to +140⁰ F.
 - 3. Workmanship: The CRM-375 marker shall exhibit good workmanship and shall be free of burns, discoloration, cracks, bulges or other objectionable marks which would adversely affect the marker's performance or serviceability.
 - 4. Marking: Each CRM-375 shall be permanently marked "Sewer Line Below". The letters shall be a minimum of 2 inches in height. A black line shall be stamped horizontally across the front of the marker near the bottom to indicate proper burial depth as shown in the standard detail.
- B. Physical and Mechanical Requirements:
 - 1. Dimensions: The CRM-375 marker shall conform to the shape and overall

dimensions shown in the standard detail.

2. Mechanical Properties: The CRM-375 shall have the minimum mechanical properties as shown in the following table:

Property	ASTM Test Method	Minimum Value
Ultimate Tensile Strength	D-638	50,000 psi
Ultimate Compressive Strength	D-638	45,000 psi
Specific Gravity	D-792	1.7
Weight % Glass Reinforcement	D-2584	50%
Barcol Hardness	D-2583	47

3. Color Fastness: The CRM-375 shall be pigmented throughout the entire cross-section so as to produce a uniform color which is an integral part of the material. Ultraviolet resistant materials shall be incorporated in the construction to inhibit fading or cracking of the delineator upon field exposure.
4. Vehicle Impact Resistance: The Carsonite CRM-375 marker shall be capable of self-erecting and remain functional after being subjected to a series of ten head on impacts by a typical passenger sedan at 35 m.p.h. The CRM-375 shall retain a minimum of 60 percent (60%) of its sheeting.

C. Reflectors:

1. The reflector shall be of impact resistant, pressure sensitive retroreflective sheeting which shall be subject to approval by the Engineer. The sheeting shall be of appropriate color to meet MUTCD requirements.
2. Mounting: The retroreflective sheeting shall consist of a minimum of a three-inch wide strip placed a maximum of two inches from the top of the post unless otherwise specified.

2.19 SURGE RELIEF VALVE

A. General:

1. The angle surge relief valve shall be heavily constructed cast iron body with a ductile iron cover/spacer to withstand severe shock conditions. The body shape shall be 90° angle pattern to permit side or downward discharge.
2. The cover/spacer shall provide an air gap between the surge valve and the hydraulic cylinder. The valve stem shall be connected to the hydraulic cylinder by means of a self-aligning universal connector to ensure smooth positive opening without binding during shock opening of the valve.
3. The hydraulic cylinder shall be removable from the valve, without dismantling or removing the valve from the line.
4. Closing speed shall be externally adjustable by means of a micrometer control

valve.

5. The valve disc shall be normally closed against the system operating pressure by means of a spring or springs. When the system pressure exceeds the normal operating pressure by 10%, the valve shall open immediately to relieve the pressure surge and close slowly as the system pressure returns to normal, by means of the hydraulic cylinder. The hydraulic cylinder shall be capped on both ends (totally enclosed) to prevent dirt or dust from fouling up the cylinder operation. It shall be fitted with an atmospheric oil reservoir.
6. The shut-off pressure shall be set at the factory, but additional adjustments can be made in the field by increasing or decreasing the tension on the externally adjustable springs.
7. Valve exterior to be painted with primer.
8. All materials shall be certified in writing to conform with ASTM specifications.
9. Valve to be APCO Series 3000 Angle Surge Relief Valve, as manufactured by Valve & Primer Corporation; Schaumburg, Illinois; GA Industries, Inc., or equal.

2.20 FLANGED PRESSURE SENSORS

A. General:

1. The sensor shall be flanged and bolted directly into ANSI flanged pipelines. Face-to-face shall be no greater than a wafer style of a butterfly valve. The flanges shall have thru bolt holes to enable positive alignment in the pipeline. Inside diameter of the sensor shall be the same as the mating pipe with a full thru uninterrupted flow. There shall be no dead ends or crevices and flow passage shall make the sensor self-cleaning.
2. The pressure sensing ring shall measure pressure for 360⁰ around the full inside circumference of the pipeline. The sensing ring shall also be clamped into the body for the full radial width of the sensor. Pressure shall be transmitted to the gauge by a locked in and sealed fluid such as ethylene glycol or silicone oil. The sensor shall have an auxiliary tapped and plugged port to allow filling connection of other equipment.
3. All sensors shall be Series 40, as manufactured by the Red Valve Co., Carnegie, PA., or equal.

2.21 FLAP VALVES

- ### A.
- Flap gates shall be entirely constructed of 304 stainless steel. All hardware shall be 304 stainless steel. The frame shall be made of structural members or formed plate welded to form a rigid one-piece frame. The frame shall be of the flange back design suitable for mounting on a concrete wall or standard pipe flange. The gate cover shall be made of structural members or formed plate adequately reinforced to withstand the maximum specified seating head. Seals shall be made of resilient neoprene attached to the body by means of a retainer ring for flaps up to 24-inches. The hinges shall consist of a stainless steel hinge pin and shall have a UHMWPE bushing. Flap valves shall be Fontaine series 60 or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Valves shall be installed as nearly as possible in the positions indicated on the Drawings consistent with conveniences of operating the hand wheel or wrench. All valves shall be carefully erected and supported in their respective positions free from all distortion and strain on appurtenances during handling and installation.
- B. All material shall be carefully inspected for defects in workmanship and material, all debris and foreign material cleaned out of valve openings and seats, all operating mechanisms operated to check their proper functioning, and all nuts and bolts checked for tightness.
- C. Valves and other equipment that do not operate easily or are otherwise defective shall be repaired or replaced at the Contractor's expense.
- D. Valves shall not be installed with stems below the horizontal.
- E. Valves shall be set plumb and supported adequately in conformance with the instructions of the manufacturer. Valves mounted on the face of concrete shall be shimmed vertically and grouted in place. Valves in the control piping shall be installed so as to be easily accessible.
- F. Where chain wheels are provided for remote operation of valves, two S-shaped hooks shall be provided for each valve to enable the chains to be hooked so as not to interfere with personnel traffic.
- G. Valves shall be provided with extension stems where required for convenience of operation. Extension stems shall be provided for valves installed underground and elsewhere so that the operating wrench does not exceed 6 feet in length.
- H. A permanent type gasket of uniform thickness shall be provided between flanges of valves and sluice gates and their wall thimble.
- I. Wall thimbles shall be accurately set in the concrete walls so that the gates can be mounted in their respective positions without distortion or strain.
- J. Plug valves in horizontal sewage and sludge piping shall be installed with the shaft horizontal such that when in the open position, the plug is located in the upper part of the valve body. Valves shall be oriented so that in the closed position, the plug is at the downstream end of the valve.
- K. Floorstand operators and stem guides shall be set so that the stems shall run smoothly in true alignment. Guides shall be anchored firmly to the walls. Distances from the

centerlines of gates to the operating level or base of floorstand shall be checked by the Contractor and adjusted if necessary to suit the actual conditions of installation.

3.02 PAINTING

- A. Valves shall be factory primed and fully coated, inside and out, with epoxy paint in accordance with the valve manufacturer's recommendation.
- B. Other painting is specified in Division 9.

END OF SECTION 02642

SECTION 02675 - DISINFECTION OF POTABLE WATER PIPE

PART 1 - GENERAL

1.01 WORK INCLUDED

The Contractor shall furnish all labor, material and water necessary to disinfect the potable water pipe as shown on the Drawings and specified herein.

1.02 RELATED WORK

- A. Section 02225 - Excavating, Backfilling and Compacting for Utilities.
- B. Section 02610 - Water Pipe and Fittings.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 DISINFECTION OF WATER MAINS

- A. All water pipe shall be disinfected by the use of chlorine or chlorine compound in such amounts as to produce a concentration of at least 50 ppm and a residual of at least 25 ppm at the end of the twenty-four (24) hours. Pipes shall be thoroughly flushed upon meeting the chlorine residual requirements. Before the pipes are placed in service, samples of the water must be taken by the Contractor and submitted to the State Department of Health for testing. No pipes shall be placed in service until the samples have been approved by the Health Department. The Contractor shall bear all the cost of sampling, testing, and postage. The cost of the disinfection and sampling shall be included in the unit price of the pipe.
- B. Copies of the results of the testing shall be submitted to the Owner and/or Engineer.

END OF SECTION 02675

SECTION 02731 - GRAVITY SEWERS

PART 1 - GENERAL

1.01 WORK INCLUDED

The Contractor shall furnish all labor, material, and equipment necessary to install gravity sewer piping together with all appurtenances as shown and detailed on the Drawings and specified herein.

1.02 RELATED WORK

- A. Section 02222 - Excavation.
- B. Section 02225 - Excavating, Backfilling, and Compacting for Utilities.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS

- A. Ductile Iron (DI) Pipe:
 - 1. Ductile iron pipe shall conform to ANSI A21.50 (AWWA C150) and ANSI A21.51 (AWWA C151) (latest revision). The pipe shall be designed for an internal working pressure of 150 psi and external loading based on flat bottom trenches without blocks and untamped backfill-laying conditions. The pipe shall have a minimum pressure class of 150 psi.
 - 2. Fittings shall be ductile iron fittings in accordance with AWWA C153.
 - 3. Joints shall be push-on type or mechanical joint type conforming to ANSI A21.11 (AWWA C111). Unless specifically required at designated locations by the Drawings, the type of joint used is optional.
 - a. Push-on joints shall have an annular recess in the pipe socket to accommodate a single rubber gasket. Plain ends shall be suitably beveled to permit easy entry into the bell. The gasket and annular recess of the socket shall be so designed and shaped that the gasket is located in place against displacement as the joint is assembled.
 - b. Mechanical joints shall be bolted and of the stuffing box type and shall consist of a bell with exterior flange and interior recess for the sealing gasket, a pipe or fitting plain end, a sealing gasket, a follower gland, tee-head bolts and hexagon nuts.
 - 4. All ductile iron pipe and fittings shall have the manufacturer's outside asphaltic coating and a cement lining and bituminous seal coat on the inside. Cement mortar lining and bituminous seal coat inside shall conform to ANSI A21.4

(AWWA C104).

5. Pipe shall be furnished in lengths of 16, 16.5, 18, or 20 feet nominal laying lengths. The weight of any single pipe shall not be less than the tabulated weight by more than 5 percent for pipe 12 inches or smaller in diameter, not by more than 4 percent for pipe larger than 12 inches in diameter.
6. The net weight, class or nominal thickness and sampling period shall be marked on each pipe. The pipe shall also be marked to show that it is ductile iron.
7. Pipe shall be as manufactured by U.S. Pipe & Foundry Company, American Cast Iron Pipe Company, or equal.

B. Polyvinyl Chloride (PVC) Pipe:

1. Solid Wall PVC Pipe (SDR 35):
 - a. PVC pipe and fittings less than 15 inches in diameter shall conform to the requirements of ASTM Standard Specifications for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings, Designation D 3034. Pipe and fittings shall have a minimum cell classification of 12454B or 12454C as defined in ASTM D-1784. All pipe shall have a pipe diameter to wall thickness ratio (SDR) of a maximum of 35.
 - b. PVC pipe and fitting with diameters 18-inch through 27-inch shall conform to the requirements of ASTM D-1784 and ASTM F-679. Pipe and fittings shall have a minimum cell classification of 12454C. The minimum wall thickness shall conform to T-1 as specified in ASTM F-679.
 - c. Joints shall be push-on bell and spigot type using elastomeric ring gaskets conforming to ASTM D 3212 and F 477. The gaskets shall be securely fixed into place in the bells so that they cannot be dislodged during joint assembly. The gaskets shall be of a composition and texture which is resistant to common ingredients of sewage and industrial wastes, including oils and groundwater, and which will endure permanently under the conditions of the proposed use.
 - d. Pipe shall be furnished in lengths of not more than 13 feet. The centerline of each pipe section shall not deviate from a straight line drawn between the centers of the openings at the ends by more than 1/16 inch per foot of length.
 - e. PVC pipe shall not have a filler content greater than ten percent (10%) by weight relative to PVC resin in the compound.
 - f. PVC pipe shall be clearly marked at intervals of 5 feet or less with the manufacturer's name or trademark, nominal pipe size, PVC cell classification, the legend "Type PSM SDR 35 PVC Sewer Pipe" and the designation "ASTM D 3034", or "ASTM F-679". Fittings shall be clearly marked with the manufacturer's name or trademark, nominal size, the material designation "PVC", "PSM" and the designation "ASTM D 3034", or "ASTM F-679".
 - g. PVC pipe shall have a minimum pipe stiffness of 46 psi for each diameter

when measured at 5 percent vertical ring deflection and tested in accordance with ASTM D-2412.

- h. Five (5) copies of directions for handling and installing the pipe shall be furnished to the Contractor by the manufacturer at the first delivery of pipe to the job. PVC pipe installation shall conform to ASTM D-2321 latest revision.
- i. Pipe shall be as manufactured by H & W Pipe Company, or equal.

2. Corrugated Wall PVC Pipe with Smooth Interior:

- a. Corrugated PVC pipe and fittings greater than 15 inches in diameter shall conform to the requirements of ASTM F-949. Pipe and fittings shall have a minimum cell classification of 12454B or 12454C in accordance with ASTM D-1784.
- b. Joints shall be push-on bell and spigot type using elastomeric ring gaskets conforming to ASTM D 3212 and F 477. The gaskets shall be double sealed so that they cannot be dislodged during joint assembly. The gaskets shall be of a composition and texture which is resistant to common ingredients of sewage and industrial waste, including oils and groundwater, and which will endure permanently under the conditions of the proposed use.
- c. Corrugated PVC pipe shall be furnished in lengths of 13 or 20 feet. The centerline of each pipe section shall not deviate from a straight line drawn between the centers of the openings at the ends by more than 1/16 inch per foot of length.
- d. Corrugated PVC pipe shall have a smooth interior.
- e. PVC pipe shall not have a filler content greater than ten percent (10%) by weight relative to PVC resin in the compound.
- f. Corrugated PVC pipe shall be clearly marked at intervals of 5 feet or less with the manufacturer's name or trademark, nominal pipe size, PVC cell classification, the plastic "PVC", the designation "ASTM F-949", and extrusion code, including date and location of manufacture. Fittings shall be clearly marked with the manufacturer's name or trademark, nominal size, the material designation "PVC", and the designation "ASTM F-949".
- g. Corrugated PVC pipe shall have a minimum stiffness of 50 psi when measured at 5 percent vertical ring deflection (tested in accordance with ASTM D-2412), as defined in ASTM F-949.
- h. Five (5) copies of directions for handling and installing the pipe shall be furnished to the Contractor by the manufacturer at the first delivery of pipe to the job. PVC pipe installation shall conform to ASTM D-2321 latest revision.
- i. Corrugated PVC pipe shall be A2000 as manufactured by Contech Construction Products, Inc. or approved equal.

C. Truss Pipe:

1. Truss pipe and fittings shall conform to the requirements of ASTM D-2680.
2. The thermoplastic material shall be rigid PVC plastic and shall be in accordance with ASTM D-1784. PVC plastic shall be manufactured with minimum cell classification of 12454B or 12454C.
3. The truss annulus shall be filled with cement pearlite concrete (or other inert filler material exhibiting the same degree of performance as cement pearlite concrete) to form a semi-rigid composite pipe.
4. Truss pipe and fittings shall have a minimum stiffness of 200 psi for each diameter when measured at 5 percent vertical ring deflection and tested in accordance with ASTM D-2412.
5. Joints shall be push-on bell and spigot type using elastomeric ring gaskets conforming to ASTM D-3212 and F-477. The gaskets shall be securely fixed into place in the bells so that they cannot be dislodged during joint assembly. The gaskets shall be of a composition and texture which is resistant to common ingredients of sewage and industrial wastes, including oils and groundwater, and which will endure permanently under the conditions of the proposed use. No solvent cement joints shall be allowed.
6. All field cutting of pipe shall be done in a neat, trim manner using a hand saw per manufacturer's recommendations. Care shall be taken to protect the filler material. All field cuts shall be sealed according to manufacturer's recommendations.
7. Pipe shall be furnished in lengths of not more than 13 feet. The centerline of each pipe section shall not deviate from a straight line drawn between the centers of the openings at the ends by more than 1/16 inch per foot of length.
8. PVC pipe shall be clearly marked at intervals of 5 feet or less with the manufacturer's name or trademark, nominal pipe size, PVC cell classification, the legend "PVC Composite Pipe", the designation "ASTM D-2680", and the extrusion code, including date and location of manufacture. Fittings shall be clearly marked with the manufacturer's name or trademark, nominal size, the material designation "PVC", and the designation "ASTM D-2680".
9. Five (5) copies of directions for handling and installing the pipe shall be furnished to the Contractor by the manufacturer at the first delivery of pipe to the job. PVC pipe installation shall conform to ASTM D-2680 latest revision.
10. Truss pipe shall be PVC truss pipe as manufactured by Contech Construction Products, Inc. or an approved equal.

D. Reinforced Concrete Pipe:

1. All reinforced concrete pipe shall conform to the requirements of ASTM C76-89. Class shall be as shown on the Drawings.
2. Joints shall be bell and spigot type using Forsheda 138 or Forsheda 103 gaskets (or equal) and shall conform to ASTM C443.
3. The pipe shall be furnish in standard lengths of 8 feet to 16 feet.
4. The pipe shall be permanently marked showing the nominal inside diameter,

manufacture date, ASTM C76 class, and manufacturer's name. These markings for 30-inch diameter and larger shall be inscribed on the pipe exterior and stenciled on the interior with paint or permanent ink.

5. There shall be no lift holes.
6. Pipe shall be as manufactured by Independent Concrete Pipe Company or an approvable equal.
7. Coating and Lining:
 - a. All concrete pipe shall be coated and lined at the pipe manufacturer's plant.
 - b. The exterior coating and interior lining shall be a high build multi-component Amine cured Novalac epoxy polymeric coating/lining equal to the Protecto 401 as manufactured by Vulcan Painters, Inc. of Birmingham, AL.
 - c. The coating/lining shall have a permeability rating in accordance with Method A of ASTM E-96-66.
 - d. The surface preparation shall remove all loose laitance, form oils, and other loose materials and include a "brush blast" per SSPC.
 - e. The coating and lining shall be applied in accordance with the manufacturer's requirements and have a minimum dry film thickness (DFT) of:
 - (1) Exterior Coating: 25 mil DFT.
 - (2) Interior Coating: 40 mil DFT.
8. Connection of existing and proposed sewer lines to the reinforced concrete pipe shall be accomplished by the following methods:
 - a. Precast concrete fittings with joints using Forsheda 138 or Forsheda 103 gaskets (or equal) conforming to ASTM C443, or
 - b. Core drilling the reinforced concrete pipe and installing a KOR-N-TEE Model 1200 GP flexible watertight connector (or equal) as manufactured by KOR-N-SEAL. Connector shall be made of EPDM rubber. All hardware shall be 304 stainless steel.

E. High Density Polyethylene Pipe:

1. Material: The polyethylene pipe shall be high performance, high molecular weight, high density polyethylene pipe equal to Driscopipe 1000 as manufactured by Phillips Driscopipe, Inc., Richardson, TX, conforming to ASTM D 1248 (Type III, Class C, Category 5, Grade P34). Minimum cell classification values shall be 3 4 5 4 3 4 C as referenced in ASTM D 3350.
2. Physical Properties of Pipe Compound:
 - a. Density - The density shall be no less than 0.941 - 0.955 gm/cm³ as referenced in ASTM D 1505.
 - b. Melt Flow - Flow rate shall not be greater than 0.14gm/10 min when tested in accordance with Method D1238 - Condition E.
 - c. Flex Modulus - Shall be 120,000 to less than 160,000 psi as referenced in ASTM D 790.

- d. Tensile Strength at Yield - Shall be 3000 - to less than 3500 psi as referenced in ASTM 638.
 - e. ESCR - The stress crack resistance shall be in excess of 1000 hours with less than 20 percent failure when tested in accordance with ASTM D 1693 Condition C.
 - f. Hydrostatic design shall be 1600 psi at 23° C when tested in accordance with ASTM 2837.
- 3. Owner may request certified lab data to verify the physical properties of pipe or may take random samples and have them tested at an independent laboratory.
 - 4. Rejection: Polyethylene pipe and fittings may be rejected for failure to meet any of the requirements of this Specification.
 - 5. Rating: The polyethylene pipe shall have a manufacturer's recommended hydrostatic design stress rating of 800 psi based on a material with a 1600 psi design basis determined in accordance with ASTM D-2837. Standard method for obtaining hydrostatic design basis for thermoplastic pipe materials.
 - 6. Dimensions: The polyethylene sewer pipe to be nominal I.P.S. with a wall thickness minimum of SDR-32.5. The pipe shall be nominal I.P.S. size.

PART 3 - EXECUTION

3.01 PIPE LAYING

- A. All pipe shall be laid with ends abutting and true to the lines and grades indicated on the Drawings. The pipe shall be laid straight between changes in alignment and at uniform grade between changes in grade. Pipe shall be fitted and matched so that when laid in the trench, it will provide a smooth and uniform invert. Supporting of pipe shall be as set out in Section 02225 and in no case shall the supporting of pipe on blocks be permitted.
- B. Before each piece of pipe is lowered into the trench, it shall be thoroughly swabbed out to insure its being clean. Any piece of pipe or fitting which is known to be defective shall not be laid or placed in the lines. If any defective pipe or fitting shall be discovered after the pipe is laid, it shall be removed and replaced with a satisfactory pipe or fitting without additional charge. In case a length of pipe is cut to fit in a line, it shall be so cut as to leave a smooth end at right angles to the longitudinal axis of the pipe and beveled to match the factory bevel for insertion into gasketed joints. Bevel can be made with hand or power tools.
- C. The interior of the pipe, as the work progresses, shall be cleaned of dirt, jointing materials, and superfluous materials of every description. When laying of pipe is stopped for any reason, the exposed end of such pipe shall be closed with a plywood plug fitted into the pipe bell so as to exclude earth or other material and precautions taken to prevent flotation of pipe by runoff into trench.

- D. All pipe shall be laid starting at the lowest point and installed so that the spigot ends point in the direction of flow.

3.02 JOINTING

All joint surfaces shall be cleaned immediately before jointing the pipe. The bell or groove shall be lubricated in accordance with the manufacturer's recommendation. Each pipe unit shall then be carefully pushed into place without damage to pipe or gasket. All pipe shall be provided with home marks to insure proper gasket seating. Details of gasket installation and joint assembly shall follow the direction of the manufacturer's of the joint material and of the pipe. The resulting joints shall be watertight and flexible. **No solvent cement joints shall be allowed.**

3.03 UTILITY CROSSING CONCRETE ENCASEMENT

- A. At locations shown on the Drawings, required by the Specifications, or as directed by the Engineer, concrete encasement shall be used when the clearance between the proposed sanitary sewer pipe and any existing utility pipe is 18 inches or less. Utility pipe includes underground water, gas, telephone and electrical conduit, storm sewers, and any other pipe as determined by the Engineer.
- B. There are two cases of utility crossing encasement. Case I is applicable when the proposed sanitary sewer line is **below** the existing utility line. Case II is applicable when the proposed sanitary sewer line is laid **above** the utility line. In either case, the concrete shall extend to at least the spring line of each pipe involved.
- C. Concrete shall be Class B (3000 psi) and shall be mixed sufficiently wet to permit it to flow between the pipes to form a continuous bridge. In tamping the concrete, care shall be taken not to disturb the grade or line of either pipe or damage the joints.
- D. Concrete for this Work is not a separate pay item and will be considered incidental to utility pipe installation.

3.04 TESTING OF GRAVITY SEWER LINES

- A. After the gravity piping system has been brought to completion, and prior to final inspection, the Contractor shall rod out the entire system by pushing through each individual line in the system, from manhole to manhole, appropriate tools for the removal from the line of any and all dirt, debris, and trash. If necessary during the process of rodding the system, water shall be turned into the system in such quantities to carry off the dirt, debris and trash.
- B. During the final inspection, the Engineer will require all flexible sanitary sewer pipe to be mandrel deflection tested after installation.

1. The mandrel (go/no-go) device shall be cylindrical in shape and constructed with nine (9) evenly spaced arms of prongs. The mandrel dimension shall be 95 percent of the flexible pipe's published ASTM average inside diameter. Allowances for pipe wall thickness tolerances of ovality (from shipment, heat, shipping loads, poor production, etc.) shall not be deducted from the ASTM average inside diameter, but shall be counted as part of the 5 percent allowance. The contact length of the mandrel's arms shall equal or exceed the nominal diameter of the sewer to be inspected. Critical mandrel dimensions shall carry a tolerance " 0.001 inch.
 2. The mandrel inspection shall be conducted no earlier than 30 days after reaching final trench backfill grade provided, in the opinion of the Engineer, sufficient water densification or rainfall has occurred to thoroughly settle the soil throughout the entire trench depth. Short-term (tested 30 days after installation) deflection shall not exceed 5 percent of the pipe's average inside diameter. The mandrel shall be hand pulled by the contractor through all sewer lines. Any sections of the sewer not passing the mandrel test shall be uncovered and the Contractor shall replace and recompact the embedment backfill material to the satisfaction of the Engineer. These repaired sections shall be retested with the go/no-go mandrel until passing.
 3. The Engineer shall be responsible for approving the mandrel. Proving rings may be used to assist in this. Drawings of the mandrel with complete dimensioning shall be furnished by the Contractor to the Engineer for each diameter and type of flexible pipe.
- C. The pipeline shall be made as nearly watertight as practicable, and leakage tests and measurements shall be made. All apparatus and equipment required for testing shall be furnished by the Contractor and the cost shall be included in the unit price bid for pipe and manholes.
1. The Engineer may require the Contractor to smoke test the first section (manhole to manhole) of each size of pipe and type of joint prior to backfilling, to establish and check laying and jointing procedures. The test shall consist of smoke blown into closed-off sections of sewer under pressure and observing any smoke coming from the pipeline indicating the presence of leaks. Other supplementary smoke tests prior to backfilling may be performed by the Contractor at his option; however, any such tests shall not supplant the final tests of the completed work unless such final tests are waived by the Engineer.
 2. Where the groundwater level is more than 1 foot above the top of the pipe at its upper end, the Contractor shall conduct either infiltration tests or low-pressure air tests on the completed pipeline.
 3. Where the groundwater level is less than 1 foot above the top of the pipe at its upper end, the Contractor shall conduct either exfiltration tests or low-pressure air tests on the completed pipeline.
- D. Low pressure air tests shall be made using equipment specifically designed and

manufactured for the purpose of testing sewer lines using low-pressure air. The equipment shall be provided with an air regulator valve or air safety valve so set that the internal pressure in the pipeline cannot exceed 8 psig.

1. The test shall be made on each manhole-to-manhole section of pipeline after placement of the backfill. The Engineer or his designated representative must be present to witness each satisfactory air test before it will be accepted as fulfilling the requirements of these Specifications.
2. Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be tested. Pneumatic plugs shall resist internal test pressures without requiring external bracing or blocking.
3. Low pressure air passing through a single control panel, shall be introduced into the sealed line until the internal air pressure reaches 4 psig greater than the maximum pressure exerted by groundwater that may be above the invert of the pipe at the time of test. However, the internal air pressure in the sealed line shall not be allowed to exceed 8 psig. When the maximum pressure exerted by the groundwater is greater than 4 psig, the Contractor shall conduct only an infiltration test.
4. At least two minutes shall be allowed for the air pressure to stabilize in the section under test. After the stabilization period, the low-pressure air supply hose shall be quickly disconnected from control panel. The time required in minutes for the pressure in the section under test to decrease from 3.5 to 2.5 psig (greater than the maximum pressure exerted by groundwater that may be above the invert of the pipe) shall not be less than that shown in the following table:

Pipe in Diameter in Inches	Minutes
4	2.0
6	3.0
8	4.0
10	5.0
12	5.5
15	7.5
18	8.5
21	10.0
24	11.5
30 & larger	13.5

5. When the sewer section to be tested contains more than one size of pipe, the minimum allowable time shall be based on the largest diameter pipe in the section, and shall be the time shown in the table reduced by 0.5 minutes.
6. Reinforced concrete pipe shall be tested in accordance with ASTM C 924 (joint testing shall be in accordance with ASTM C 1103). Test time shall be a function

of pipe diameter and the length of installed line to be tested as provided in ASTM C 924.

- E. Infiltration tests shall be made after underdrains, if present, have been plugged and other groundwater drainage has been stopped such that the groundwater is permitted to return to its normal level insofar as practicable.
 - 1. Upon completion of a section of the pipeline, the line shall be dewatered and a satisfactory test conducted to measure infiltration for at least 24 hours. The amount of infiltration, including manholes, tees and connections shall not exceed 200 gallons per nominal inch diameter per mile of sewer per 24 hours.
- F. Exfiltration tests which subject the pipeline to an internal pressure, shall be made by plugging the pipe at the lower end and then filling the line and manholes with clean water to a height of 2 feet above the top of the sewer at its upper end. Where conditions between manholes may result in test pressures, which would cause leakage at the plugs or stoppers in branches, provisions shall be made by suitable ties, braces and wedges to secure the plugs against leakage resulting from the test pressure.
 - 1. The rate of leakage from the sewers shall be determined by measuring the amount of water required to maintain the level 2 feet above the top of the pipe.
 - 2. Leakage from the sewers under test shall not exceed the requirements for leakage into sewers as hereinbefore specified.
- G. The Contractor shall furnish suitable test plugs, water pumps, and appurtenances, and all labor required to properly conduct the tests. Suitable bulkheads shall be installed, as required, to permit the test of the sewer. The Contractor shall construct weirs or other means of measurements as may be necessary.
- H. Should the sections under test fail to meet the requirements, the Contractor shall do all work of locating and repairing the leaks and retesting as the Engineer may require without additional compensation.
- I. If in the judgment of the Engineer, it is impracticable to follow the foregoing procedures for any reason, modifications in the procedures shall be made as required and as acceptable to the Engineer, but in any event, the Contractor shall be responsible for the ultimate tightness of the line within the above test requirements.

3.05 INSTALLATION OF HDPE PIPE

A. Construction Practices:

- 1. Handling Pipe:
 - a. Pipe shall be stored on clean level ground to prevent undue scratching or gouging.

- b. Sections of pipe with deep cuts or gouges in excess of 10 percent of the wall thickness shall be removed completely and the ends of pipeline rejoined.
 - c. The handling of the joined pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects.
- 2. Pipe Joining:
 - a. Sections of the polyethylene pipe shall be joined into continuous lengths on the job site above the ground. The joining method shall be the butt fusion method and shall be done in strict accordance with the pipe manufacturer's recommendation.
 - b. The hydraulically operated machines shall have a pressure regulator to preset the correct pressure for the desired fusion force, and there shall be an auxiliary system to control "feed" rate for the pipe face-off. Each machine shall be permanently equipped with a chart showing correct fusion pressure for each pipe size and wall thickness (SDR).
- 3. Direct Burial Installation:
 - a. The trench and trench bottom shall be constructed in accordance with the Drawings.
 - b. Embedment materials to be used shall be as recommended in ASTM D-2321-74, Section 6.
 - c. The proper bedding practices to be followed shall be subject to those described in ASTM D-2321-74, Section 8.
 - d. Installation practices shall be those specified in ASTM D-2321-74, Section 9.

END OF SECTION 02731

SECTION 02732 - SEWAGE FORCE MAINS

PART 1 - GENERAL

1.01 WORK INCLUDED

The Contractor shall furnish all labor, material, and equipment necessary to install force main piping together with all appurtenances as shown and detailed on the Drawings and specified herein.

1.02 RELATED WORK

- A. Section 02222 - Excavation.
- B. Section 02225 - Excavating, Backfilling, and Compacting for Utilities.
- C. Section 02733 - Sewage Pump Station.

PART 2 - PRODUCTS

2.01 DUCTILE IRON PIPE (DIP) AND FITTINGS

- A. Ductile iron pipe (DIP) shall conform to ANSI/AWWA C150/A21.50, ANSI/AWWA C151/A21.51 Standard (latest). The pipe shall conform to pressure class 150 unless noted otherwise. All pipe, fittings and joints should be capable of accommodating pressure up to 150 psi. The ductile iron pipe shall be as manufactured by Clow Corporation, U.S. Pipe & Foundry Company, American Cast Iron Pipe Company, or equal.
- B. Fittings shall be ductile iron in accordance with AWWA C153 and have a body thickness and radii of curvature conforming to ANSI A21.10 or ANSI A21.53 for compact fittings and shall conform to the details and dimensions shown therein. Fittings shall have rubber gasket joints meeting the requirements of AWWA C111. Fittings shall be cement-mortar lined and bituminous coated to conform to the latest revision of ANSI/AWWA standards.
- C. Ductile iron flanged joint pipe shall conform to ANSI/AWWA C115/A 21.15 Standard and have a thickness Class of 53. The pipe shall have a rated working pressure of 250 psi with Class 125 flanges. Gaskets shall be ring gaskets with a thickness of 1/8 inch. Flange bolts shall conform to ANSI B 16.1.
- D. Flanged fittings shall meet all requirements of ANSI/AWWA C110/A21.10 and have Class 125 flanges. Fittings shall accommodate a working pressure up to 250 psi and be supplied with all accessories.

- E. All pipe and fittings shall be tar coated outside and shall receive a standard cement lining with bituminous seal coat on the inside in accordance with ASA Specification A21.40 (AWWA-C104).
- F. Cement mortar lining and seal coating for pipe and fittings, where applicable shall be in accordance with ANSI/AWWA C104/A21.4. Bituminous outside coating shall be in accordance with ANSI/AWWA C151/A21.51 for pipe and ANSI/AWWA C110/A21.10 for fittings.
- G. All ductile fittings shall be rated at 250 psi water working pressure plus water hammer. Ductile iron fittings shall be ductile cast-iron grade 80-60-03 per ASTM Specification A339-55.
- H. Restrained joint pipe and fittings shall be a boltless system equal to "Field Lok" restraining gaskets or "TRFLEX Joint" as manufactured by U.S. Pipe & Foundry Company.
- I. No separate pay item has been established for fittings and no determination of the number of fittings required on the job has been made. The Contractor, during the bidding phase, shall determine the number of fittings required on the job and include the cost of the fittings and installation in the Contract unit price.

2.02 POLYVINYL CHLORIDE (PVC) FORCE MAIN PIPE

- A. Polyvinyl chloride (PVC) pipe for force mains shall be Class 200 (SDR 21) PVC pressure rated pipe with integral bell joints with rubber O-ring seals.
- B. All PVC pipe shall conform to the latest revisions of ASTM D-1784 (PVC Compounds), ASTM D-2241 (PVC Plastic Pipe, SDR) and ASTM D-2672 (Bell - End PVC Pipe). PVC pipe shall have a minimum cell classification of 12454B or 12454C as defined in ASTM D-1784. Rubber gasketed joints shall conform to ASTM D-3139. The gaskets for the PVC pipe joint shall conform to ASTM F-477 and D-1869.
- C. Fittings shall be ductile iron and in accordance with Article 2.01 B of this section.
- D. All pipe and couplings shall bear identification markings that will remain legible during normal handling, storage and installation, which have been applied in a manner that will not reduce the strength of the pipe or coupling or otherwise damage them. Pipe and coupling markings shall include the nominal size and OD base, material code designation, dimension ratio number, ASTM Pressure Class, ASTM designation number for this standard, manufacturer's name or trademark, seal (mark) of the testing agency that verified the suitability of the pipe material for sanitary sewer service. Each marking shall be applied at intervals of not more than 5 feet for the pipe and shall be marked on each coupling.

2.03 POLYETHYLENE PIPE

- A. Polyethylene pipe shall be of high density, high molecular weight polyethylene and conform to the requirements of ASTM Specification D-3350 (SDR 21) and have recommended designation values of 3-4-5-4-3-4-C. Fittings shall be SDR 9.3.
- B. Pipe shall have dimensions and workmanship in accordance with ASTM F-714.
- C. Polyethylene pipe shall be supplied in standard lengths of at least 12 feet 6 inches. Longer lengths are permitted.
- D. Polyethylene pipe shall be marked with the manufacturer's name, production lot number, ASTM designation, and nominal diameter.
- E. Polyethylene pipe shall be joined by the butt-fusion technique utilizing controlled temperature and pressure to produce a fused, leak-free joint, stronger than the pipe itself in both tension and hydrostatic loading.
- F. Pipe shall be Phillips Driscopipe, or equal.

PART 3 - EXECUTION

3.01 LAYING DEPTHS

In general, force mains shall be laid with a minimum cover of 30 inches, except as otherwise indicated on the Drawings.

3.02 RELATIONSHIP TO WATER LINE

Where a force main and water line cross one another, the force main shall be laid under the water line and encased with concrete in accordance with Section 02731 and as detailed on the Drawings.

3.03 PIPE LAYING

- A. All pipe shall be laid with ends abutting and true to the lines and grades indicated on the Drawings. Pipe shall be fitted and matched so that when laid in the Work, it will provide a smooth and uniform invert. Supporting of pipe shall be as set out in Section 02225 and in no case shall the supporting of pipe on blocks be permitted.
- B. Before each piece of pipe is lowered into the trench, it shall be thoroughly swabbed out to insure it being clean. Any piece of pipe or fitting which is known to be defective shall not be laid or placed in the lines. If any defective pipe or fittings shall be discovered after the pipe is laid, it shall be removed and replaced with a satisfactory pipe or fitting without

additional charge. In case a length of pipe is cut to fit in a line, it shall be so cut as to leave a smooth end at right angles to the longitudinal axis of the pipe. Bevel can be made with hand or power tools.

- C. The interior of the pipe, as the Work progresses, shall be cleaned of dirt, jointing materials, and superfluous materials of every description. When laying of pipe is stopped for any reason, the exposed end of such pipe shall be closed with a plywood plug fitted so as to exclude earth or other material and precautions taken to prevent floatation of pipe by runoff into trench.
- D. Anchorage of Bends:
 - 1. At all tees, plugs, caps and bends of 11-1/4 degrees and over, and at reducers or in fittings where changes in pipe diameter occur, movement shall be prevented by using suitable harness, thrust blocks or ballast. Thrust blocks shall be as shown on the Drawings, with sufficient volumes of concrete being provided; however care shall be taken to leave weep holes unobstructed and allow for future tightening of all nearby joints. Unless otherwise directed by the Engineer, thrust blocks shall be placed so that pipe and fitting joints will be accessible for repair.
 - 2. Bridles, harness or pipe ballasting shall meet with the approval of the Engineer. Steel rods and clamps shall be galvanized or otherwise rust-proofed or painted.
 - 3. No extra pay shall be allowed for work on proper anchorage of pipe, fittings or other appurtenances. Such items shall be included in the price bid for the supported item.

3.04 JOINTING

All joint surfaces shall be cleaned immediately before jointing the pipe. The bell or groove shall be lubricated in accordance with the pipe manufacturer's recommendations. Each pipe unit shall then be carefully pushed into place without damage to pipe or gasket.

All pipe shall be provided with home marks to insure proper gasket seating. Details of gasket installation and joint assembly shall follow the direction of the manufacturer's of the joint material and of the pipe. The resulting joints shall be watertight and flexible.

3.05 TESTING OF FORCE MAINS

- A. The completed work shall comply with the provisions listed herein, or similar requirements which will insure equal or better results. Suitable test plugs, water pump or other equipment and apparatus, and all labor required to properly conduct the tests shall be furnished by the Contractor at no expense to the Owner.
- B. Force main piping shall be pressure tested to 250 percent of the normal system operating pressure or to 150 percent of the rated working pressure of the pipe, whichever is less. At no time shall the test pressure exceed 150 percent of the pipe's rated working pressure. A pipe section shall be accepted if the test pressure does not fall more than 5 percent during the 4-hour period.

- C. All piping shall be tested for leakage at a pressure no less than that specified for the pressure test. The leakage shall be less than an allowable amount determined by the following equation:

$$L = \frac{ND (P)^{1/2}}{7400}$$

Where

- L = allowable leakage (gallon/hour)
- N = number of joints in length of pipeline tested
- D = nominal diameter of pipe (inches)
- P = test pressure (psig)

- D. Should the sections under test fail to meet the requirements, the Contractor shall do all work locating and repairing the leaks and retesting as the Engineer may require without additional compensation.
- E. If in the judgement of the Engineer, it is impracticable to follow the foregoing procedures for any reason, modifications in the procedures shall be made as required and as acceptable to the Engineer, but in any event, the Contractor shall be responsible for the ultimate tightness of the line within the above test requirements.

END OF SECTION 02732

SECTION 02735 - MANHOLES

PART 1 - GENERAL

1.01 WORK INCLUDED

The Contractor shall furnish all labor, material, and equipment necessary to construct manholes for sanitary sewers, including steps, frames and covers, together with all appurtenances as shown and detailed on the Drawings and specified herein. Manhole materials shall be precast concrete.

1.02 RELATED WORK

- A. Section 02731 - Gravity Sewers.
- B. Division 3 - Concrete.
- C. Section 02733 – Sewage Pump Station

1.03 DEFINITIONS

- A. Standard Manhole: A standard manhole is defined as any manhole that is greater than 4 feet in depth, as measured from the invert of the manhole base at its center to the bottom of the manhole frame.
- B. Shallow Manhole: A shallow manhole is defined as any manhole that is 4 feet or less in depth, as measured in the preceding sentence.

PART 2 - PRODUCTS

2.01 CONCRETE MANHOLES - GENERAL

- A. Manholes shall conform in shape, size, dimensions, materials, and other respects to the details indicated on the Drawings or bound in the Specifications.
- B. All concrete manholes shall have precast reinforced concrete developed bases. No other type of base will be allowed. Invert channels shall be factory constructed when the base is made. Sloping invert channels shall be constructed whenever the difference between the inlet and outlet elevation is 2 feet or less.
- C. The concrete manhole walls (barrels and cones) shall be precast concrete sections. The top of the cone shall be built of reinforced concrete adjustment rings to permit adjustment of the frame to meet the finished surface. Minimum strength of the

concrete for the precast sections shall be 4,000 psi at the time of shipment.

- D. For concrete manholes, the inverts of the developed bases shall conform accurately to the size of the adjoining pipes. Side inverts shall be curved and main inverts (where direction changes) shall be laid out in smooth curves of the longest possible radius which is tangent, within the manhole, to the centerlines of adjoining pipelines.
- E. For concrete manholes, the cast-iron frames and covers shall be the standard frame and cover as indicated on the Drawings and specified hereinafter in this Section.
- F. Manholes shall be manufactured by Sherman Dixie, Oldcastle, or equal.

2.02 PRECAST CONCRETE SECTIONS

- A. Precast concrete sections and appurtenances shall conform to the ASTM Standard Specifications for Precast Reinforced Concrete Manhole Sections, Designation C478, latest revision, with the following exceptions and additional requirements.
- B. The base section shall be monolithic for 4-foot diameter manholes. Manholes with diameter of 5 feet or larger shall have base slab.
- C. The wall sections shall be not less than 5 inches thick.
- D. Type II cement shall be used except as otherwise permitted.
- E. Joints between sections shall be made watertight through the use of rubber O-ring gaskets or rubber profile gaskets such as Forsheda 138. Gaskets shall conform to the ASTM Standard C-443, latest revision. Rope mastic or butyl mastic sealant will not be allowed except as noted in Article 2.02 F.
- F. Butyl mastic sealant shall be installed between the cone section, any adjusting sections or rings, and casting.

2.03 CONCRETE MANHOLE - FRAMES AND COVERS

- A. The Contractor shall furnish all cast-iron manhole frames and covers conforming to the details shown on the Drawings, or as herein before specified.
- B. The castings shall be of good quality, strong, tough, evengrained cast iron, smooth, free from scale, lumps, blisters, sandholes, and defects of every nature which would render them unfit for the service for which they are intended. Contact surfaces of covers and frame seats shall be machined to prevent rocking of covers.
- C. All casting shall be thoroughly cleaned and subject to a careful hammer inspection.

- D. Castings shall be at least Class 25 conforming to the ASTM Standard Specifications for Gray Iron Casting, Designation A48, latest revision.
- E. Unless otherwise specified, manhole covers shall be 22-3/4 inches in diameter, weighing not less than 350 pounds per frame and cover. Manhole covers shall set neatly in the rings, with contact edges machined for even bearings and tops flush with ring edge. They shall have sufficient corrugations to prevent slipperiness. The covers shall have two (2) pick holes about 1-1/4 inches wide and 1/2 inches deep with 3/8-inch undercut all around. Covers shall not be perforated. Frames and covers shall be J.R. Hoe and Sons, Mc-350, or approved equal.
- F. All covers shall be marked in large letters "SANITARY SEWER" in the center.

2.04 MANHOLE STEPS (CONCRETE MANHOLES)

Manholes steps shall be the polypropylene plastic type reinforced with a deformed steel rod. The steps shall be of the size and configuration as shown on the Drawings. Steps shall line up over the downstream invert of the manhole. The steps shall be embedded into the manhole wall a minimum of 3-3/8 inches. Steps shall be uniformly spaced at 12-inch to 16-inch intervals.

2.05 PREMOLDED ELASTOMERIC-SEALED JOINTS

All holes for pipe connections in concrete barrels and bases shall have a factory-installed flexible rubber gasket to prevent infiltration. The manhole boots shall conform to the latest revision of ASTM-C973. The boots shall be Contour Seal or Kor-N-Seal made by National Pollution Control Systems, Inc., Nashua, NH; A-Lok Manhole Pipe Seal made by A-Lok Corporation, Trenton, NJ; or an approved equal.

2.06 POLYETHYLENE DIAPHRAGM

- A. Polyethylene diaphragm manhole inserts shall be manufactured from corrosion-proof material suitable for atmospheres containing hydrogen sulfide and diluted sulfuric acid. Diaphragm shall be installed in manholes susceptible to inflow as indicated on the Drawings.
- B. The body of the manhole insert shall be made of high density polyethylene copolymer material meeting ASTM Specification D 1248, Class A, Category 5, Type III (the insert shall have a minimum impact brittleness temperature of -180 degrees fahrenheit). The thickness shall be uniform 1/8 inches or greater. The manhole insert shall be manufactured to dimensions as shown on the Drawings to allow easy installation within the manhole frame.
- C. Gaskets shall be made of closed cell neoprene. The gasket shall have a pressure sensitive adhesive on one side and shall be placed under the weight-bearing surface of

the insert by the manufacturer. The adhesive shall be compatible with the manhole insert material so as to form a long lasting bond in either wet or dry conditions.

- D. Lift strap shall be attached to the rising edge of the bowl insert. The lift strap shall be made of 1 inch wide woven polypropylene web and shall be seared on all cut ends to prevent unraveling. The lift strap shall be attached to the manhole insert by means of a stainless steel rivet. Location of the lift strap shall provide easy visual location.
- E. Standard ventilation shall be by means of vent hole on the sidewall of the manhole insert approximately 3/4-inches below the lip. The vent hole will allow a maximum release of 10 gallons per 24 hours when the insert is full.
- F. The manhole insert shall be manufactured to fit the manhole frame rim upon which the manhole cover rests. The Contractor is responsible for obtaining specific measurements of each manhole cover to insure a proper fit. The manhole frame shall be cleaned of all dirt, scale and debris before placing the manhole insert on the rim.

2.07 CHIMNEY SEALS

Manhole frame seals shall consist of a flexible internal rubber sleeve and extension and stainless steel compression bands, all conforming to the following requirements:

1. Rubber Sleeve and Extension – The flexible rubber sleeve, extensions, and wedge strips shall be extruded or molded from a high grade rubber compound conforming to the applicable requirements of ASTM C-923, with a minimum 1,500 psi tensile strength, maximum 18% compression set and a hardness (durometer) of 48.5”.
2. The sleeve shall be either double or triple pleated, with a minimum unexpanded vertical height of 8 inches and 10 inches respectively and a minimum thickness of 3/16 inches. The top and bottom section of the sleeve shall contain an integrally formed expansion band recess and multiple sealing fins.
3. The top section of the extension shall have a minimum thickness of 3/32 inches and shall be shaped to fit into the bottom band recess of the sleeve under the bottom chimney seal band and the remainder of the extension shall have a minimum thickness of 3/16 inches. The bottom section of the extension shall contain an integrally formed expansion band recess and multiple sealing fins matching that of the rubber sleeve. Any splice used to fabricate the sleeve and extension shall be hot vulcanized and have a strength such that the sleeve shall withstand a 180 degree bend with no visible separation.
4. The continuous wedge strip used to adapt the rubber sleeve to sloping surfaces shall have the slope differential needed to provide a vertical band recess

surface, be shaped to fit into the band recess and have an integral band restraint. The length of the wedge strip shall be such that, when its ends are butted together, it will cover the entire inside circumference of that band recess needing slope adjustment.

5. The expansion bands used to compress the sleeve against the manhole shall be integrally formed from 16 gauge stainless steel conforming to ASTM A-240 Type 304, with no welded attachments and shall have a minimum width of 1 inch. The bands shall have a minimum adjustment range of 2 diameter inches and the mechanism used to expand the band shall have the capacity to develop the pressures necessary to make a watertight seal. The band shall be permanently held in this expanded position with a positive locking mechanism. Any studs and nuts used for this mechanism shall be stainless steel conforming to ASTM F-923 and 594, Type 304.

2.08 CLEANOUTS

Cleanouts shall be extended to finish grade and capped with a clean-out plug in accordance with details and at locations shown on the Drawings. Pipe shall be the same as the gravity sewer line in which the cleanout is located. A 4-inch thick concrete pad, 2 feet 0-inches square, with the valve box lid section, shall be provided around each cleanout.

2.09 DROP CONNECTIONS

Drop connections shall be installed in the manhole as shown on the Drawings.

PART 3 - EXECUTION

3.01 FABRICATION - PRECAST SECTIONS

- A. Manhole sections shall contain manhole steps accurately positioned and embedded in the concrete when the section is cast.
- B. Sections shall be cured in an enclosed curing area and shall attain a strength of 4,000 psi prior to shipment.
- C. No more than two (2) lift holes or inserts may be cast or drilled in each section.
- D. Flat slab tops shall have a minimum thickness of 6 inches and reinforcement in accordance with ASTM C478.
- E. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the precast sections.

- F. Acceptance of the sections will be on the basis of material tests and inspection of the completed product and test cylinders if requested by the Engineer.
- G. Cones shall be precast sections of similar construction.

3.02 SETTING PRECAST MANHOLE SECTIONS

- A. Precast-reinforced concrete manhole sections shall be set so as to be vertical and with sections and steps in true alignment.
- B. Rubber gaskets shall be installed in all manhole joints in accordance with the manufacturer's recommendations.
- C. All holes in sections used for their handling shall be thoroughly plugged with rubber plugs made specifically for this purpose.

3.03 ADJUSTING MANHOLE FRAMES AND COVERS TO GRADE

- A. Except where shown on the Drawings, the top of the precast concrete eccentric cone of a standard manhole or the top of the flat slab of a shallow manhole shall terminate 4 inches below existing grade in an unpaved non-traffic area except in a residential yard and 13 inches below existing grade in a paved or unpaved traffic area and in a residential yard. The remainder of the manhole shall be adjusted to the required grade as described hereinafter in paragraphs B and C of this article.
- B. When a manhole is located in an unpaved non-traffic area other than in a residential yard, the frame and cover shall be adjusted to an elevation 3 inches to 5 inches above the existing grade at the center of the cover. If field changes have resulted in the installed manhole invert elevation to be lower than the invert elevation shown on the Drawings, the adjustment to an elevation of 3 inches to 5 inches above existing grade shall be accomplished by the use of precast concrete rings. If field changes have resulted in the completed manhole invert to be greater than the invert shown on the Drawings and the cover higher than 5 inches above existing grade, then the top of the eccentric cone, when used, or the top of the barrel section, when used, shall be trimmed down so that the manhole cover, after installation, is no greater than 5 inches above existing grade at the center of the cover. The area around the adjusted frame and cover shall be filled with the required material, sloping it away from the cover at a grade of 1 inch per foot.
- C. When a manhole is located in a bituminous, concrete, or crushed stone traffic area, or in a residential yard, the frame and cover shall be adjusted to the grade of the surrounding area by the use of precast concrete rings. The adjusted cover shall conform to the elevation and slope of the surrounding area. If field changes have resulted in the installed manhole invert elevation to be so much higher than the invert elevation shown on the Drawings that the top of the eccentric cone, when used, or the

top of the flat slab, when used, is less than the thickness of the frame and cover 7 inches from the grade of the surrounding area, then the top of the cone or barrel section shall be trimmed down enough to permit the cover, after installation, to conform to the elevation and slope of the surrounding area. After installation, the inside and outside surfaces of the brick shall receive a waterproofing bitumastic coating.

1. The Contractor shall coordinate elevations of manhole covers in paved streets with the Owner. If resurfacing of the street in which sewers are laid is expected within twelve (12) months, covers shall be set 1-1/2 inches above the existing pavement surface in anticipation of the resurfacing operations.

3.04 ADJUSTING SECTIONS

Only clean adjusting sections shall be used. Each adjusting section shall be laid in a bead of butyl mastic sealant and shall be thoroughly bonded.

3.05 SETTING MANHOLE FRAMES AND COVERS

- A. Manhole frames shall be set with the tops conforming to the required elevations set forth herein before. Frames shall be set concentric with the top of the concrete and in a full bead of butyl mastic sealant so that the space between the top of the masonry and the bottom flange of the frame shall be completely watertight.
- B. Manhole covers shall be left in place in the frames on completion of other work at the manholes.

3.06 EXFILTRATION TESTING

The Contractor shall conduct exfiltration tests to ensure that connections and joints in sanitary sewer manholes are watertight. Exfiltration tests shall be performed in accordance with ASTM C 969, Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines. The maximum allowable exfiltration rate shall be 0.1 gallon per foot diameter, per foot of head, per hour. If the exfiltration rate exceeds this value, the Contractor shall make repairs as required **including re-testing**, at no additional costs to the Owner. **Vacuum testing of the sanitary sewer manholes may be used in lieu of the exfiltration test.**

3.07 VACUUM TESTING OF MANHOLES

- A. Manholes shall be tested after installation with all connections in place.
 1. Lift holes, if any, shall be plugged with an approved, non-shrinkable grout prior to testing.
 2. Drop connections shall be installed prior to testing.

3. The vacuum test shall include testing of the seal between the cast iron frame and the concrete cone, slab or grade rings.
4. The manholes shall be backfilled and finished to design grade.

B. Testing Procedure:

1. Temporarily plug, with the plugs being braced to prevent the plugs or pipes from being drawn into the manhole, all pipes entering the manhole at least eight inches into the sewer pipe(s). The plug must be inflated at a location past the manhole/pipe gasket.
2. The test head shall be placed inside the frame at the top of the manhole and inflated, in accordance with the manufacturer's recommendations.
3. A vacuum of 10 inches of mercury shall be drawn on the manhole. The valve on the vacuum line to the manhole shall be shut and the vacuum line disconnected.
4. The pressure gauge shall be liquid filled, having a 3.5-inch diameter face with a reading from zero to thirty inches of mercury.
5. The manhole shall be considered to pass the vacuum test if it holds at least 9 inches of mercury for the following time durations:

<u>Time (Minutes)</u>			
<u>Manhole Depth</u>	<u>4' Dia.</u>	<u>5' Dia.</u>	<u>6' Dia.</u>
20 feet or less	1	2	3
20.1 to 30 feet	2	3	4

6. If a manhole fails the vacuum test, the manhole shall be repaired with a non-shrinkable grout or other suitable material based on the material of which the manhole is constructed and retested, as stated above.
7. All temporary plugs and braces shall be removed after each test.

END OF SECTION 02735

SECTION 02900 - LANDSCAPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to work of this Section.

1.02 DESCRIPTION OF WORK

This section includes furnishing labor, materials, equipment and related items required to complete all landscape plantings as indicated on the Drawings and Specifications as specified, including but not limited to the following:

1. Spreading of topsoil.
2. Seeding and sodding.
3. Furnishing and planting trees and shrubs.
4. Turf and planting maintenance.

1.03 QUALITY ASSURANCE

- A. General: Ship landscape materials with certificates of inspection required by governing authorities. Comply with regulations applicable to landscape materials.
- B. Substitutions: Substitutions will be permitted after Award of Contract only upon submission of proof in writing that a plant is not obtainable and authorization by the Owner for use of the nearest equivalent obtainable size or variety of plant having the same essential characteristics.
- C. Analysis and Standards: Packaged products shall bear manufacturer's certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists, wherever applicable.
- D. All plant materials for this project must come from nurseries located in Zones 5a to 6a as established in the most recent United States Department of Agriculture (USDA) Plant Hardiness Zone Chart.
- E. Topsoil: The Contractor shall be required to take representative soil samples from the area from which topsoil shall be stripped for this project. Samples shall be taken over the entire area in a manner as recommended by the testing agency or laboratory. Samples shall be forwarded to the Engineer office for evaluation. Additional samples will be forwarded for testing by a State or commercial soil testing laboratory using methods approved by the Association of Official Agricultural Chemist or the State Agricultural

Experiment Station. The Contractor shall include this in his bid and shall pay for all tests required.

- F. Inspection of Plants: The Engineer may inspect trees and shrubs either at place of growth or at landscape contractor's nursery before the plants are delivered to the site for compliance with requirements for genus, species, variety, size and quality. The Engineer retains right to further inspect trees and shrubs for size and condition of balls and root systems, insects, injuries and latent defects and to reject unsatisfactory or defective material at any time during progress of work.
- G. Seeding: The Contractor shall present to the Engineer, upon request, receipts of seed bags for assurance of quality and quantity of seeding work performed.

1.04 SUBMITTALS

- A. Certification. Submit certificates of inspection as required by governmental authorities. Submit manufacturer's or vendors certified analysis for soil amendments and fertilizer materials. Submit other data substantiating that materials comply with specified requirements.
 - 1. Submit seed vendor's certified statement for each grass seed mixture required, stating botanical and common name, percentage by weight and percentages of purity, germination and weed seed for each grass seed species.
- B. Maintenance Instructions: Submit three (3) sets of typewritten instructions recommending procedures to be established by Owner for maintenance of landscape work for one (1) full year. Submit prior to final acceptance.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery and while stored at site.
- B. Burlap: Synthetic or treated burlap shall not be used on any tree or shrub scheduled for installation on this project. Any plant ball found to be covered with such burlap shall be removed from the site and replaced with acceptable material.
- C. Sod: Time delivery so that sod will be placed within 24 hours after stripping. Protect sod against drying and breaking of roller strips.
- D. Trees and Shrubs: Provide freshly dug trees and shrubs. Do not prune prior to delivery unless otherwise approved by Owner. Do not bend or bind-tie trees or shrubs in such manner as to damage bark, break branches or destroy natural shape. Provide protective covering during delivery. Do not drop balled and burlapped stock during delivery.

- E. Deliver trees and shrubs after preparations for planting have been completed and plant immediately. If planting is delayed more than 6 hours after delivery, set trees and shrubs in shade, protect from weather and mechanical damage and keep roots moist by covering with mulch, burlap or other acceptable means of retaining moisture.

1.06 JOB CONDITIONS

- A. Proceed with and complete landscape work as rapidly as portions of site become available, working within seasonal limitations for each kind of landscape work required.
- B. Utilities: Determine location of underground utilities and perform work in a manner which will avoid possible damage. Hand excavate as required. Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.
- C. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions or obstructions, notify Owner before planting. Refer to planting notes and Part 3, Execution for more restrictive requirements.
- D. Time of Planting: Planting operations shall be conducted under favorable weather conditions during the planting season extending from October 1 to December 15 or March 1 to May 15. At the option of and with full responsibility for the plantings, the Contractor may conduct limited planting operations under unseasonable weather conditions without additional compensation or any waiver of the guarantee if requested in writing by the Contractor and approved by the Owner.
- E. Time of Seeding: Seeding operations shall be conducted under favorable weather conditions during the season extending from August 15 to October 15 or March 1 to May 1. At the option of and with full responsibility for the seeding, the Contractor may work under unseasonable weather conditions without additional compensation.
- F. Time of Sodding: Sodding operation shall be conducted any time when weather conditions are suitable and the ground is dry enough and not frozen.
- G. Coordination with Lawns: Plant trees and shrubs after final grades are established and prior to planting of lawns unless otherwise acceptable to the Owner. If planting of trees and shrubs occurs after lawn work, protect lawn areas and promptly repair damage to lawns resulting from planting operations.

1.07 PLANT GUARANTEE AND REPLACEMENT

- A. Guarantee: Plants shall be guaranteed for the duration of one (1) full year after the formal acceptance of the planting by the Owner and shall be alive and in satisfactory growth at the end of the guarantee period. The Owner shall be responsible for all maintenance

necessary to keep the plants alive and healthy between the time the plantings are accepted and the end of the guarantee period. The basic needs of the plants during this period are for adequate water and protection from insects and other similar pests.

- B. Seeded or sodded lawn areas are subject to a one (1) year guarantee, and new lawns shall be alive, vigorous and healthy at time of final acceptance.
- C. The Contractor shall check the plantings regularly. Should the Contractor find the plant material is not receiving the proper maintenance at any time prior to the end of the guarantee period, he should advise the Owner immediately in writing so corrective measures may be initiated.
- D. Replacement: At the end of the guarantee period, inspection will be made by the Owner upon receipt of written or verbal notice requesting such inspection submitted by the Contractor at least ten (10) days prior to the anticipated date. Any plant required under this Contract that is dead or not satisfactory in growth as determined by the Owner shall be removed from the site. These, and any plants missing due to the Contractor's negligence, shall be replaced as soon as conditions permit but during the normal planting season.
- E. Any plant that has die-back or otherwise loses over 30 percent or more of its branches, excluding branches removed by trimming required under "Pruning and Repair", as existing and living prior to removal from the nursery field shall be rejected.
- F. The Contractor shall be responsible for removing dead or diseased plants from the site during the guarantee period when notified by the Owner of dead materials. Replacements shall be made only at the end of the guarantee period as described herein.
- G. Material and Operations: All replacements shall be plants of the same kind and size as specified in the Plant List. They shall be furnished and planted as specified under "New Planting", the cost of which shall be borne by the Contractor.
- H. Replaced plants are not subject to a full one (1) year guarantee, but replacements must be alive and vigorous when inspected after planting and must leaf out fully in the spring if replacements are made while the plant is dormant.
- I. Cost of Plant Replacement: A sum sufficient to cover the estimated cost of possible replacements, including materials and labor, shall be retained by the Owner and paid to the Contractor at the end of the guarantee period after all replacements have been made and approved. The minimum retainage shall be seven (7) percent of the total cost of planting. A larger percentage shall be withheld if the condition of the plantings indicate the potential value of replacements will exceed the minimum retainage.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Existing topsoil shall be stripped and stockpiled. Should inadequate topsoil be available within the stockpile to complete the specified work, the Contractor shall furnish at his own expense sufficient topsoil of the quality described herein to complete the work.
 - 1. The Contractor shall furnish a soil analysis and reports as performed by the Agricultural Extension Service or commercial testing laboratory for any areas from which topsoil is to be stripped or used for this project. The soil shall be tested for nutritional content, organic matter and texture. The Contractor shall incorporate necessary additives in proper quantities as recommended in the soil analysis, or as necessary to bring the soils up to acceptable standards.
 - 2. Topsoil shall be original surface loam obtained from well-drained areas from which topsoil has not been removed previously, either by erosion, clearing and removal of trees or mechanical means. It shall not contain subsoil material and shall be clean and free of clay lumps, roots, stones or similar substances more than 1 inch in diameter, debris, discarded fragments of building materials or weeds and weed seeds. Topsoil shall be classified as a loam, silt loam, clay loam or a combination thereof, as determined from the Bureau of Plant Industry, Soils and Agricultural Engineering, U.S.D.A. Triangular soil texture chart. It shall be rich, friable loam containing not less than 3 percent, nor more than 10 percent, by weight of organic matter as determined by loss on ignition of oven dried samples. The ignition test shall be performed on samples which have been thoroughly oven dried at a temperature of 221 degrees fahrenheit.
- B. Commercial fertilizer shall be complete fertilizer, 10-10-10, or as specified and shall conform to the applicable state fertilizer laws. Fertilizer shall be uniform in composition, dry and free-flowing and shall be delivered to the site in the original, unopened containers, each bearing the manufacturer's guaranteed analysis. Any fertilizer which becomes caked or otherwise damaged will not be accepted.
- C. Herbicide shall be an approved commercial grade pre-emergent herbicide used in soil preparation. The particular type of herbicide shall be certified safe for the plants specified in the Plant List or for the plants around which the herbicide shall be used.
- D. Lime shall be ground limestone (Dolomite) containing not less than 85 percent of total carbonates and shall be ground to a fineness that 50 percent will pass through a 100-mesh sieve and 90 percent will pass through a 20-mesh sieve. Coarser material shall be acceptable provided that specified rates of application are increased proportionally on the basis of quantities passing the 100-mesh sieve.
- E. Peat shall be a domestic product consisting of partially decomposed vegetable matter of natural occurrence. It shall be brown, clean, low in content of mineral and woody materials, mildly acid and granulated or shredded.

- F. Aluminum sulfate shall be a commercially available agricultural chemical and shall be furnished under the manufacturer's guaranteed statement of analysis giving percentage of active ingredients.
- G. Ammonium nitrate shall be a commercially available agricultural chemical and shall be furnished under the manufacturer's guaranteed statement of analysis giving percentage of active ingredients.
- H. Bark mulch shall be an approved, clean, sterilized pine or fir bark, chipped to a uniform size not to exceed a length of 2 inches or a thickness of 1/2-inch. It shall be decay and fire resistant, non-toxic to plant material and shall have a maximum water content of 18 percent and an average weight of 17 to 20 pounds per cubic foot. The bark shall be screened to remove sawdust and fine shavings and shall contain no hardwood or sapwood.
- I. Water: The Contractor shall provide, at no additional expense, an adequate supply of water to meet the needs of this Contract. The Contractor shall furnish all necessary hoses, equipment, attachments and accessories for the adequate irrigation of planted areas as may be required to complete the work as specified.
- J. Watering plants to be installed in tree planting pits shall be perforated PVC and ADS corrugated pipe in individual lengths as required for the specific ball sizes as detailed in the Plant List.
- K. French drain shall be polyethylene perforated drain pipe 4 inches diameter, corrugated and wrapped with high-modulus geotextile filter fabric meeting or exceeding ASTM D1248 with Class C pigments with a minimum of 4 percent black color concentrate for ultraviolet protection.
- L. Materials for Staking, Guying and Wrapping:
 - 1. Stakes shall be 7 feet to 8 feet long, heavy duty "T" section fence posts, painted a dark brown.
 - 2. Wire for fastening trees to stakes shall be No. 10 gauge pliable, galvanized iron.
 - 3. Hose to encase wire used for fastening trees to stakes shall be new or used two-ply reinforced rubber garden hose, black or green in color. Only one color shall be used throughout the project.
- M. Lawn Materials:
 - 1. Sod shall be well-rooted, nursery grown on a mat, 100 percent Rebel Fescue or approved mix of similar fescues (KY 31 not acceptable) completely free of noxious weeds and grasses. It shall be mowed to a height not to exceed 2" before lifting and shall be of uniform thickness, with not over 1-1/4 inches or less than 1-inch of soil and shall be approved by the Owner before planting.
 - 2. Seed shall be mixed and guaranteed by the dealer to be as shown in the following table:

Common Name	Proportion by Weight	Percent Purity	Percent Germination
Rebel Fescue (or equal)	100%	98%	90%

N. Plant Materials (See Plant Material List):

1. Nomenclature: The names of plants required under this Contract conform to those given in Standardized Plant Names, 1942 Edition, prepared by the American Joint Committee on Horticultural Nomenclature. Names of varieties not included therein conform generally with names accepted in the nursery trade.
2. Quantities: Quantities necessary to complete the planting as shown in the following Plant Material List and located as directed by the Owner.

Plant Material List

Quantity	Botanical Name	Common Name	Caliper	Min. Spread	Height	Ball Dia.	No. Cane
0	<i>Acer rubrum</i> "Red Sunset"	Red Sunset Maple	2"	4'	12'	28"	1
0	<i>Acer compostre</i> "Postelense"	Hedge Maple	2"	4'	10'	24"	1
0	<i>Cornus florida</i> "Cloud 9"	Flowering Dogwood	2"	4'	10'	24"	1
0	<i>Fraxinus Americana</i> "Autumn Purple"	Autumn Purple Ash	2"	5'	12'	30"	1
0	<i>Fraxinus pennsylvanica</i> "Emerald"	Green Ash	2"	4'	12'	28"	1
0	<i>Platanus occidentalis</i>	American Sycamore	2"	5'	12'	28"	1
0	<i>Quercus rubra</i>	Red Oak	2"	4'	12'	28"	1

3. Quality and Size: Plants shall have a habit of growth that is normal for the species and shall be sound, healthy, vigorous stock, grown in a recognized nursery in accordance with good horticultural practice and free of disease, insects, eggs, larvae and defects such as knots, sun-scald, injuries, abrasions or disfigurement. All plants shall equal or exceed the measurements specified in the Plant Material List that are minimum acceptable sizes. They shall be measured before pruning with branches in normal position. Any necessary pruning shall be done at the time of planting (see "Pruning and Repairs"). Requirements for the measurement, branching, grading, quality, balling and burlapping of plants in the Plant List generally follow or exceed the Code of Standards currently recommended by the American Association of Nurserymen, Inc. in the American Standard for Nursery Stock ANSI Z60.1.
4. Type of Protection to Roots:
 - a. Balled and Burlapped Plants: Plants shall be balled and burlapped unless otherwise noted on the Drawings. They shall be dug with firm, natural balls of earth of sufficient diameter and depth to encompass the fibrous and

feeding roots system necessary for full recovery of the plant and of minimum sizes shown on the Plant List. Balls shall be firmly wrapped with untreated burlap or similar material and bound with twine, cord or wire mesh. Where necessary to prevent breaking or cracking of the ball during the process of planting, the ball may be secured to a platform.

- b. Container-grown Plants: Designated for "containers" in the Plant List shall have been grown in containers such as pots, cans, tubs or boxes and have sufficient roots to hold earth together intact after removal without being rootbound. Container size shall be in proportion to plant size and in accordance with the AAN Standards. The Owner shall have the option to reject container-grown material if the growing media is too porous to hold adequate water for the plant's survival without watering more than once a week.
 - c. Protection after Delivery: The balls of plants which cannot be planted immediately upon delivery shall be covered with moist soil or mulch or provided with other protection from drying winds and sun. All plants shall be watered as necessary until planted.
- O. Anti-Desiccant: Emulsion type, film-forming agent designed to permit transpiration but retard excessive loss of moisture from plants. Deliver in manufacturer's fully identified containers and mix in accordance with manufacturer's instructions.

PART 3 - EXECUTION

3.01 PREPARATION

Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations and outline areas and secure Owner's acceptance before start of planting work. Make minor adjustments as may be requested.

3.02 OBSTRUCTION BELOW GROUND OR OVERHEAD

- A. It is not contemplated that planting shall be done where the depth of soil over underground construction, obstructions or rock is insufficient to accommodate the roots or where pockets in rock or impervious soil will require drainage. Where such conditions are encountered in excavation of planting areas and where the stone, boulders or other obstructions cannot be broken and removed by hand methods in the course of digging plant pits of the usual size and where trees to be planted are found to be under overhead wires, other locations for the planting may be designated by the Owner.
- B. Removal of rock or other underground obstruction, relocation of construction and provisions of drainage for planting areas shall be done only as approved by the Owner.
- C. Should the landscape contractor encounter unsatisfactory surface or subsurface drainage

conditions, soil depth, latent soils, hard pan, steam or other utility lines or any other conditions that will jeopardize the health and vigor of the plantings, he must advise the Owner in writing of the conditions prior to installing the plants. Otherwise, the landscape contractor warrants that the planting areas are suitable for proper growth and development of the plants to be installed.

3.03 PREPARATION FOR PLANTING LAWNS

- A. All areas disturbed by the Contractor's operation, not scheduled for other improvements, shall be seeded or sodded. See Drawings for more detailed requirements.
- B. Preparation of Subgrade: All areas to be planted in lawn, except as specified below, shall be subsoiled by disking, harrowing or tilling. The term "subsoiling" as used herein means the mechanical cleavage of the subsoil without major displacement or inversion of the existing soil horizon. It is the purpose of this operation to rupture the subsoil, creating cracks and fissures to a depth of 6 inches, except where rock or other equally resistant material is encountered. All subgrades for lawns shall be subsoiled on slopes of 3:1 or less, lawn areas with slopes greater than 3:1 shall not be subsoiled. When subsoiling operation is complete, all stones over 1-inch in size, sticks and rubbish shall be removed, and the surface graded and lightly compacted so that it will be parallel to the proposed finish grade. No heavy objects, except lawn rollers, shall be moved over lawn areas after the subgrade soil has been prepared, unless the subgrade soil is again graded and loosened as specified above before topsoil is spread.
- C. Topsoil Placement and Finish Grading: After the subgrade soil has been prepared, topsoil shall be spread evenly thereon and lightly compacted. No topsoil shall be spread in a frozen or muddy condition. Topsoil shall be spread to a minimum depth of 6 inches on all areas to be seeded or sodded and shall be graded to lines, grades and/or contours shown on the Drawings and/or specified. The finish surface shall be smooth and free of bumps, depressions or other irregularities or foreign materials. In areas where the original existing topsoil is still in place and relatively undisturbed, except for compaction, additional topsoil will not be required.
 - 1. Allowance for settlement shall be made.
 - 2. Areas where the topsoil has not been removed shall be scarified, smoothed and sticks, stones and rubbish shall be removed.
- D. Soil Preparation: Soil used in planting shall be topsoil as previously specified and shall be amended in accord with the soil test results. Newly prepared topsoil backfill will be required in all planting areas unless specifically exempted by notes on the Drawings.
 - 1. Topsoil shall be spread to a minimum depth of 6" inches in all lawn areas.
- E. Soil Improvements: Fertilizer shall be applied at the rate of 20 pounds of 10-10-10 per 1,000 square feet or as recommended by the testing laboratory. Limestone shall be thoroughly mixed into the topsoil at a rate of 20 pounds per 1,000 square feet or as recommended by the testing laboratory and as far ahead of seeding as will not interfere

with other grading operations. If areas to be sodded have been heavily compacted, they shall be disked, rolled and drug to prepare a suitable growing media.

F. Seeding of Lawns:

1. Sowing of Seed: Immediately before any seed is to be sown, the ground shall be scarified as necessary and shall be raked until the surface is smooth, friable and of uniformly fine texture. Lawn areas shall be seeded evenly with a mechanical drilling seeder at the rate of 7 pounds per 1,000 square feet of area, lightly raked and rolled with a 200-pound roller and watered with a fine spray. The method of seeding may be varied at the discretion of the Contractor, on his own responsibility to establish a smooth, uniform turf composed of the grasses specified. The sowing of seed shall be done only within the seasons extending from March 1 to May 1 and from August 15 to October 15 unless other seasons may be approved by the Owner.
2. Mulching: All seeded areas having a slope of 4 to 1 or greater shall be mulched with a straw and asphalt mat or with a spray mulch of an approved latex-type material.
3. Straw and asphalt mat shall be applied at the rate of 1-1/2 tons of straw per acre (70 pounds per 1,000 square feet), and 480 gallons of asphalt per acre (11 gallons per 1,000 square feet). Asphalt shall either be emulsified RS-1 grade or cutback RC-1 grade. The method of application may be: (1) by spreading the straw evenly over the seeded area after which the asphalt tie-down is sprayed over the straw in a solid pattern, or (2) by applying the mat in one operation by a jet-type mulch spreader in which the straw and asphalt are sprayed in mixture evenly over the area.
4. Spray mulch of a latex-type material shall be applied by hydrojet method at the rate of 75 gallons of concentrate mixed in 1,000 gallons of water per acre (23 gallons per 1,000 square feet).

G. Laying of Sod:

1. Before any sod is laid, all soft spots and inequalities in grade shall be corrected. Fertilizer spread shall be raked in. Sod shall be laid so that no voids occur, tamped or rolled and then watered thoroughly. The complete sodded surface shall be true to finished grade, even and firm at all points.
2. Sod on slopes steeper than 2 1/2 to 1 shall be held in place by wooden pins about 1 inch square and about 6 inches long, driven through the sod into the soil until they are flush with the top of the sod or by other Owner approved methods for holding the sod in place. Stakes shall be spaced along the centerline of a strip of sod at intervals of approximately 3 feet.
3. During dry periods, sod must be watered as it is laid.
4. The Contractor shall sod all lawn areas as shown on the Drawings.

3.04 NEW PLANTING

- A. Layout: New planting shall be located where shown on the Drawings except where obstructions below ground or overhead are encountered or where changes have been made in the construction. Necessary adjustments shall be made only after approval by the

Owner. No planting, with the exception of ground cover, espalier plants and hedge, shall be placed closer than 2 feet to pavement or structures. The landscape contractor shall be responsible for staking and layout of plantings on this project. The Owner shall be advised when stakes are in place and ready for inspection on various planting areas. All layout work shall be inspected and approved by the Owner prior to opening any plant pits.

- B. Planting Pits: Reasonable care shall be exercised to have pits dug and soil prepared prior to moving plants to their respective locations for planting to insure that they will not be unnecessarily exposed to drying elements or to physical damage. However, no open holes shall be left overnight or unmarked or unattended.
 - 1. Before planting any area, fill a representative sample of the excavated planting pits and beds with water to a depth of 6 inches or more as required to verify if the subsoil is permeable enough to percolate satisfactorily and drain adequately after plants are installed. Advise the Owner in writing if any problems are anticipated regarding excessive ground water or unsuitable percolation.
- C. Soil Preparation:
 - 1. Soil use in planting shall be topsoil as previously specified and shall be amended in accord with the soil test results. Newly prepared topsoil backfill will be required in all planting areas unless specifically exempted by notes on the Drawings.
 - 2. Topsoil shall be spread to a minimum depth of 15 inches in all shrub planting beds and ground cover beds.
 - 3. Width of shrub beds shall be equal to three (3) times the width of the root ball.
 - 4. Fertilizer shall be placed in each tree or shrub planting pit at a depth of 6 inches to 8 inches when the plant is set in place. The exact quantity and distribution shall be in strict accordance with the soil test results.
 - 5. Additional fertilization may be required prior to acceptance of plantings or individual plants that are visibly in a weakened or stressful condition.
- D. Excess excavated soil shall be disposed of by the Contractor.
- E. Setting Plants: Unless otherwise specified, all plants shall be planted in pits, centered and set to such depth that the finished grade level at the plant after settlement will be the same as that at which the plant was grown.
 - 1. Prior to setting container-grown plants, make four to five cuts 1/2-inch to 1 inch deep, top to bottom on rootbound mass to loosen roots.
 - 2. Plants shall be planted upright and faced to give the best appearance or relationship to adjacent structures.
 - 3. All cords and bindings shall be cut from plants prior to planting. The top one-third of burlap shall be removed from the root ball prior to backfilling. All broken or frayed roots shall be cut off cleanly.
 - 4. Topsoil shall be placed and compacted carefully to avoid injury to roots and to fill all voids. When the hole is nearly filled, add water as necessary to allow it to soak away. Fill the hole to finished grade. After the ground settles, additional soil shall be filled in, to the level of the finished grade.

- F. Watering pipes shall be set adjacent to each tree ball at the time of planting and backfilled with washed river gravel 1/4-inch to 3/8-inch diameter.
- G. Guying and Staking: Trees shall be supported immediately after planting. All trees shall be staked as detailed and shown on the Drawings. Wires shall be encased in hose to prevent direct contact with the bark of the tree and shall be placed around the trunk in a single loop. Wires shall be tightened and kept taut by the use of turnbuckles. Stakes shall be equally spaced about each tree and shall be driven vertically into the ground to a depth of about 2 feet in such a manner as not to injure the ball or roots. Trees shall be fastened to each stake at a height of about 5 feet by means of two (2) strands of wire. Stakes shall be uniform in length and placed according to the type, the type, size and location of the tree as follows:
1. Shade trees up to 1-3/4 inches in caliper shall be anchored with one (1) 7 foot or 8 foot diagonal stake and guy wires per Planting Detail.
 2. Shade trees 2 inches in caliper and larger shall anchored with two (2) equally spaced 7 feet or 8 feet stake and guy wires per Planting.
 3. Ornamental trees (conifers) to 6 feet in height, anchor with one (1) 7 foot or 8 foot diagonal stake per Planting Detail.
 4. Ornamental trees (conifers) over 6 feet in height, anchor with two (2) equally spaced 7 foot or 8 foot stakes and guy wires per Planting Detail.
 5. Ornamental trees (deciduous and broadleaf evergreen) to 2-1/2 inches in caliper, anchor with one (1) 7 foot or 8 foot diagonal stake per Planting Detail.

The Contractor shall remove the stakes and wires one (1) year after the trees have been planted, unless otherwise directed by the Owner.

- H. Wrapping: Promptly after planting, the trunks of all trees, except conifers, shall be wrapped spirally from the groundline to the height of the second branches. Overlap half of each spiral to form a double wrapping. All wrapping shall be neat and snug, and the material shall be held in place by a suitable cord.
- I. Herbicide Treatment: All tree saucers and ground cover beds shall be treated after plants have been installed with an approved pre-emergent herbicide material applied in strict conformance with rates and methods recommend by the manufacturer. Plants installed during the fall planting seasons shall be treated with the approved herbicide during the first week of April of the following year. Plants installed in the spring shall be treated with the approved herbicide immediately after installation. Herbicide shall be cleared by the manufacturer as safe for use around plants itemized in the Plant List.
- J. Mulching: Tree and shrub beds shall be mulched as noted in the Planting Details or as shown on the Drawings. This mulch shall cover the entire bed area and shall have a neat and well-defined edge between lawn area and shrub bed. Trees in lawn areas with individual saucers shall be mulched with 2 inches of bark mulch.

- K. Pruning and Repair: All pruning and repair work must be completed within a ten (10) day period after planting. The amount of pruning included under the work of this Section shall be limited to the minimum necessary to remove dead or injured twigs and branches and to compensate for the loss of roots as a result of transplanting operations.
1. Trees and some shrubs will be pruned back after planting to maintain a balance between the reduced root system and the branches. Care will be taken in this work to insure that the plants preserve their natural form. Branches shall be pruned to reduce total leaf area by 20 percent on all trees 3 inch in caliper and larger and on all deciduous and broadleaf evergreen shrubs 36 inches in height or spread or larger.
 2. The natural form of newly planted trees and shrubs will be preserved in pruning by the removal of branches and/or part of branches at different lengths in accord with standard horticulture practices and as directed by the Owner. Pruning will always be done with a clean cut in living wood without bruising or tearing of bark and without leaving any stubs which would prevent the wound from healing over. Horizontal cuts may cause rot and will be avoided. Larger cuts, 3/4-inch or more in diameter, will be painted with two (2) coats of orange shellac.

3.05 CLEAN-UP

- A. Clean-up: Any soil, bark, peat or similar material which has been brought onto paved areas within or outside the construction area by hauling operations or otherwise shall be removed promptly, keeping these areas clean at all times. Upon completion of the planting, all excess soil, stones and debris which have not been cleaned up shall be removed from the site or disposed of as directed by the Owner. All planting areas shall be prepared for final inspection.
- B. Other Work: The Contractor shall be responsible for the repair of any damage caused by his activities or those of his subcontractors within or outside the construction area such as the storage of topsoil or other materials, operation of equipment and other usages. Such repair operations shall include any regarding, sodding or other work necessary to restore damaged work or areas to a condition acceptable to the Owner.

3.06 MAINTENANCE

- A. Maintenance shall begin immediately following the last operation of installation for each portion of lawn and for each plant and shall continue until installation of planting is complete and the planting is formally accepted by the Owner. Maintenance shall include mowing, watering, weeding, cultivating, mulching, removal of dead material, resetting plants to proper grades or upright position and restoration of the planting saucer and other necessary operations. Any damage resulting from planting operations shall be repaired promptly.
- B. Seeded areas shall be protected and maintained by watering, regular mowing and replanting as may be necessary to produce a uniform stand of grass. Maintenance shall continue until a dense, uniform turf is established composed of the grass specified, and

shall include repair of damage caused by erosion until acceptance. For the purpose of an acceptable standard, scattered bare spots, none of which is larger than one square foot, will be allowed up to a maximum of 3 percent of any lawn area.

- C. Sodded areas shall be watered and mowed regularly and replanted until all sod is in place and ready for inspection. Maintenance shall continue until acceptance of the project and for at least thirty (30) days after installation of the sod.
- D. The Owner shall be responsible for all required maintenance after the planting is formally accepted.

3.07 INSPECTION FOR ACCEPTANCE

- A. Inspection of the work of this Section to determine completion of the Contractor's work, exclusive of the possible guarantee replacement of plants, shall be made by the Owner upon receipt of written notice requesting such inspection submitted by the Contractor at least ten (10) days prior to the anticipated date of inspection.
- B. Acceptance: After inspection, the Contractor will be notified in writing by the Owner of acceptance of all work of this Section, exclusive of the possible replacement of plants subject to guarantee or the Contractor will be notified in writing if there are any deficiencies from the requirements for completion of the work. Replacement, maintenance and repair work remaining to be done shall be subject to reinspection before acceptance. All seeded and sodded areas and all plants shall be alive and in a healthy and vigorous condition at the time of the final inspection.

END OF SECTION 02900

SECTION 02930 - SEEDING AND SODDING

PART 1 - WORK INCLUDED

1.01 CLEAN-UP

Upon completion of the Project, the Contractor shall remove all debris and surplus construction materials resulting from his work. The Contractor shall grade the ground along each side of the pipe trenches and/or structures in a uniform and neat manner leaving the construction area in a shape as near as possible to the original ground line, or as shown on the Drawings.

PART 2 - PRODUCTS

2.01 SEED

Grass seed shall be mixed and guaranteed by the supplier to consist of the following:

Annual Rye	60 percent
Kentucky Bluegrass	20 percent
Falcon Fescue	20 percent

2.02 TOPSOIL

Topsoil shall be material stripped and stored under work of Section 02200 and shall be used for all work under this Section. If the quantity of stored topsoil is inadequate or if none has been salvaged from the Project site, the Contractor shall furnish at his own expense sufficient topsoil to properly install all work as specified herein. Topsoil shall be original surface loam obtained from well drained areas from which topsoil has not been removed previously, either by erosion, clearing and removal of trees or mechanical means. It shall not contain subsoil material and shall be clean and free of clay lumps, roots, stones or similar substances more than 2 inches in any dimension, debris, discarded fragments of building materials or weeds and weed seeds.

2.03 SOIL IMPROVEMENTS

- A. Commercial fertilizers shall be of analyses specified, or as recommended by the Agricultural Extension Service for treatment of topsoil in the area from which removed, and shall conform to the applicable state fertilizer laws. Fertilizer shall be uniform in composition, dry and free flowing, and shall be delivered to the site in the original, unopened containers, each bearing the manufacturer's guaranteed analysis. Any fertilizer which becomes caked or otherwise damaged, making it unsuitable for use, will not be accepted.
- B. Lime, if recommended for soil treatment by the Agricultural Extension Service, shall

be ground limestone (Dolomite) containing not less than 85 percent of total carbonates, and shall be ground to such a fineness that 50 percent will pass through a 100-mesh sieve, and 90 percent will pass through a 20-mesh sieve. Coarser material shall be acceptable provided that required rates of application are increased proportionally on the basis of quantities passing the 100-mesh sieve.

PART 3 - EXECUTION

3.01 SEEDING AND SODDING

- A. After installation of the Project, topsoil shall be spread evenly to a minimum 4-inch depth and lightly compacted. No topsoil shall be spread in a frozen or muddy condition.
 - 1. Any stored topsoil remaining after work is in place shall be disposed of by the Contractor as directed by the Engineer.
- B. Soil improvement shall be made if and as recommended by the Agricultural Extension Service prior to seeding.
 - 1. Ground limestone, if required, shall be applied at the recommended rates per square yard and shall be thoroughly mixed into the topsoil.
 - 2. Fertilizers, if required shall be of analysis and rates per square yard as recommended in the topsoil analysis and shall be mixed lightly in the top few inches of topsoil.
- C. Immediately before any seed is to be sown, the ground shall be scarified as necessary and shall be raked until the surface is smooth, friable and of a uniformly fine texture. Areas shall be seeded evenly with a mechanical spreader at a rate of 2 pounds per 1,000 square feet, lightly raked and watered with a fine spray.
- D. After seed has been distributed, the Contractor shall cover areas that are likely to washout with straw to a depth of 1-1/2 inches.
- E. Seeded areas shall be protected and maintained by watering, regular mowing and reseeded as may be necessary to produce a uniform stand of grass. Maintenance shall continue throughout the guarantee period until a dense, uniform turf is established.
- F. All paved streets, roads, sidewalks, curbs, fences, stonewalls, lawns, etc., disturbed during construction shall be restored, repaired, or replaced to as good a condition as existed prior to construction. All materials and workmanship shall conform to standard practices and specifications of the Owner and/or the Kentucky Department of Highways, whichever applies.
- G. The Contractor shall remove from the site all equipment, unused materials and other items at his expense. The construction site shall be left in a neat, orderly condition,

clear of all unsightly items, before the Work is finally accepted.

END OF SECTION 02930

Division 3 – Concrete

SECTION 03100 - CONCRETE FORMWORK

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Formwork for cast-in-place concrete, with shoring, bracing, and anchorage.
- B. Openings for other affected work.
- C. Form accessories.
- D. Stripping forms.

1.02 RELATED WORK

- A. Section 03210 - Reinforcing Steel.
- B. Section 03251 - Expansion and Contraction Joints.
- C. Section 03310 - Structural Concrete.

1.03 REFERENCES

- A. ACI 301 - Specifications for Structural Concrete for Buildings.
- B. ACI 347 - Recommended Practice for Concrete Formwork.
- C. PS 1 - Construction and Industrial Plywood.
- D. ACI 318 - Building Code Requirements for Reinforced Concrete.
- E. ACI 350 R - Environmental Engineering Concrete Structures.

1.04 SYSTEM DESCRIPTION

Design, engineer and construct formwork, shoring, bracing to meet design and code requirements so that resultant concrete conforms to required shapes, lines, dimensions and tolerances.

1.05 QUALITY ASSURANCE

Construct and erect concrete formwork in accordance with ACI 301 and 347, latest revisions.

PART 2 – PRODUCTS

2.01 FORM MATERIALS

- A. Plywood; Douglas Fir species; medium density overlaid one side grade; sound, undamaged sheets with straight edges.
- B. Glass fiber fabric reinforced plastic forms; matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to structural tolerances and appearance of finished concrete surface.
- C. Forms shall be sufficiently rigid to prevent displacement or sagging between supports and so constructed that the concrete will not be damaged by their removal. The Contractor shall be entirely responsible for their adequacy.
- D. For surfaces to be given a rubbed finish, the form surface in contact with the concrete shall be made of heavy gage metal, new plywood (used plywood may not be used), tempered wood fiberboards with smooth surface, or similar material. Metal forms or form linings shall have square edges so that the concrete will not have fins or fluting. Forms shall not be pieced out by use of material different from those in the adjacent form or in such manner as will detract from the uniformity of the finished surface.
- E. For surfaces other than those to be given a rubbed finish, forms shall be made of wood, metal, or other acceptable material. Wooden forms shall be constructed of sound lumber or plywood of suitable dimensions, free from knotholes and loose knots. Plywood shall be reasonably good as accepted. Metal forms shall be of an acceptable type for the work involved. Edges of forms in contact with concrete shall be flush within 1/16-inch.
- F. Forms for walls, columns, or piers shall have removable panels at the bottom for cleaning, inspection, and scrubbing in of bonding grout. Forms for thin sections (such as walls or columns) of considerable height shall be arranged with suitable openings so that the concrete can be placed in a manner that will prevent segregation and accumulations of hardened concrete on the forms or reinforcement above the fresh concrete, unless special spouts are used to place concrete, and so that construction joints can be properly keyed and treated.
- G. Forms for exposed surfaces shall be built with 3/4-inch chamfer strips attached to produce smooth, straight chamfers at all sharp edges of concrete.
- H. All forms shall be oiled with an acceptable nonstaining oil or liquid form coating before reinforcement is placed.
- I. Before form material is reused, all surfaces that are in contact with the concrete shall be thoroughly cleaned, all damaged places repaired, and all projecting nails withdrawn.

2.02 FORMWORK ACCESSORIES

- A. Form ties to be encased in concrete shall not be made of through bolts or common wire, but shall be made and installed as to embody the following features:
 - 1. After removal of the protruding part of the tie, there shall be no metal nearer than 1 inch to the face of the concrete.
 - 2. That part of the tie which is to be removed shall be at least 1/2-inch in diameter, or if smaller, it shall be provided with a wood or metal cone 1 inch long placed against the inside of the forms. Cones shall be carefully removed from the concrete after the forms have been stripped.
 - 3. Ties which pass through walls subject to hydrostatic pressure shall be provided with acceptable water stops, such as washers, securely fastened to the ties.
- B. Form Release Agent: Colorless material which will not stain concrete, absorb moisture or impair natural bonding or color characteristics of coating intended for use on concrete. Form oil shall be placed prior to reinforcing steel when possible and surplus oil on form surfaces or reinforcing steel shall be removed.
- C. Fillets for Chamfered Corners: Chamfer strips shall be 1-inch, 45-degree angle with a leg, polyvinyl chloride strips by Greenstreak, Inc. St. Louis, MO, or equal.
- D. Dovetail Anchor Slots: Minimum 10 gage thick galvanized steel; foam filled; release tape sealed slots; bent tab anchors securable to concrete formwork.
- E. Nails, spikes, lag bolts, through bolts, anchorages: Sized as required of strength and character to maintain formwork in place while placing concrete.
- F. Tapered tie-through bolts that will not remain encased in concrete may be used to secure concrete forms upon review and approval by the Engineer. A watertight sure plug with non-shrink grout (dry pack) shall be used to fill the void made by the tapered tie-through bolt. The vinyl plug shall be as manufactured by Dayton Superior Corporation, Miamisburg, Ohio, or equal. Installation shall be in accordance with the manufacturer's recommendation and as approved by the Engineer.

PART 3 - EXECUTION

3.01 INSPECTION

Verify lines, levels and measurements before proceeding with formwork.

3.02 PREPARATION

Earth forms not permitted except for continuous strip footings of buildings.

3.03 ERECTION

- A. Provide bracing to ensure stability of formwork. Strengthen formwork liable to be overstressed by construction loads.
- B. Camber slabs and beams to achieve ACI 301 tolerances.
- C. Provide temporary ports in formwork to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain. Close ports with tight fitting panels, flush with inside face of forms, neatly fitted so that joints will not be apparent in exposed concrete surfaces.
- D. Concrete surfaces not exposed to view shall be formed with sound tight lumber or other material producing equivalent finish.
- E. Concrete surfaces to be exposed to view shall be formed with material that is not reactive with concrete surfaces and shall be equivalent in smoothness and appearance to that produced by new plywood panels conforming to PS 1, exterior type Grade B-B.

3.04 APPLICATION OF RELEASE AGENT

Apply form release agent on formwork in accordance with manufacturer's instructions. Apply prior to placing reinforcing steel, anchoring devices, and embedded items.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings where required for work embedded in or passing through concrete.
- B. Coordinate work of other sections in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.
- C. Install accessories in accordance with manufacturer's instructions, level and plumb. Ensure items are not disturbed during concrete placement.

3.06 FORM REMOVAL

- A. Do not remove forms and bracing until concrete has sufficient strength to support its own weight and construction and design loads which may be imposed upon it. Remove load supporting forms when concrete has attained 75 percent of required 28-day compressive strength, provided construction is reshored.
- B. Reshore structural members due to design requirements or construction conditions to permit successive construction.
- C. Remove formwork progressively so that no unbalanced loads are imposed on structure.

- D. Do not damage concrete surfaces during form removal.

3.07 CLEANING

- A. Clean forms to remove foreign matter as erection proceeds.
- B. Ensure that water and debris drain to exterior through clean out ports.
- C. During cold weather, remove ice and snow from forms. Do not use deicing salts. Do not use water to clean out completed forms unless formwork and construction proceed within heated enclosure. Use compressed air to remove foreign matter.

END OF SECTION 03100

SECTION 03210 - REINFORCING STEEL

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Reinforcing steel.
- B. Shop Drawings.

1.02 RELATED WORK

- A. Section 03100 - Concrete Formwork.
- B. Section 03251 - Expansion and Contraction Joints.
- C. Section 03310 - Structural Concrete.

1.03 REFERENCES

- A. ASTM A-615.
- B. ASTM A-616.
- C. ASTM A-617.
- D. ACI 351.
- E. ASTM A-120.
- F. ASTM A-185.

1.04 SUBMITTALS

- A. Shop Drawings: The Contractor shall submit a complete set of shop drawings including schedules and bending drawings for all reinforcement used in the work in accordance with the "Manual of Standard Practice for Detailing Concrete Structures" (ACI 351).
- B. Submittals: The Contractor shall submit the shop drawings in accordance with Section 00700 and Section 01300.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. The minimum yield strength of the reinforcement shall be 60,000 pounds per square inch. Bar reinforcement shall conform to the requirements of ASTM A-615, A-616, or A-617. All bar reinforcement shall be deformed.
- B. Smooth dowels shall be plain steel bars conforming to ASTM A-615, Grade 40, or steel pipe conforming to ASTM A-120, Schedule 80. Pipe, if used, shall be closed flush at each end with mortar or metal or plastic cap.
- C. Welded wire fabric shall conform to ASTM 185, welded steel wire fabric for concrete reinforcement.
- D. Reinforcement supports and other accessories in contact with the forms for members which will be exposed to view in the finished work shall have approved high density polyethylene tips so that the metal portion shall be at least 1/4-inch from the form or surface. Supports for reinforcement, when in contact with the ground or stone fill, shall be precast stone concrete blocks.

2.02 FABRICATION

- A. Reinforcement shall be bent cold. It shall be bent accurately to the dimensions and shapes shown on the plans and to within tolerances specified in the CRSI Manual of Standard Practice.
- B. Reinforcing shall be shipped with bars of the same size and shape, fastened securely with wire and with metal identification tags giving size and mark.

PART 3 - EXECUTION

3.01 PLACING AND FASTENING

- A. Before being placed in position, reinforcement shall be cleaned of loose mill and rust scale, dirt and other coatings that will interfere with development of proper bond.
- B. Reinforcement shall be accurately placed in positions shown on the Drawings and firmly held in place during placement and hardening of concrete by using annealed wire ties. Bars shall be tied at all intersections except where spacing is less than 1 foot in both directions, then alternate intersections may be tied.

- C. Distance from the forms shall be maintained by means of stays, blocks, ties, hangers or other approved supports. If fabric reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.
- D. Before any concrete is placed, the Engineer shall have inspected the placing of the steel reinforcement and given permission to deposit the concrete. Concrete placed in violation of this provision will be rejected and thereupon shall be removed.
- E. Unless otherwise specified, reinforcement shall be furnished in the full lengths indicated on the Drawings. Splicing of bars, except where shown on the Drawings, will not be permitted without the approval of the Engineer. Where splices are made, they shall be staggered insofar as possible.
- F. Wire mesh reinforcement shall be continuous between expansion joints. Laps shall be at least one full mesh plus 2 inches, staggered to avoid continuous lap in either direction and securely wired or clipped with standard clips.
- G. Dowels shall be installed at right angles to construction joints and expansion joints. Dowels shall be accurately aligned parallel to the finished surface, and shall be rigidly held in place and supported during placing of the concrete. One end of dowels shall be oiled or greased or dowels shall be coated with high density polyethylene with a minimum thickness of 14 mils.

END OF SECTION 03210

SECTION 03251 - EXPANSION AND CONTRACTION JOINTS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Forming integral contraction and control joints in concrete.
- B. Visually concealing expansion joints in concrete.

1.02 RELATED WORK

- A. Section 03100 - Concrete Formwork.
- B. Section 03310 - Structural Concrete.
- C. Section 01300 - Submittals.

1.03 SUBMITTALS

The Contractor shall submit shop drawings and/or cut sheets for review in accordance with Specification Section 01300.

PART 2 - PRODUCTS

2.01 INTEGRAL JOINT MATERIALS

- A. Waterstop: PVC, minimum 1750 PSI tensile strength, -51 degrees F to +175 degrees F working temperature range; flat profile; corrugated flaps, large split center bulb; size as noted on the Drawings (or 6 inches if not shown).
- B. Waterstop: Hydrophilic type, having a minimum cross sectional dimension of 3/16" x 3/4". Hydrophilic waterstops shall be bentonite-free and shall expand by a minimum of 80 percent of dry volume when exposed to moisture to form a watertight joint without damage to the concrete. Hydrophilic waterstops shall be used only as indicated on the drawings or as otherwise approved by the engineer.
- C. Formed Construction Joints: Galvanized steel, tongue and groove type; with removable top strip exposing sealant trough knockout holes spaced at 6 inches on center, ribbed steel spikes with tongue to fit top screed edge.
- D. Joint Filler: ANSI/ASTM D994, bituminous impregnated fiberboard; closed cell neoprene; self-expanding cork; of the sizes detailed and in the locations indicated on the Drawings. Bituminous impregnated fiberboard shall not be used to fill joints in liquid

retaining structures.

2.02 EXTERNAL JOINT COVERS

Joint covers: ANSI/ASTM B221; alloy extruded aluminum retainers with resilient neoprene filler strip; extruded aluminum cover plate; 25 shore hardness; to permit plus or minus 50 percent joint movement; of longest manufactured length; mounted as detailed; with anchors.

2.03 SEALANTS

Sealant and Caulking: Specified in Section 07900.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Locate and form expansion control and contraction joints.
- B. Install waterstops continuous without displacing reinforcement. All joints between adjacent continuing and intersecting sections of waterstops including butt joints, tee joints, and other angled joints shall be heat fused to form a watertight seal. Waterstops shall not be lapped.
- C. Place formed construction joints in slabs or walls as detailed on the Drawings or as directed by the Engineer. Set top screed to required elevations. Secure to resist movement of wet concrete.
- D. Install joint cover anchorage in accordance with manufacturer's instructions. Set cover as detailed in the Drawings or as directed by the Engineer.
- E. Install joint fillers and sealants in accordance with manufacturer's instructions. Use primers of type recommended by joint filler and sealant manufacturer.
- F. Apply sealants in accordance with Section 07900.
- G. Install joint covers after adjacent construction activity is complete.

END OF SECTION 03251

SECTION 03310 - STRUCTURAL CONCRETE

PART 1 - GENERAL

1.01 WORK INCLUDED

The work in this section shall include all formwork, shoring, bracing, anchorage, concrete reinforcement and accessories for cast-in-place concrete.

1.02 GENERAL REQUIREMENT

All concrete construction shall conform to all applicable requirements of ACI 301, ACI 318 and ACI 350 R, except as modified by the supplemental requirements specified herein.

1.03 RELATED WORK

- A. Section 02222 - Excavation.
- B. Section 03100 - Concrete Formwork.
- C. Section 03370 - Concrete Curing.
- D. Section 04200 - Unit Masonry.
- E. Section 05500 - Miscellaneous Metals, Fasteners, and Special Finishes.

1.04 REFERENCES

- A. The Contractor shall obtain and have available in the field office at all times the following references:
 - 1. Specifications for Structural Concrete for Building ACI 301 (latest revision).
 - 2. Field Reference Manual: Specifications for Structural Concrete for Buildings ACI Sp-15(88).
 - 3. Manual of Standard Practice - CRSI (latest revision).
 - 4. Placing Reinforcing Bars - CRSI (latest revision).
 - 5. Building Code Requirements for Reinforced Concrete ACI 318.
 - 6. Environmental Engineering Concrete Structures ACI 350R.
- B. The following standard shall also apply to this work:
 - 1. ASTM C-143.
 - 2. ASTM C-150.
 - 3. ASTM C-33.
 - 4. ASTM C-260.

5. ASTM C-494.
6. ASTM A-615.
7. ASTM D-638.
8. ASTM D-695.
9. ASTM D-570.
10. ASTM D-1252.
11. ASNI A-116.1.
12. ASTM A-120.
13. ASTM C-94.
14. ASTM D-2146.
15. Federal Specifications FF-S-325.

1.05 SUBMITTALS

- A. The Contractor shall submit the following data to the Engineer for review:
 1. Proposed mix designs, test results, plotted curves and all other substantiating data as required by Sections 3.8 and 3.9 of ACI 301.
 2. Mix designs for all mixes proposed or required to be used, including all mixes containing admixtures.
 3. A certified copy of the control records of the proposed production facility establishing the standard deviation as defined in Section 3.9 of ACI 301.
- B. Certification attesting that admixtures equal or exceeds the physical requirements of ASTM C-494 for Type A admixture and when required, for Type D admixture.
- C. Notarized certifications by the manufacturer that epoxy bonding adhesive meets the specification contained herein.
- D. Drawings showing locations of all proposed construction joints.
- E. Shop drawing for reinforcing steel showing bar schedules, location, and splices.

1.06 QUALITY ASSURANCE

- A. Consistency:
 1. Concrete shall be of such consistency that it can be worked readily into all parts of the forms and around embedded work, without permitting the materials to segregate, or free water to collect on the surface. Consistency shall be measured by the ASTM Standard Test Method for Slump of Portland Cement Concrete, Designation C143-78. The consistency of concrete shall be as given in Table I.
 2. Slump tests shall be made in the field by the Contractor, as directed by the Engineer.
- B. Compression Tests:
 1. During the progress of the work, at least one set of four compression test cylinders

shall be made for each 50 cubic yards of concrete or major fraction thereof, and not less than one such set for each type of concrete for each days' pouring. Cylinders made in the field shall be made and cured in accordance with ASTM Standard Method of Making and Curing Concrete Test Specimens in the Field, Designation C31-69, except that wherever possible molds shall be left on cylinders until they have reached the laboratory.

2. One (1) cylinder of each set shall be broken in accordance with ASTM C-39 at seven (7) days and two (2) at twenty-eight (28) days. Two (2) copies of these test results shall be submitted to the Engineer on the same day of the tests. The remaining cylinder shall be reserved for future testing if required.
3. On evidence of these tests, any concrete that fails to meet the specified strength requirements shall be strengthened or replaced as directed by the Engineer at the Contractor's expense.

C. Inserts in Concrete by Other Trades:

1. All trades shall be notified, at the proper time, to install items to be embedded in concrete.
2. All castings, inserts, conduits, and other metalwork shall be accurately built into or encased in the concrete by the Contractor as directed and all necessary precautions shall be taken to prevent the metalwork from being displaced or deformed.
3. Anchor bolts shall be set by means of substantial templates.
4. The Contractor shall build into new concrete against which facing brick or tile is to be laid, suitable, acceptable, non-corrodible metal, dovetail grooves for ties for securing the brickwork to the concrete.

D. Testing:

1. All testing shall be in accordance with provisions of ACI 301.
2. Testing services to meet the requirements of ACI shall be paid for in accordance with Section 01400 – QUALITY CONTROL, Part 1.06 Cash Allowance.”

E. Additional Requirements:

1. Unless otherwise directed by the Engineer, the vertical surfaces of all footings shall be formed. Excavations and reinforcement for all footings shall have been inspected by the Engineer before any concrete is placed.
2. The installation of underground and embedded items shall be inspected before slabs are placed. Pipes and conduits shall be installed below the concrete unless otherwise indicated. Fill required to raise the subgrade shall be placed as specified in Division 2. Unless shown otherwise, porous fill not less than 6 inches in compacted thickness shall be installed under all slabs, tank bottoms, and foundations. The fill shall be leveled and uniformly compacted to a reasonably true and even surface. The surfaces shall be clean, free from frost, ice, mud and water. Where indicated, waterproof paper, polyethylene sheeting of nominal 4-mil minimum thickness, or polyethylene coated burlap shall be laid over surfaces receiving concrete. Structures having pressure relief valves shall have a free draining granular stone layer of not less than 12” directly beneath the base slab.

- F. Hot Weather Requirements: Placing of concrete under conditions of high temperatures, low humidity or wind shall be done in accordance with the American Concrete Institute "Hot Weather Concreting" (ACI 305R-77).
- G. Cold Weather Requirements: Cold weather concreting procedures and precautions shall conform with American Concrete Institute "Cold Weather Concreting" (ACI 306 R-78).

PART 2 - PRODUCTS

2.01 Contractor shall supply concrete only from an approved ready mixed concrete supplier.

2.02 CONCRETE MIX WITHOUT FLY ASH

Structural concrete required for this project shall be proportioned by Section 3.9 of ACI 301 to produce the following 28-day compressive strengths:

- A. Selection of Proportions for Class A Concrete:
 - 1. 4,500 psi compressive for strength at 28 days.
 - 2. Type II cement plus water reducing, dispersing agent and air. Type IP cement may be used in place of Type II.
 - 3. Maximum water/cement plus water reducing dispersing agent ratio = 0.42.
 - 4. Minimum cement content = 564 pounds (6.0 bags)/cubic yards concrete.
 - 5. Nominal maximum size coarse aggregate = No. 67 (3/4-inch maximum) or No. 57 (1-inch maximum).
 - 6. Air content = 6 percent plus or minus 2 percent by volume.
 - 7. Slump = 2 inches to 3 inches in accordance with ASTM C-143.

2.03 OPTIONAL CONCRETE MIX USING FLY ASH

- A. Selection of Proportions for Class A Concrete:
 - 1. 4,500 psi compressive for strength at 28 days.
 - 2. Type II cement plus water reducing dispersing agent and air.
 - 3. Maximum (water)/(cement plus water reducing dispersing agent) ratio = 0.42.
 - 4. Minimum cement content = 517 pounds (5.5 bags)/cubic yards concrete.
 - 5. Maximum Fly Ash Content = 71 pounds/cubic yards
 - 6. Nominal maximum size coarse aggregate = No. 67 (3/4-inch maximum) or No. 57 (1-inch maximum).
 - 7. Air content = 6 percent plus or minus 2 percent by volume.
 - 8. Slump = 2 inches to 3 inches in accordance with ASTM C-143.
- B. Applicable Standards:
 - 1. ANSI C 311-77 "Standard Methods of Sampling and Testing Fly Ash for Use as an Admixture in Portland Cement Concrete".
 - 2. ANSI C 618-80 "Standard Specification for Fly Ash and Raw or Calcined Natural

Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete".

- C. All concrete work shall use Class A concrete.
- D. All testing shall be or have been performed by an approved independent testing laboratory.
- E. Cement for exposed concrete shall have a uniform color classification.
- F. Type II cement conforming to ASTM C-150 shall be used in all structural concrete. The alkali content shall not exceed 0.6 percent calculated as sodium oxide. Type IP Cement may be used in place of Type II cement.
- G. Coarse aggregate shall conform to all requirements of ASTM C-33.
- H. Manufactured sand shall not be used as fine aggregate in concrete.

2.04 FLY ASH CONCRETE

- A. In the absence of a verified and acceptable history of fly ash concrete mixes, the following procedure is required to establish the quality of the concrete mix.
- B. Trial batches must be made starting thirty (30) days ahead of initial concrete pour. Four (4) mixes shall be designed and produced at no cost to the Owner or the Engineer as follows:
 - 1. Mix using Type II cement with water reducing admixture for normal temperatures (Class A).
 - 2. Mix using Type II cement with water reducing admixture for cold weather temperatures (Class A).
 - 3. Mix using Type II cement with water reducing admixture for hot weather temperatures (Class A).
- C. Four (4) test cylinders shall be cast for each of the three (3) mixes. Two (2) cylinders shall be broken at 7 days, and two (2) cylinders shall be broken at 28 days, for each of the three (3) mixes. The trial batch design report shall include strength breaks at 7 days and 28 days, air content, etc.
- D. The water-reducing, cement dispersing admixture (such as Master Builders Pozzolith 344-N, Nox-Crete Plastiflow, Plastocrete 161 by Sika Chemical Company, or approved equal) used in fly ash concrete, shall be a normal, accelerated, or retarded hardening admixture. The admixture shall be used at optimum dosage to offset the slow strength development and setting characteristics of the fly ash. Only those brands of admixture that can provide readily available field service on short notice to provide field services, inspection, and assistance, will be acceptable.

- E. Prior to the use of fly ash concrete, recent mill reports shall be submitted on a regular basis during the project. Maximum loss of ignition (LOI) shall be 6 percent.
- F. Tests for air content shall be made twice a day at the jobsite prior to pouring, for all mixes containing fly ash.

2.05 ADMIXTURES

- A. An air entraining admixture shall be used on all concrete and shall be the neutralized vinsol resin type such as Master Builders MB-VR, or Euclid Chemical Co. AIR-MIX or equal. The admixture shall meet the requirements of ASTM C-260. Certification attesting to the percent of effective solids and compliance of the material with ASTM C-260 shall be furnished, if requested.
- B. A water reducing, set controlling admixture (non-lignin type) shall be used in all concrete. The admixture shall be a combination of polyhydroxylated polymers including catalysts and components to produce the required setting time based on job site conditions, specified early strength development, finishing characteristics required, and surface texture, as determined by the Engineer.
- C. Certification shall be furnished attesting that the admixture exceeds the physical requirements of ASTM C-494, Type A, water reducing and normal setting admixture, and when required, for ASTM C-494, Type D, water reducing and retarding admixture when used with local materials with which the subject concrete is composed.
- D. The admixture manufacturer, when requested, shall provide a qualified concrete technician employed by the manufacturer to assist in proportioning concrete for optimum use. He also will be available when requested to advise on proper addition of the admixture to the concrete and on adjustment of the concrete mix proportions to meet changing job conditions.
- E. The use of admixtures to retard setting of the concrete during hot weather, to accelerate setting during cold weather, and to reduce water content without impairing workability will be permitted if the following conditions are met.
- F. The admixture shall conform to ASTM C-494 except that the durability factor for concrete containing the admixture shall be at least 100 percent of control, the water content a maximum of 90 percent of control and length change shall not be greater than control, as defined in ASTM C-494.
- G. Where the Contractor finds it impractical to employ fully the recommended procedures for hot weather concreting, the Engineer may at his discretion require the use of a set retardant admixture for mass concrete greater than 2.5 feet thick and for all concrete whenever the temperature at the time concrete is cast exceeds 80 degrees F. The admixture shall be selected by the Contractor subject to the review of the Engineer. The

admixture and concrete containing the admixture shall meet all the requirements of these Specifications. Preliminary tests of this concrete, provided the test results satisfy the requirements of the Contract Documents, shall be paid for in accordance with Section 01400 – QUALITY CONTROL, Part 1.06 Cash Allowance.

- H. Admixtures shall be used in concrete design mixes in the same manner and proportions as in the field so that the effects of the admixtures are included in preliminary tests submitted to the Engineer for review prior to the start of construction.
- I. When more than one admixture is used, all admixtures shall be compatible. They should preferably be by the same manufacturer.
- J. Calcium chloride will not be permitted as an admixture in any concrete.

2.06 WATER

The water for concrete shall be clean, fresh, and free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances. Mix water shall also be potable.

2.07 AGGREGATES

- A. Fine aggregates shall be natural sand having clean, hard, uncoated grains, free from injurious amounts of clay, dust, organic matter or other deleterious substances, and shall conform to ASTM C-33.
- B. Coarse aggregates shall be crushed stone having clean, hard, uncoated particles, and shall be free from injurious amounts of soft, friable, thin, elongated or laminated pieces. Shale may not be used as aggregate. Coarse aggregates shall conform to ASTM C-33 and shall not exceed the following maximum sizes:
 - 1. 3/4-inch for slabs, beams, girders, and walls.
 - 2. 1-inch for all other concrete.

2.08 TESTING AGGREGATES AND DETERMINING PROPORTIONS

- A. No concrete shall be used in the work until the materials and mix design have been accepted by the Engineer.
- B. The conformity of aggregates to the specifications hereinbefore given shall be demonstrated and determined by tests per ASTM C-33 made with representative samples of the materials to be used on the work.
- C. The actual proportions of cement, aggregates, admixtures and water necessary to produce concrete conforming to the requirements set forth shall be determined by making test cylinders using representative samples of the materials to be used in the work. A set of four (4) standard 6-inch cylinders shall be made and cured per ASTM C-31. Two (2) shall

be tested at 7 days and two (2) at 28 days per ASTM C-39. The slump shall not be less than the greatest slump expected to be used in the work.

- D. Reports on the tests and a statement of the proportions proposed for the concrete mixture, shall be submitted in triplicate to the Engineer for review as soon as possible, but not less than five (5) days prior to the proposed beginning of the concrete work. If the Contractor furnishes in writing, similar, reliable detailed information from an acceptable source, and of date not more than four (4) months prior to the time when concrete will be used on this project, the above requirements for laboratory tests may be modified by the Engineer. Such data shall derive from mixtures containing constituents, including the admixtures where used, of the same types and from the same sources as will be used on this project.
- E. The Engineer shall have the right to make check tests of aggregates and concrete, using the same materials, and to order changes as may be necessary to meet the specified requirements.
- F. The Contractor may request permission to add water at the job site, and when the addition of water is permitted by the Engineer, the quantity added shall be the responsibility of the Contractor and in no case shall the total water per bag of cement exceed that determined by the designed mix.
- G. All concrete exposed to weather, such as foundations, walls, exterior steps and retaining walls, etc. shall be air entrained.
- H. If concrete of the required characteristics is not being produced as the work progresses, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure concrete of the specified quality. The Contractor shall make such changes at his own expense and no extra compensation will be allowed because of such changes.

2.09 MIXING

All central plant and rolling stock equipment and methods shall conform to the Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers' Bureau of the National Ready Mixed Concrete Assn., as well as the ACI Standards for Measuring, Mixing and Placing Concrete (ACI 614), and with Sections 7 to 14, inclusive, of the ASTM Standard Specification for Ready Mixed Concrete, Designation C94-78a, insofar as applicable.

2.10 WATERSTOPS

See Section 03251 - Expansion and Contraction Joints.

PART 3 - EXECUTION

3.01 PLACING AND COMPACTING CONCRETE

- A. At least 24 hours before the Contractor proposes to make any placement of concrete, he shall notify the Engineer of his intention and planned procedure. Unless otherwise permitted, the work shall be so executed that a section begun on any day shall be completed during daylight of the same day.
- B. Ready mixed concrete shall be transported to the site in watertight agitator or mixer trucks. The quantity of concrete to be mixed or delivered in any one batch shall not exceed the rated capacity of the mixer or agitator for the respective conditions as stated on the nameplates.
- C. Central mixed concrete shall be plant mixed a minimum of 1-1/2 minutes per batch, and then shall be truck mixed or agitated a minimum of 8 minutes. Agitation shall begin immediately after the premixed concrete is placed in the truck and shall continue without interruption until discharge. For transit mixed concrete, the major portion of the mixing water shall be added and mixing started immediately after the truck is charged.
- D. The amount of water initially added shall be recorded on the delivery slip for the Engineer's information, no additional water shall be added, either in transit or at the site, except as directed. Mixing (at mixing speed) shall be continued for at least 10 minutes followed by agitation without interruption until discharge. Concrete shall be discharged at the site within 1-1/2 hours after water was first added to the mix, and shall be mixed at least 5 minutes after all water has been added.
- E. Concrete that has become compacted or segregated during transportation to or on the site of the work shall be satisfactorily remixed just prior to being placed in the forms.
- F. Partially hardened concrete shall not be deposited in the forms. The retempering of concrete that has partially hardened (that is, the remixing of concrete with or without additional cement, aggregate, or water) will not be permitted.
- G. The concrete shall be mixed only in the quantity required for immediate use. Concrete that has developed an initial set shall not be used. The Contractor shall have sufficient plant capacity and transporting apparatus to insure continuous delivery at the rate required.
- H. The temperature of the concrete mixture immediately before placement shall be between 50 degrees F and 90 degrees F.
- I. Concrete mixed in stationary mixers and transported by non-agitating equipment shall be placed in the forms within 45 minutes from the time ingredients are charged into the

mixing drum. Concrete that is truck mixed or transported in truck mixers or truck agitators shall be delivered to the site of the work and discharge completed in the forms within the time specified in paragraph 10.7 of ASTM C-94, except that when the concrete temperature exceeds 85 degrees F, the time shall be reduced to 30 minutes. Transmit mixed concrete that is completely mixed at the site of concrete placement or batched cement and aggregates transported to mixers shall be placed in the forms within 1-1/2 hours after cement has been added. Concrete shall be placed in the forms within 15 minutes after discharge from the mixer at the job site.

- J. If concrete is placed by pumping, no aluminum shall be used in any parts of the pumping system that contact or might contaminate the concrete. Aluminum chutes and conveyors shall not be used.
- K. No concrete shall be placed on frozen subgrade or in water, or until the subgrade, forms, and preliminary work have been accepted. No concrete shall be placed until all materials to be built into the concrete have been set and have been accepted by the various trades and by the Engineer. All such materials shall be thoroughly clean and free from rust, scale, oil, or any other foreign matter.
- L. Forms and excavations shall be free from water and all dirt, debris, and foreign matter when concrete is placed. Except as otherwise directed, wood forms and embedded wood called for or allowed shall be thoroughly wetted just prior to placement of concrete.
- M. Concrete placed at air temperatures below 40 degrees F shall have a minimum temperature of 50 degrees F and a maximum of 70 degrees F when placed.
- N. Chutes for conveying concrete shall be metal or metal lined and of such size, design, and slope as to ensure a continuous flow of concrete without segregation. The slope of chutes shall have approximately the same slope. The discharge end of the chute shall be provided with a baffle, or if required, a spout and the end of the chute. The spout shall be kept as close as practicable to, but in no event more than 5 feet above the surface of the fresh concrete. When the operation is intermittent, the chute shall discharge into a hopper.
- O. In thin sections of considerable height (such as walls and columns), concrete shall be placed in such manner as will prevent segregation and accumulations of hardened concrete on the forms or reinforcement above the mass of concrete being placed. To achieve this end, suitable hoppers spouts with restricted outlets, etc. shall be used as required or permitted unless the forms are provided with suitable openings.
- P. Chutes, hoppers, spouts, etc. shall be thoroughly cleaned before and after each run and the water and debris shall not be discharged inside the form.
- Q. For any one placement, concrete shall be deposited continuously in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently

to cause the formation of seams and planes of weakness within the section, and so as to maintain until the completion of the unit, an approximately horizontal plastic surface.

- R. No wooden spreaders shall be left in the concrete.
- S. During and immediately after being deposited, concrete shall be thoroughly compacted by means of suitable tools and methods, such as internal type mechanical vibrators operating at not less than 5,000 rpm. or other tool spading to produce the required density and quality of finish. Vibration shall be done only by experienced operators and shall be carried in such manner and only long enough to produce homogeneity and optimum consolidation without permitting segregation of the solid constituents, "pumping" of air, or other objectionable results.
- T. The concrete shall be thoroughly rodded and tamped about embedded materials so as to secure proper adhesion and prevent leakage. Care shall be taken to prevent the displacement of such materials during concreting.
- U. The distance between construction joints shall not exceed 50 feet for all concrete construction and not less than 48 hours shall elapse between casting of adjoining units unless these requirements are waived by the Engineer. Provision shall be made for jointing successive units as indicated or required. Where joints are not shown on the Drawings, they are required to be made at a spacing of approximately 25 feet. Additional construction joints required to satisfy the 25 foot spacing requirement shall be located by the Contractor subject to the review of the Engineer. The Contractor shall submit for review Drawings separate from the steel reinforcing Drawings, showing the location of all proposed construction joints. All construction joints shall be prepared for bonding as specified in paragraph 6.1.4.3 of ACI Standard 301 and Section 3.02 Bonding Concrete at Construction Joints. Joints in walls and columns shall be maintained level.
- V. Formwork for beam soffits and slabs and other parts that support the weight of concrete shall remain in place until the concrete has reached its specified 28-day strength, unless otherwise specified or permitted.

3.02 BONDING CONCRETE AT CONSTRUCTION JOINTS

- A. In order to secure full bond at construction joints, the surface of the concrete previously placed (including vertical, inclined, and substantially horizontal areas) shall be thoroughly cleaned of foreign materials and laitance, if any, and then roughened.
- B. The previously placed concrete at the joint shall be free of standing water.
- C. Waterstops shall be used on all construction joints below water level and as otherwise indicated on the drawings.

3.03 CURING AND PROTECTION

- A. All concrete, particularly slabs and including finished surfaces, shall be treated immediately after concreting or cement finishing is completed, to provide continuous moist curing for at least seven days, regardless of the adjacent air temperature. Walls and vertical surfaces may be covered with continuously saturated burlap, or kept moist by other acceptable means. Horizontal surfaces, slabs, etc., shall be ponded to a depth of 1/2-inch wherever practicable, or kept continuously wet by the use of lawn sprinklers, a complete covering of continuously saturated burlap, or by other acceptable means.
- B. For at least seven days after having been placed, all concrete shall be so protected that the temperature at the surface will not fall below 45 degrees F. The methods of protecting the concrete shall be as specified in that section of the General Specifications titled "Precautions During Adverse Weather" and shall be subject to the review of the Engineer.
- C. No manure, salt, or other chemicals shall be used for protection.
- D. The above mentioned 7-day periods may be reduced to 3 days in each case if high-early-strength cement is allowed to be used in the concrete.
- E. Wherever practicable, finished slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

3.04 TRIMMING AND REPAIRS

- A. The Contractor shall use suitable forms, mixture of concrete, and workmanship so that concrete surfaces, when exposed, will not require patching. Concrete which, in the opinion of the Engineer has excessive honeycomb, aggregate pockets, or depressions will be rejected and the Contractor shall, at his own expense remove the entire section containing such defects and replace it with acceptable concrete.
- B. As soon as the forms have been stripped and the concrete surfaces exposed, fins and other projections shall be removed, recesses left by the removal of form ties shall be filled and surface defects which do not impair structural strength shall be repaired.
- C. Defective concrete shall be cut perpendicular to the surface until sound concrete is reached, but not less than 1-inch deep. The remaining concrete shall be thoroughly roughened and cleaned. Concrete around the cavity or the form tie recess shall be thoroughly wetted and promptly painted with a 1/16-inch brush coat of neat cement mixed to the consistency of thick paint. The hole shall then be filled with mortar.
- D. Mortar shall be 1:1-1/2 cement and sand mix with sufficient white cement, or fine limestone screening in lieu of sand, to produce a surface matching the adjoining work. Cement and sand shall be from the same sources as in the parent concrete.

- E. Mortar in patches shall be applied so that after partial set it can be compressed and rubbed to produce a finish flush and uniform in texture with the adjoining work. All patches shall be warm-moist cured as above specified.
- F. The use of mortar patching as above specified shall be confined to the repair of small defects in relatively green concrete. If substantial repairs are required, the defective portions shall be cut out to sound concrete and the defective concrete replaced by means of a cement gun, or the structure shall be taken down and rebuilt, all as the Engineer may decide or direct.

3.05 FINISHES

- A. Exposed to View Concrete Surfaces:
 - 1. All concrete exposed to view in the completed structure shall be produced using materials and workmanship to such quality that only nominal finishing will be required. The provisions of paragraphs 13.3, 13.4, and 13.6 of ACI shall apply to all exposed to view concrete surfaces (limited to 1 foot below grade and 1 foot below the minimum liquid level for structures that will contain liquids).
 - 2. Forms for exposed concrete surfaces shall be exterior grade, high density overlay plywood, steel, or wood forms with smooth tempered hard board form liners.
 - 3. Forms shall be coated with Nox-Crete Form Coating Release Agent, Debond Form Coating by L & M Construction Chemicals, Inc. or an approved equal, before initial pour and between subsequent pours, in accordance with the manufacturer's printed instructions. Form boards shall not be wet with water prior to placing concrete.
 - 4. Recessed joints in concrete shall be formed using lacquer coated wooden battens or forms, milled to indicated profiles. Battens and corner strips shall be carefully inspected before concrete is placed and damaged pieces replaced.
 - 5. Chamfer strips shall be 1-inch radius with leg, polyvinyl chloride strips by Gateway Building Products, Saf-T-Grip Specialties Cor., Vinylex Corp., or equal.
 - 6. Particular attention is directed to the requirements of paragraphs 10.2.2 and 13.3 of ACI 301. Form panels shall be provided in the maximum form joints. Wherever practicable, form joints shall occur at recessed joints. All form joints in exterior exposed to view surfaces shall be carefully caulked with an approved nonstaining caulking compound. Joints shall not be taped. Form oil or other material which will impart a stain to the concrete shall not be allowed to contact concrete surfaces.
 - 7. Care shall be taken to prevent chipping of corners or other damage to concrete when forms are removed. Exposed corners and other surfaces which may be damaged by ensuing operations shall be protected from damage by boxing, corner boards or other approved means until construction is completed.
 - 8. Form ties shall remain in the walls and shall be equipped with a waterseal to prevent passage of water through the walls. Particular care shall be taken to bend tie wire ends away from exposed faces of beams, slabs and columns. In no case shall ends to tie wires project toward or touch formwork. Minimum set back of form ties shall be 1 inch from faces of wall. The hole left by removal of tie ends shall be sealed and grouted as per ACI Par. 9.3 and in accordance with procedure

described hereinafter in Par. 3.04.E. Form ties will be permitted to fall within as cast areas of architecturally treated wall surfaces (ACI Chapter 13); this does not apply to walls receiving textured decorative waterproof masonry coating.

9. All formed exposed to view concrete shall be prepared as paragraph 3.04 B, then receive a grout-cleaned finish. The grout-cleaned finish shall use a mix of one part white Portland cement and 1½ parts of fine sand mixed with sufficient water to form a grout having the consistency of thick paint. Apply to damp surface and rub down in such a manner as to obtain a smooth, filled surface uniform in color and free from defects and blemishes. Exterior vertical surfaces shall be finished to one foot below grade. Interior exposed to view vertical surfaces of dry pits shall be finished full height, interior vertical surfaces of liquid containers shall be finished to one foot below the minimum liquid level that will occur during normal operations.
 10. Slope all slabs to prevent water pocketing.
- B. All vertical surfaces below minimum liquid level in liquid containing structures shall have a smooth form finish.
 - C. All smooth form concrete vertical surfaces shall be true plane within 1/4-inch in 10 feet as determined by a 10 foot straight edge place anywhere on the surface in any direction. Abrupt irregularities shall not exceed 1/8-inch.
 - D. Basin, flume, conduit and tank floors shall have a "troweled" finish unless shown otherwise on Drawings.
 - E. Weirs and overflow surfaces shall be given a troweled finish.
 - F. Exterior platforms, steps and landings shall be given a broom finish. Broom finish shall be applied to surfaces which have been steel troweled to an even smooth finish. The troweled surface shall then be broomed with a fiber bristle brush in the direction transverse to that of the main traffic.
 - G. Walking surfaces of slabs shall have a troweled finish unless shown otherwise on Drawings.
 - H. Patching of holes due to removal of tie ends and other repairable defective areas shall be as follows: Entire contact area of hole shall be coated with two part moisture insensitive epoxy bonding compound in accordance with manufacturer's specifications, and prior to placing of freshly mixed patching mortar. Patching mortar shall be mixed and placed in general accordance with ACI Par. 9.2.2, 9.2.3, and 13.6.
 - I. Nox-Crete Harbeton, Chem Hard by L & M Construction Chemicals hardener treatment, or an approved equal shall be applied to all exposed concrete floors in occupied spaces. The floors shall be thoroughly cured, cleaned, and perfectly dry with all work above them completed. The hardener shall be applied evenly and freely and in conformance with manufacturer's instructions, using not less than three (3) coats, allowing 24 hours between

coats. One gallon of hardener shall cover not more than 100 square feet. After the final coat is completed and dry, surplus hardener shall be removed from the surface of the concrete by scrubbing and mopping with water.

3.06 CONCRETE WALKS AND CURBS:

- A. Subgrade shall be true and well compacted at the required grades. Spongy and otherwise unsuitable material shall have been removed and replaced with properly compacted, approved material. Concrete walks shall be placed upon 8-inch DGA unless noted otherwise on the Drawings.
- B. Concrete walks shall be not less than 4 inches in thickness. Walks shall have contraction joints every 5 linear feet in each direction, formed in the fresh concrete by cutting a groove in the top surface of the slab to a depth of at least one-fourth the slab thickness with a jointing tool. Transverse expansion joints shall be installed at driveways, and opposite expansion joints in adjacent curbs. Where curbs are not adjacent, transverse expansion joints shall be installed at intervals of approximately 25 feet. Sidewalks shall receive a broomed finish. Scoring shall be in a transverse direction. Edges of the sidewalks and joints shall be edged with a tool having a radius not greater than 1/6-inch. Sidewalks adjacent to curbs shall have a slope of 1/4-inch per foot toward the curb. Sidewalks not adjacent to curbs shall have a transverse slope of 1/4-inch per foot or shall be crowned as directed by the Engineer. The surface of the concrete shall show no variation in cross section in excess of 1/4-inch in 5 feet. Concrete walks shall be reinforced with 6 x 6 - W1.4 x W1.4 welded wire fabric unless noted otherwise on the Drawings.
- C. Concrete curbs shall be constructed to the section indicated on the Drawings, and all horizontal and vertical curves shall be incorporated as indicated or required. Forms shall be steel or as approved by the Engineer. At the option of the Contractor, the curbs may be precast or cast-in-place. Cast-in-place curbs shall be divided into Sections 8 to 10 feet in length using steel divider plates. The divider plates shall extend through the concrete and shall be removed. Precast curbs shall be finished smooth. Dividers shall be installed where the curb crosses pipe trenches or other insecure area. Transverse expansion joints shall be installed at all curb returns and at intervals of approximately 40 feet.

3.07 WATERTIGHTNESS

- A. The structures which are intended to contain liquids and/or will be subjected to exterior hydrostatic pressures shall be so constructed that when completed and tested, there shall be no loss of water and no wet spots shall show.
- B. As soon as practicable after the completion of the structures, the Contractor shall fill such structures with water and if leakages develop or wet spots show, the Contractor shall empty such structures and correct the leakage in an approved manner. Any cracks which appear in the concrete shall be dug out and suitably repaired. Temporary bulkheads over

pipe openings in walls shall be provided as required for the testing.

- C. After repairs, if any are required, the structures shall be tested again and further repaired if necessary until satisfactory results are obtained. All work in connection with these tests and repairs shall be at the expense of the Contractor.
- D. Waterstops shall be placed in all locations as indicated on the Drawings and as may be required to assure the watertightness of all containers of liquids. Special shop fabricated ells, tees and crosses shall be provided at junctions. Waterstops shall be extended at least 6 inches beyond end of placement in order to provide splice length for subsequent placement. In slabs and tank bottoms, waterstops shall be turned up to be made continuous with waterstops at bottom of walls or in walls. All joints between adjacent, continuing, and intersecting sections of waterstop including butt joints, tee joints, and other angled joints shall be heat fused to form a watertight seal. Waterstops shall not be lapped. Waterstops shall be secured in place to maintain proper position during placement of concrete. Care shall be taken to avoid folding while concrete is being placed and to prevent voids in the concrete surrounding the waterstop. All materials shall be installed in accordance with the manufacturer's recommendations.
- E. Joints between pipe (except cast iron wall pipe) and cast-in-place concrete walls shall be sealed as required by the Drawings.
- F. The top surface of all concrete decks (except slabs on grade) shall be coated with Sikagard-70 water-repellant penetrating sealer as manufactured by the Sika Corporation, Nox-Crete Stifel, or another approved equal. The manufacturer's recommendations shall be followed in all areas of application.

3.08 GROUTING BASE PLATES, BEARING PLATES AND MACHINE BASES

- A. Column base plates, bearing plates for beams and similar structural members, machinery and equipment bases shall, after being plumbed and properly positioned, be provided with full bearing on epoxy nonshrink grout. Concrete surfaces shall be rough, clean, free of oil, grease and laitance and shall be moistened thoroughly immediately before grout is placed. Metal surfaces shall be clean and free of oil, grease and rust. Mixing and placing shall be in conformance with the material manufacturer's printed instructions.
- B. Grout fill that is formed in place by using rotating equipment as a screed, such as for clarifiers and similar types of equipment, shall be mixed in proportions and consistencies as required by the manufacturer or supplier of the equipment.

3.09 EQUIPMENT PADS

Unless otherwise shown or directed, all equipment and items such as lockers, motor control centers, etc., shall be installed on concrete bases. The bases shall be constructed to the dimensions shown on the Drawings or as required to meet plan elevations. Where

no specific plan elevations are required, the bases shall be 6 inches thick and shall extend 3 inches outside the equipment base. In general, the concrete bases shall be placed up to 1-inch below the base. The equipment shall then be properly shimmed to grade and the 1-inch void filled with nonshrink epoxy grout.

END OF SECTION 03310

SECTION 03350 – CONCRETE FINISHES

PART 1 GENERAL

1.01 SUMMARY

- A. Provide processed concrete surface finishes:
 - 1. Floor Slabs – Steel Troweled
 - 2. Exposed Surfaces – Rubbed

1.02 SUBMITTALS

- A. Submit for approval samples, product data, 4' by 4' mock-ups.

1.03 QUALITY ASSURANCE

- A. Comply with governing codes and regulations. Deliver, handle, and store materials in accordance with manufacturer's instructions.

1.04 RELATED WORK

- A. Section 03310 – Structural Concrete.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete design mixes based on application and surface integrity:

PART 3 INSTALLATION

- A. Floor Slabs: Steel trowel to hard finish without adding cement or other additives (Conform to ACI Code).
- B. Exposed Surfaces: All exposed to view concrete, exterior and interior, shall be prepared as described in Section 03310 – Structural Concrete, then receive a grout-cleaned finish. The grout-cleaned finish shall use a mix of one part white Portland cement and 1½ parts of fine sand mixed with sufficient water to form a grout having the consistency of thick paint. Apply to damp surface and rub down in such a manner as to obtain a smooth, filled surface uniform in color and free from defects and blemishes. Exterior vertical surfaces shall be finished to one foot below grade. Interior exposed to view vertical surfaces of dry pits shall be

finished full height, interior vertical surfaces of liquid containers shall be finished to one foot below the minimum liquid level that will occur during normal operations.

END OF SECTION 03350

SECTION 03370 – CONCRETE CURING

PART 1 GENERAL

1.01 WORK INCLUDED

Concrete curing materials and methods

1.02 RELATED WORK

Section 03310 – Structural Concrete.

1.03 REFERENCES

- A. ACI 301 – Specifications for Structural Concrete Buildings.
- B. ASTM C309 – Liquid Membrane-Forming Compounds for Curing Concrete.
- C. ASTM D2103 – Polyethylene Film and Sheeting
- D. FS TT-C-800 – Curing Compound, Concrete for New and Existing Surfaces.

1.04 QUALITY ASSURANCE

Conform to requirements of ACI 301.

1.05 PRODUCT DATA

- A. Submit product data under provisions of Section 01300.
- B. Provide product data for specified products.
- C. Submit manufacturer's installation instruction under provisions of Section 01300.

1.06 ENVIROMENTAL REQUIREMENTS

Maintain ambient temperature at 70 degrees F for three days after placing concrete.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Water: Clean and not detrimental to concrete.

- B. Absorptive Mat: Burlap fabric of clean roll goods.
- C. Membrane Curing Compound: Clear finish, conforming to ASTM C-309, Type 1-D, Class A or B, having a minimum of 18 percent solids.
- D. Impervious sheet conforming to ASTM C-171, polyethylene film shall be white opaque.

PART 3 EXECUTION

GENERAL

Protect freshly placed concrete from premature drying and excessive temperatures. Begin curing immediately after free water has disappeared from exposed surface. Keep exposed surface continuously moist for not less than seven (7) days.

3.01 INSPECTION

Verify concrete surfaces are ready for curing.

3.02 MEMBRANE CURING COMPOUND

- A. Apply curing compound in two coats with second coat at right angles to the first.
- B. Apply in accordance with manufacturer's instructions.

3.03 SPRAYING

Spray water over slab areas; maintain continuously moist for seven days.

3.04 ABSORPTIVE MAT:

Spread absorptive mat over slab areas. Lap edges and ends 12 inches. Spray with water until mat saturation. Maintain saturation for seven days.

3.04 CURING COMPOUNDS:

- A. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours). Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Recoat areas subject to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

- B. Curing Formed Surfaces: Cure formed concrete surfaces, including undersides of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- C. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by application of appropriate curing compound.

END OF SECTION 03370

SECTION 03460 - CONTROLLED LOW STRENGTH MATERIAL (CLSM)

PART 1 – GENERAL

1.01 DEFINITION

Controlled Low Strength Material (CLSM) is a material that has a specified compressive strength of 1200 PSI or less at 28 days. This material is not concrete and is in a flowable state at the time of placement. It is also referred to as flowable fill.

1.02 APPLICATIONS

Possible application of CLSM may include, but are not limited to; removable backfills, structural fills, insulating and isolation fills, road base, floor base, trench bedding, void fills, caisson and pile fills, small bridge restoration.

1.03 ROAD BASE

CLSM mixes may be used for pavement bases and subbases in subdivision, arterial streets and parking lots. The mixture can be placed directly from mixer onto the subgrade. According to AASHTO, the structural coefficients for this type of material are in the range of 0.25 to 0.35 depending on the compressive strength that is achieved in the field. CLSM must have a wearing surface applied since due to poor wear resistance.

1.04 STRUCTURAL FILL

CLSM may be used for foundation support to help distribute structural loads over weak soil. In the case of uneven soil surfaces CLSM provides a uniform surface for foundation construction. Structure fill mixture shall have a compressive strength of 1000 psi.

PART 2 – PRODUCTS

2.01 MATERIALS

A conventional CLSM mixture usually consists of water, Portland cement, type “F” flash ash and fine aggregate. In areas where fly ash is not available CLSM has been produced using high dosage of an air entraining admixture of help flowability. Non-standard materials may perform satisfactorily. Selection should be based on the specific application and the necessary characteristics of the mix, flowability, strength, removability, density, etc.

2.02. CEMENTITIOUS MATERIALS

Generally Type I or II Portland Cement is used conforming to ASTM C-150 Natural pozzolons and class “F” fly ash.

2.03 WATER

Water that is acceptable for concrete mixes is acceptable for CLSM mixtures.

2.04 AGGREGATES

Fine aggregates generally are the major constituents of CLSM mixture, most common is concrete quality sand meeting ASTM C-33. Manufactured sand can be used. Also, mixes can be designed to use non-spec fine aggregate.

2.05 MIX DESIGNS

Proportioning CLSM differs from that for concrete. Mixture proportions shall be as listed below. These mixes are only guides. Test mixes proposed with local materials must be approved by the Engineer.

Application	Cement lb/cu. yd.	Fly Ash Type F lb/cu. Yd.	Sand lb/cu. yd.	Water lb/cu. Yd.	28 Day PSI
Road Base and Structural Fill	200	250-300	2800	380	1000

PART 3 – EXECUTION

3.01 MIXING AND TRANSPORTATION

CLSM must be transported by a mixer truck to be sure that the mixture is in suspension when placed. Agitation of CLSM is required during transportation and waiting time. Subsidence begins as soon as agitation stops.

3.02 PLACING

Placement of CLSM can be directly from the truck chute. A properly proportioned CLSM can be tremied or pumped using a conventional concrete pump. Where pumping is required, trial mixtures should be tested prior to actual job placement. Considerable bleeding can be expected with CLSM mixtures.

3.03 SETTING TIME

CLSM is not concrete and should not be rated on setting time. CLSM will achieve density as soon as water leaves mixture. The time involved until CLSM may be paved over varies with permeability of adjacent soils, temperatures, humidity, moisture in adjacent soils. But under most conditions 2 to 6 hours the in place CLSM can be ready to use.

3.04 FLOW TEST

A recommended test for flow consists of filling a 3" x 6" open-ended cylinder to the top with the CLSM mixture. If necessary, strike off the top of the cylinder so the mixture is level, pull the cylinder straight up and measure the approximate diameter of the CLSM mix. For good flow in placement the diameter of the material spread should be at least 8".

3.04 QUALITY CONTROL

- A. During the progress of the work, at least one set of four compression test cylinders shall be made for each 50 cubic yards of CLSM or major fraction thereof, and not less than one such set for each days' pouring. Cylinders made in the field shall be made and cured in accordance with ASTM Standard Method of Making and Curing Concrete Test Specimens in the Field, Designation C31-69, except that wherever possible molds shall be left on cylinders until they have reached the laboratory.
- B. One (1) cylinder of each set shall be broken in accordance with ASTM C-39 at seven (7) days and two (2) at twenty-eight (28) days. Two (2) copies of these test results shall be submitted to the Engineer on the same day of the tests. The remaining cylinder shall be reserved for future testing if required.
- C. On evidence of these tests, any concrete that fails to meet the specified strength requirements shall be strengthened or replaced as directed by the Engineer at the Contractor's expense.

END OF SECTION 03420

SECTION 03600 - PRECISION GROUTING

PART 1 - GENERAL

1.01 WORK INCLUDED

Provide all labor, material, equipment and services required for grouting of equipment, machinery, structural steel, handrails, anchor bolts and other items or work for which grouting is specified or required. All unnecessary holes, openings and cracks in existing concrete shall be filled and patched.

1.02 DESCRIPTION OF WORK

- A. High strength, precision support of machine bases and soleplates, setting anchor bolts, including equipment subject to thermal movement and repetitive dynamic loading.
- B. Work includes providing a non-shrink, ready-to-use, fluid precision epoxy grout material; proportioned, pre-mixed and packaged at the factory; delivered to the job site to place with only the addition of water; forming, placing and curing as specified in this section.

1.03 RELATED WORK

- A. Section 03310 - Structural Concrete.
- B. Review all divisions and sections for equipment, machinery and other items to be grouted.

1.04 QUALITY ASSURANCE

Comply with the following codes, standards, test and recommended practices for foundation concrete as apply to precision grouting:

- A. ACI 347 "Recommended Practice for Concrete Formwork".
- B. ASTM C 309 "Standard Specifications for Liquid Membrane Forming Compounds for Curing Concrete".
- C. Manufacturer's Information on Use of Grout: Attached to each bag of grout.

1.05 SUBMITTALS

- A. Manufacturer's data of grout to be used shall be submitted to Engineer for review (see Section 01300).

PART 2 - PRODUCTS

2.01 GROUT

- A. Precision-support grout shall consist of an epoxy three component system, special graded and processed (non-ferrous metallic internal reinforcing aggregate), carefully graded natural fine aggregate and additional technical components.
- B. Grouts which depend upon aluminum powders, chemicals, or other agents which produce gas for expansion are not acceptable.
- C. Precision-support grout shall also meet the following requirements:
 - 1. Free of gas producing agents.
 - 2. Free of oxidizing catalysts.
 - 3. Free of inorganic accelerators, including chlorides.

2.02 WATER

Water shall be suitable for drinking.

PART 3 - EXECUTION

3.01 PREPARATION FOR GROUTING

- A. Remove laitance down to sound concrete.
- B. Surface to receive grout shall be rough and reasonably level.
- C. Surface shall be properly cured. DO NOT USE CURING COMPOUNDS.
- D. Clean surface of oil, grease, dirt, and loose particles.
- E. Clean bolt holes, bolts and underside of equipment base.
- F. Install per manufacturer's recommendations.

3.02 FORMWORK

- A. Formwork shall be compatible with proposed method of placing grout. Design for rapid, continuous and complete filling of space to be grouted.
- B. Build strong, tight forms braced so they will not leak or buckle under weight of fluid grout.

3.03 FINISHING AND CURING

- A. Follow manufacturer's printed instructions for the brand and type of grout being used.
- B. The grout shall meet the following strengths:

	<u>Plastic Mix</u>	<u>Flowable Mix</u>
1 day	4,000 psi	2,000 psi
3 days	6,000 psi	3,000 psi
7 days	8,000 psi	5,000 psi
28 days	10,000 psi	7,000 psi

END OF SECTION 03600

Division 5 – Metals

SECTION 05120 - STRUCTURAL STEEL

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide structural steel for building construction including sub-framing units which are part of the general framing system. Include anchors, bases, bearing plates, bracing, lintels when part of structural framing, and detail fittings.
- B. Modify existing structural steel systems and components to accommodate remodelling and new work.

1.02 SUBMITTALS

Submit for approval shop drawings, product data, test reports.

1.03 QUALITY ASSURANCE

Comply with governing codes and regulations. Provide products of acceptable manufacturers. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Steel shapes, plates and bars: ASTM A 36, or ASTM A 572, Grade 50.
- B. Steel pipe: ASTM A 53.
- C. Anchor bolts: ASTM A 307.
- D. High strength threaded fasteners: ASTM A 325.
- E. Non-metallic shrinkage resistant grout; Euclid Euco NS, L&M Crystex, Sonneborn Sonnegrout or approved equal. Compressive strength suited for project requirements.
- F. Shop finish for structural steel in accordance to Section 09900.
- G. Galvanized lintels: Hot dip galvanized ASTM A 123.
- H. Welding: AWS D1.1.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with AISC codes and specifications, and with AWS "Structural Welding Code".
- B. Contractor shall employ a registered engineer to check elevations and plumb and level tolerances; certify that installed work is within AISC Standards.
- C. Architecturally exposed steel: Fabricate with special care using materials carefully selected for best appearance. Store materials off ground and keep clean. Cut, fit and assemble work with surfaces smooth, square and with complete contact at joints. Set all cambers up. Weld all work continuously; grind smooth and flush to make seams invisible after priming. Prepare surfaces to comply with SSPC-SP6; apply prime coat within 24 hours after cleaning.
- D. Touch-up field welds and abraded areas in accordance with Section 09900.

END OF SECTION 05120

SECTION 05500 - MISCELLANEOUS METALS, FASTENERS, SPECIAL FINISHES

PART 1 - GENERAL

1.01 WORK INCLUDED

Provide all labor, materials, equipment and service necessary for fabrication and erection of structural steel and aluminum and for fabrication and installation of miscellaneous non-ferrous metals as shown on the Drawings and not specifically included under other sections of these Specifications.

- A. Erection.
- B. Shop and Erection Drawings.
- C. Shop Painting.
- D. Galvanizing.
- E. Aluminum Work Protection.
- F. Cleaning Aluminum Work.
- G. Miscellaneous Items.
- H. Loose Lintels.
- I. Sleeves and Inserts.
- J. Aluminum Pipe Railing.
- K. Aluminum Stairs.
- L. Ladders.
- M. Ship Ladders.
- N. Plate Covers and Frames.
- O. Guard Chains.
- P. Lifting Hooks.
- Q. Sand Trap Grating and Frame.

- R. Cast Iron Wheel Guard.
- S. Cast Aluminum Nosings.
- T. Floor Hatches and Frames.
- U. Access Doors.

1.02 RELATED WORK

- A. Section 04200 - Concrete Masonry Unit.
- B. Section 05530 - Aluminum Grating.

1.03 REFERENCES

All work under this Section shall be governed by:

- A. Specifications for the design, fabrication and erection of structural steel for buildings - American Institute of Steel Construction, current edition.
- B. Aluminum Construction Manual, Section 1, Specifications for Aluminum Structures - the Aluminum Association.
- C. All welding shall conform to the latest code of the American Welding Society.
- D. ASTM A-276.
- E. ASTM A-325.
- F. ASTM F-593, 294.
- G. Federal Specification FF-S-325.
- H. ASTM A-48.
- I. Federal Specification TT-V-51F.
- J. ANSI B94.12.
- K. ASTM A-12, A-153, A-384, A-563 and A-780.
- L. SSPC SP-1, SP-2, SP3, SP-7.

1.04 SUBMITTALS

- A. As required by the Specifications, the Contractor shall submit for review completely detailed and certified shop and erection drawings of the miscellaneous metal work. All coatings or other protection against corrosion to be applied at the shop or in the field shall be indicated on these drawings. The shop drawings for aluminum work shall show the alloys and tempers to be used, and the finish, if any to be applied.
- B. Shop drawings, giving complete information necessary for fabrication, layout and installation of metal work shall be submitted to the Engineer for review prior to fabrication.
- C. Preparation of shop drawings for fabricated metal items shall be coordinated by the Contractor with the manufacturers of various equipment in order to comply with details, locations, openings, and arrangements required by the manufacturers.
- D. Field measurements shall be made to verify all dimensions in the field that may affect installation of work before shop drawings are made and/or fabrication is performed.

1.05 QUALITY ASSURANCE

- A. The design, detail and workmanship of steel plates and structural steel shall conform to the AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings.
- B. Where welding is permitted or required, it shall conform to the current requirements of the American Welding Society for the type of work in question.
- C. Aluminum work shall be fabricated in a shop where the quality of work is in accordance with the highest standards for work of this type. All work shall be executed by mechanics skilled in the fabrication of aluminum, and shall be true to detail with sharp, clean profiles, fitted with proper joints and intersections and with finishes as specified.
- D. All miscellaneous metal work shall be formed to shape and size with sharp lines and angles. Shearing and punching shall leave clean true lines and surfaces.

1.06 RESPONSIBILITY FOR DIMENSIONS

The general design and dimensions of the miscellaneous metal work are indicated on the Drawings, but the Contractor shall be responsible for the correctness of the details and dimensions of the finished articles. He shall verify conditions at the job before fabrication and coordinate the work with that of all other trades to prevent interference.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Steel plates and structural steel shapes shall conform to ASTM Standard Specification for Structural Steel, Designation A36.
- B. Sheet steel shall be cold rolled or hot rolled carbon sheet steel conforming to ASTM Standard Specification for Steel, Carbon, Cold Rolled Sheet, Commercial Quality, Designation A36 or ASTM Standard Specification for Steel, Carbon (0.15 maximum, percent), Hot Rolled Sheet and Strip, Commercial Quality, Designation A569, as appropriate.
- C. Steel pipe shall conform to ASTM Standard Specifications for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless, Designation A53.
- D. Stainless steel shall be Type 304 unless otherwise indicated or specified.
- E. Aluminum work shall be fabricated of plates, rolled or extruded shapes, sheets or casting conforming (unless otherwise permitted or indicated) to the following alloy and temper designations of the Aluminum Association:
 - 1. Structural rolled or extruded shapes 6061-T6.
 - 2. Extruded shapes 6063-T5.
 - 3. Plates 6061-T6.
 - 4. Gratings (bearing bars) 6061-T6 (crimp bars) 6063-T6.
 - 5. Castings 214.
 - 6. Sheets 3003-F.
 - 7. Bolts and nuts 2024-T4.
 - 8. Pipe Railing 6063-T6.
- F. The Contractor shall furnish the Engineer with mill certificates and a signed statement from the fabricator that all aluminum work furnished is of the proper alloys, as specified above.

2.02 STEEL

- A. Structural steel shall conform to the requirements of ASTM A-36. Structural tubing, where used, shall conform to the requirements of ASTM A-500, Grade B, and the ends of the tubing shall be properly sealed to protect the internal surfaces. Steel anchor bolts shall be ASTM A-36 hot rolled threaded rod or bar stock, except where stainless steel is indicated on the Drawings.
- B. Structural steel members as required shall conform to ASTM Standard shapes.

- C. Base and bearing plates shall be provided where necessary to provide maximum bearing value of not more than 200 psi on solid concrete masonry units not more than 750 psi on concrete and shall be grouted in place.
- D. Steel lintels shall be provided for all square head openings in masonry where shown and where other lintels are not indicated on the Drawings. Lengths of bearing at each end of lintels shall be not less than 1 inch per foot of span, but in no case less than 8 inches shall be increased or the lintels shall be fitted with bearing plates as required to provide unit pressures in pounds per square inch of not more than 200 on solid concrete masonry units and 625 on concrete. All new steel lintels shall be hot-dipped galvanized. Finish coats are specified in Division 9 - Finishes.

2.03 SHOP PAINTING

Painting of miscellaneous ferrous metal work is specified under Division 9.

2.04 GALVANIZING

Items of miscellaneous iron work and steel work indicated on the Drawings or specified to be galvanized shall be zinc coated by the hot dip process in conformity with ASTM Standard Specification for Zinc (hot galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip, Designation A123-78; or ASTM Standard Specifications for Zinc Coating (hot-dip) on Iron and Steel Hardware, Designation A153-78, as appropriate. Galvanizing is specified under Article 3.04, "Hot-Dip Galvanizing".

2.05 ALUMINUM

All structural and miscellaneous aluminum shall be Alloy 6061 (Alloy 6063 for extrusions), Temper T6, unless otherwise noted, indicated or accepted by the Engineer. Where welding is necessary in fabrication, it shall be done in conformance with Section 7 "Welded Construction" of Specification for Aluminum Structures, referenced hereinbefore.

2.06 ALUMINUM WORK PROTECTION

- A. Aluminum surfaces which after erection would otherwise be in contact with concrete or brick masonry or with mortar, shall be protected from contact therewith by a coat of bitumastic super service black manufactured by the Koppers Company, Inc., Pittsburgh, PA; Tarmastic 100 manufactured by Porter Coating Division, Porter Paint Company, Louisville, KY; 450 Heavy Tnemecol manufactured by Tnemec Company, North Kansas City, MO; or equal. Areas where the paint has been damaged by abrasion or other cause shall be cleaned and repainted as directed so that the aluminum will have a complete protective paint film when brought into contact with the material against which it is being protected. Before application of coating, the surface shall be cleaned of all dirt, heavy

deposits of grease or oil, and other foreign substances and shall be immersed in or swabbed with an acceptable solvent. Next the surfaces shall be rinsed with clear water and thoroughly dried.

- B. The Contractor's attention is directed to the requirements of the Specifications in regard to protection against electrolysis where aluminum is to be used in conjunction with dissimilar metals.
- C. Where a shop coating of methacrylate lacquer has been specified on aluminum work to protect the surface from stain, the protective coating of lacquer worn off during handling or erection shall be replaced in the field by a new coating of lacquer of the same type.
- D. During construction, care shall be taken to prevent damage to the aluminum work from splashing or the accumulation of paint, concrete, mortar, or other similar materials.

2.07 STAINLESS STEEL

Stainless steel shapes shall be ANSI Type 304 or 316 in accordance with ASTM A-276. Miscellaneous bar stock products such as pipe straps shall be 400 Series stainless steel. Anchor bolts, nuts and washers shall be ANSI Series 300 stainless steel.

2.08 FASTENERS

- A. Bolts, Nuts and Washers:
 - 1. Structural bolts shall be high strength ASTM A-325, Type 1, galvanized and galvanized ASTM A-325 hardened flat washers and galvanized ASTM A-325 hex nuts. Galvanized bolts, nuts and washers shall be centrifugally spun after galvanizing. Nuts shall have threads tapped oversize after galvanizing. All stainless steel bolts, nuts and washers shall be ANSI Type 300 Series stainless steel in accordance with ASTM F-593, with ASTM F-594 nuts. All bolts shall have hexagonal heads.
 - 2. Anchors and bolts including nuts and washers shall be provided where necessary for securing the work in place. Sizes, types and spacings of anchors and bolts not indicated or specified otherwise shall be as necessary for their purposes. Anchor bolts and anchors for the erection of structural steel shall be galvanized. Anchored bolts, nuts, and washers for all other uses including, but not limited to, underwater use and for the installation of equipment, piping, pumps and motors shall be stainless steel Type 304.
- B. Expansion Anchors (In Concrete):
 - 1. Expansion anchors shall be of two (2) types:
 - a. Stainless steel wedge type.
 - b. Self drilling plated type with stainless steel bolt and stainless steel washer.Type of expansion anchor desired shall be noted on Drawings

2. Stainless steel wedge type anchors shall be ITW Ramset/Red Head, or equal of Type 303 stainless steel. Anchors shall meet or exceed latest Government GSA Federal Specifications FF-S-325, Group II, Type 4, Class 1. Anchor shall be used with 300 series stainless steel bolt and washer.
3. Self drilling plated anchors shall be ITW Ramset/Red Head, or equal. Anchors shall meet or exceed latest Government GSA Federal Specification FF-S-325, Group III, Type 1. Self-drilling anchors shall be electro-deposited zinc plated and chromate dipped, to meet or exceed the requirements of the latest Federal Specification QQ-Z-325, Type II, Class 3. Cutting teeth shall have minimum hardness of 82 Rockwell A scale.
4. Stainless steel expansion anchors shall be installed in accordance with manufacturer's recommendations.
5. Self-drilling expansion anchors shall be installed in accordance with manufacturer's recommendations. To insure full development strength, all self-drilling expansion anchors shall be expanded over the plug in the final set, by using a bolt screwed into the female threads and impacted by hand with a suitable hammer. The final set shall not be accomplished by using the drilling tool.
6. After installation, pull-out tests by the anchor manufacturer's representative may be requested by the Engineer. If so, the Engineer's inspector will specify the number and location of the tests.

2.09 ALUMINUM LADDERS

- A. Aluminum ladders shall be furnished and installed at the locations shown on the Contract Drawings.
- B. The ladders shall be constructed with side rails of 2-1/2 inches by 1/2-inch flat bar and brackets of 3 inches by 1/2-inch flat bar with rungs of 1 inch diameter bars, shouldered, driven through the side rails and peened. Maximum bracket support spacing shall be 5 feet - 0 inches on centers. The brackets shall be welded to the side rails. Rung spacing shall be 12 inches on centers. In general, the ladders shall extend to within 6 inches of the access opening. Ladders shall be constructed of 6061-T6 aluminum. Wedge type stainless steel expansion anchors shall be used to attach aluminum ladders to walls as indicated on Contract Drawings.

2.10 MISCELLANEOUS ITEMS

Items of miscellaneous metal work not particularly specified hereinafter shall be of the shape, size, material and details indicated on the Drawings or suitable for the purpose intended.

2.11 LOOSE LINTELS

The Contractor shall furnish all loose lintels as indicated on the Drawings or required by the work. The loose lintels shall be fabricated from structural steel shapes and plates. All

loose lintels shall be hot-dip galvanized after fabrication.

2.12 SLEEVES AND INSERTS

The Contractor's attention is directed to the requirements of the Specifications regarding sleeves and inserts.

2.13 ALUMINUM PIPE RAILING

- A. The aluminum pipe railing shall be the product of company normally engaged in the manufacture of pipe railing. Railing shall be shop assembled in lengths not to exceed 24 feet for field erection.
- B. Handrails and stair rails shall be designed to withstand a 200-pound concentrated load applied in any direction at any point on the top rail. Handrails and stair rails shall also be designed to withstand a load of 50 lbs/ft. applied horizontally to the top rail. The 200-pound load will not be applied simultaneously with the 50 lbs/ft. load. In addition, the handrails shall be designed to withstand a load of 100 lbs/ft. applied vertically downward to the top rail and simultaneously with the 50 lbs/ft. horizontal load. The 100 lbs/ft. vertical load does not apply to stair rails.
- C. The manufacturer shall submit calculations to the Engineer for approval. Testing of base castings or base extrusions by an independent lab or manufacturer's lab (if manufacturer's lab meets the requirements of the Aluminum Association) will be an acceptable substitute for calculations. Calculations will be required for approval of all other design aspects.
- D. Post spacing shall be a maximum of 6 feet 0 inches. Posts and railings shall be a minimum of 1-1/2 inches Schedule 40 aluminum pipe alloy 6063-T6, ASTM-B-429 or ASTM-B-221. The handrail manufacturer shall show that their posts are of adequate strength to meet the loading requirements. If the manufacturer's posts are not of adequate strength, the manufacturer may reduce the post spacing or add reinforcing dowels or may do both in order to meet loading requirements.
- E. The handrail shall be made of pipes joined together with component fittings. Samples of all components, bases, toe plate and pipe must be submitted for approval. Components that are glued or pop riveted at the joints will not be acceptable. All components must be mechanically fastened with stainless steel hardware. Handrail and components shall be Thompson Fabricating Company or approved equal.
- F. Posts shall not interrupt the continuation of the top rail at any point along the railing, including corners and end terminations. The top surface of the top railing shall be smooth and shall not be interrupted by project fittings.
- G. The midrail at a corner return shall be able to withstand a 200-pound load without loosening.

- H. Expansion bolts shall be spaced 10 diameters apart and 5-diameter edge distance for no reduction in pullout strength. A safety factor of four shall be used on expansion bolt pullout values published by the manufacturer. Expansion bolts shall be stainless steel type 303 wedge bolts.
- I. Toe plate shall conform to OSHA standards. Toe plate shall be a minimum of 4 inches high and shall be an extrusion that attaches to the posts with clamps which will allow for expansion and contraction between posts. Toe plates shall be set 1/4-inch above the walking surface. Toe plates shall be provided on handrails as required by OSHA and/or as shown on Drawings. Toe plates shall be shipped loose in stock lengths with pre-manufactured corners for field installation.
- J. Openings in the railing shall be guarded by a self-closing gate. Safety chains shall not be used unless specifically shown on the Drawings.
- K. Finish shall be Aluminum Association M10-C22-A41 (215-R1). The pipe shall be plastic wrapped. The plastic wrap is to be removed after erection.
- L. Aluminum surfaces in contact with concrete, grout or dissimilar metals will be protected with a coat of bituminous paint, mylar isolators or other approved material.

2.14 ALUMINUM STAIRS

- A. The aluminum stairs shall have structural aluminum channel stringers and supports, aluminum tread plate treads and platforms and sheet aluminum risers as indicated on the Drawings and in the details.
- B. The treads shall be aluminum grating (see Section 05530). The treads shall be supported by and attached to 1-1/4 inch by 3/16 inch aluminum carrier angles bolted to the stringers. The treads shall be the widths indicated.
- C. All platforms shall be fabricated of 1/4-inches thick aluminum tread plate and shall be supported on the edges by structural aluminum angles and at the mid-spans by structural aluminum tees.
- D. The aluminum tread plate for treads and platforms shall have an acceptable nonskid pattern surface.
- E. The Contractor shall provide all structural aluminum angle hangers, struts, rod hangers, closure plates and brackets indicated or necessary to complete the stairs as indicated.

2.15 SHIP LADDERS

- A. Ship ladders as located on the Drawings shall have structural aluminum channel stringers, aluminum pipe handrails and aluminum riveted grating treads. The treads shall be Type K

manufactured by Borden Metal Products Company, Elizabeth, NJ; Reticuline Type M manufactured by IKG Industries, Long Island City, NY; Type KM manufactured by Kerrigan Iron Works, Inc., Nashville, TN; or equal. The bearing bars of the treads shall be 3/16 inches thick by 1-1/4 inches deep and shall be fabricated of 6061-T6 aluminum alloy. Crimp bars shall be fabricated of 6063-T5 aluminum alloy riveted on 7-inch centers, and raised slightly above the bearing bars and serrated. The treads shall have integral slotted and punched end plates for attaching to the stringers. All treads shall be provided with 1-1/4-inch abrasive or extruded aluminum corrugated nosing.

- B. The handrails shall be fabricated of 1-1/2 inch IPS, Schedule 40 aluminum pipe with flush welded joints ground smooth. The rails shall be secured to the stringers as indicated. The handrails shall be given an Aluminum Association Standard Anodic finish, Designation C22A31 followed by a shop coat of methacrylate lacquer.
- C. The Contractor shall provide all structural aluminum clip angles, brackets and fasteners required to complete the ship ladders as indicated. All fasteners shall be stainless steel.

2.16 PLATE COVERS AND FRAMES

- A. The plate covers and frames shall be of the sizes indicated on the Drawings. The frames shall be aluminum angles of the sizes indicated with welded strap anchors for securing the frames in the concrete. The frames shall have mitered corners with welded joints ground smooth where exposed.
- B. The covers shall be 1/4-inch thick aluminum tread plate having an acceptable nonskid surface and reinforced with aluminum bars welded to the underside of the cover in accordance with the details. Plate covers shall be capable of supporting a uniform superimposed load of 100 psf for the span with a deflection of less than 1/4-inch based on an allowable fiber stress of 16,000 psi. The covers shall be made to fit neatly and accurately in the frames.
- C. Hinged covers shall be furnished with heavy duty stainless steel, plain bearing hinges with stainless steel pins. The hinges shall be fastened to the covers and frames with stainless steel machine screws. The hinged covers shall be provided with flush lift handles fabricated from 1/2-inch diameter aluminum rod, alloy 6061-T6511.
- D. A single leaf of hinged plate covers shall be no greater than 3 feet square in size.
- E. Removable plate covers shall have 1-inch diameter finger holes to facilitate removal. All edges of holes cut in the plate covers shall be ground smooth.
- F. Removable plate covers shall be no greater than 14 square feet in size with the longer dimension no greater than 7 feet.
- G. Gasket plate covers shall have continuous compressible neoprene seals between the cover

and frame at the perimeter. The covers shall be secured to the frames with countersunk, flathead, stainless steel machine screws spaced approximately 6 inches on centers.

2.17 GUARD CHAINS

Removable guard chains at openings in aluminum pipe railings shall be fabricated from wrought, non-welded aluminum chain having 12 links per foot. The chains shall be secured to aluminum eyes bolted or welded to pipe stanchion at one end of the opening. The free ends of the chains shall be provided with hooks formed from 1/4-inch diameter solid aluminum rod for attaching to similar eyes in the pipe stanchion at the opposite end of the opening.

2.18 LIFTING HOOKS

- A. Lifting hooks in concrete shall be fabricated from 3/4-inch diameter steel rod bent in a U-shape and threaded at the ends to receive nuts. The lifting hook shall be fastened to a 1/2-inch by 4-inch by 8-inch steel anchor plate and the assembly placed in the formwork before the concrete is placed. Lifting hook assemblies shall be hot-dip galvanized after fabrication.
- B. Lifting hooks supported from steel shall be fabricated 3/4 inch diameter steel rod bent in a U-shape and threaded at both ends to receive nuts. The lifting hooks shall be placed in punched holes in the bottom flange of steel beams and secured in place by nuts as indicated. Lifting hooks and appurtenances shall be hot-dip galvanized.

2.19 SAND TRAP GRATING AND FRAME

The sand trap grating and frames in the building shall be heavy duty weight constructed of high strength gray iron.

2.20 CAST IRON WHEEL GUARDS

- A. Wheel guards where indicated on the Drawings shall be cast iron guards of the sizes and types indicated on the Drawings and as herein specified and shall be manufactured by Neenah Foundry Company, Neenah, WI; Flockhart Foundry Company, Neward, NJ; McKinley Iron Works, Fort Worth, TX; or equal. Wheel guards shall be given one shop coat of rust inhibitive paint before shipment.
- B. Wheel guards shall be heavy duty concrete fill type, cast iron wheel guards, No. R-4983-C manufactured by Neenah Foundry Company; Type 706A manufactured by Flockhart Foundry Company; or an acceptable equivalent product. The guards shall be set 2 inches into the pavement and shall be bolted to the masonry walls. The guards shall be filled with Class A concrete and the top of the fill sloped at a 15 degree angle from the building.

2.21 CAST ALUMINUM NOSINGS

- A. The cast aluminum nosing shall be abrasive cast aluminum nosings securely fastened with stainless steel, flat head bolts and wing anchors set into the fresh concrete. The nosings shall be the products of Wooster Products, Inc., Wooster, OH; American Abrasive Metals Company, Irvington, NJ; Andco Building Specialties, Division of Andco Industries Corporation, Greensboro, NC; or equal.
- B. Cast aluminum nosings for concrete steps and platforms shall be of the widths indicated and shall be Type 101 made by Wooster Products, Inc.; Style A made by American Abrasive Metals Company; Style 801 made by Andco Building Specialties, or equal.

2.22 FLOOR HATCHES AND FRAMES

- A. The floor hatches and frames shall be flush floor hatches manufactured by the Bilco Company, New Haven, CT; or equal. The hatches shall be double leaf gutter type and of the sizes indicated on the Drawings. The hatches shall be factory assembled and shipped complete with frame for installation on the job. The hatches shall be furnished with hinges, hold open safety lock bars, and flush lift handles. Gutter type hatches shall have a 1-1/2 inch drainage coupling located in on corner of the channel frame.
- B. The floor hatches and frames shall be fabricated from aluminum with 1/4-inch extruded aluminum frames and 1/4-inch diamond checkered aluminum plate covers. The covers shall be reinforced to be capable of withstanding a uniform live load of 300 psf.

2.23 ACCESS DOORS

Doors shall be flush panel access doors as manufactured Inryco Inc., Milwaukee , WI; Karp Associates, Inc., Maspeth, NY; BOICO, Birmingham, AL; or equal. Doors and frames to be galvanized steel with concealed hinge and flush screw driver operated locks.

2.24 SAFETY CHAIN

Safety chain shall be 3/8-inch trade size, proof coil, welded polyester coated low carbon steel in OSHA safety yellow designed for barrier chain application as manufactured by Campbell Chain Company, York, PA., or equal.

2.25 CASTINGS

All miscellaneous iron casting shall be of best quality materials free from flaws and unsightly defects. Gray cast iron shall be ASTM A-48 Class 35 (35,000 psi tensile strength). Furnish and install in the locations indicated casting of the type and size shown on the Drawings.

2.26 CARPENTER'S IRON WORK

Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required for framing and supporting woodwork and for anchoring or securing woodwork to concrete or other structures. Manufacture or fabricate items of sizes, shapes, and dimensions required. Furnish malleable iron washers for heads and nuts which bear on wood structural connections, elsewhere, furnish steel washers.

2.27 MISCELLANEOUS FRAMING AND SUPPORTS

Provide miscellaneous steel framing and supports as required to complete the work. Fabricate miscellaneous units to the sizes, shapes, and profiles shown or if not shown, of the required dimensions to receive adjacent grating plates, louvers, vents, grilles, screens or other work to be retained by the framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars of all welded construction using mitered corners, welded brackets and splice plates and a minimum number of joints for field connection. Cut, drill and tap units to receive hardware and similar items to be anchored to the work.

PART 3 - EXECUTION

3.01 ANCHORAGE ITEMS

The Contractor shall furnish all bolts, nuts, shims, pins, screws, straps, nails and other anchors which may be required by the Drawings or job conditions to secure all items permanently in place whether or not specifically called for or shown on the Drawings.

3.02 FABRICATION AND INSTALLATION OF METAL WORK

- A. General: All metal items shall be accurately fabricated and erected with exposed joints close fitting. All joints shall be of such character and so assembled that they will be as strong and rigid as adjoining sections. Joints shall be located where least conspicuous. Items shall have smooth finished surfaces except where otherwise shown or specified.
- B. Built-in Items: Members or parts to be built-in with masonry or concrete shall be in a form affording a suitable anchorage or shall be provided with approved anchors, expansion shields or other approved means of securing members.
- C. Dissimilar Metals: Ferrous and non-ferrous metals shall be insulated at all contacts with felt washer, strips or sheets, bitumastic paints, or other acceptable means. All aluminum surfaces in contact with concrete shall be coated with two (2) coats of Federal Specification TT-V51F Asphalt Varnish, or approved equal.

D. Connections:

1. All required anchors, couplings, bolts, and nuts required to support miscellaneous metal work shall be furnished and installed as required.
2. Weights of connections and accessories shall be adequate to safely sustain and withstand stresses and strains to which they will be normally subjected.
3. Connections shall be bolted except where welding is called for in the Drawings. Bolts shall be 3/4-inch diameter unless noted or required otherwise.

E. Expansion Anchors:

1. Expansion anchors shall be installed in holes drilled into concrete with carbide tipped drill bits conforming to ANSI B94.12-1977, using a rotary impact hammer for 1/2-inch and 3/8-inch anchors. Hole depth shall equal or exceed the anchor manufacturer's minimum recommended embedment. Should hole depth equal anchor manufacturer's minimum recommended embedment, hole shall be cleaned out by air pressure. The minimum hole depth shall be per anchor manufacturer's recommendations. Contractor shall assure hole is perpendicular and conforms in size to anchor manufacturer's recommendation.
2. Washer and nut shall be assembled on anchor so that the top of the nut is flush with the top of the anchor. Then the anchor shall be driven into the hole through the work until the washer bears against the work. The anchor shall be expanded in accordance with the manufacturer's recommendations.
3. General: Provide stainless steel fasteners for exterior use or where built into exterior walls. Select fasteners for the type, grade and class required.
4. Bolts and Nuts: Regular hexagon head type, stainless steel, Grade A.
5. Lag Bolts: Stainless steel.
6. Machine Screws: Stainless steel.
7. Wood Screws: Stainless steel.
8. Plain Washers: Stainless steel.
9. Masonry Anchorage Devices: Stainless steel.
10. Toggle Bolts: Stainless steel.
11. Lock Washers: Stainless steel.

3.03 WELDING

Welding procedures, welders and welding operators, both for shop and field welding, shall be qualified and certified in accordance with the requirements of AWS D1.1 "Welding in Building Construction" of the American Welding Society. Manufacturer's and fabricator's shop drawings shall clearly show complete information and Contractor shall perform all field welding in conformance with this information regarding location, type, size and length of all welds, all in accordance with AWS A2.0 "Standard Welding Symbols" of the American Welding Society. Special conditions shall be fully explained by notes and details.

3.04 HOT-DIP GALVANIZING

- A. All fabrication, galvanizing and repair shall comply with ASTM Standards as they apply in accordance with the publication "ASTM Standards for Materials Hot-Dip Galvanized after Fabrication, 1981" issued by American Hot-Dip Galvanizers Association, Inc. In particular, the following specific standards shall apply to work under this contract: ASTM A-123, A-153, A-384, A-385, A-563 and A-780.
- B. Items to be galvanized shall be fabricated in accordance with ASTM A-385-80.
- C. Galvanizing for fabricated steel items shall conform to ASTM A-123-78 and shall be done after fabrication. Steel assemblies shall be subject to safe guarding from warpage and distortion during galvanizing per ASTM A-384-76.
- D. Galvanizing for structural steel fasteners and hardware shall conform to ASTM A-153-80. Galvanized bolts, nuts and washers shall be centrifugally spun after galvanizing. Nuts shall have threads tapped oversize, after galvanizing, per ASTM A-563-80.
- E. Upon field erection, any damage measuring more than 1/10-inch wide shall be repaired with a zinc-based solder or zinc-rich paint in accordance with ASTM A-780-80. Marred, damaged, or uncoated areas 4 square inches and less shall be patched with a zinc-based solder to a thickness of 5 milligrams; areas greater than 4 square inches shall be patched with an organic zinc-rich paint to a dry film, Devcon Z, LPS Instant Cold Galvanized; or equal. The resident project representative shall determine the extent of damage which would require recoating.
- F. Items subject to distortion during transit, such as thin, curved members, etc., shall be stacked on edge and/or blocked to prevent radius change or other distortion while in transit to and from the galvanizing plant.

3.05 PAINTING

Painting of miscellaneous ferrous metal work is specified under Division 9.

3.06 MISCELLANEOUS METAL FABRICATIONS

- A. Rough Hardware:
 - 1. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division 5.
 - 2. Fabricate items to sizes, shapes and dimensions required. Furnish malleable iron washers for heads and nuts that bear on wood structural connections; elsewhere, furnish steel washers.

B. Miscellaneous Steel Trim:

1. Provide shapes and sizes for profiles shown. Except as otherwise indicated, fabricate units from structural steel shapes and plates and steel bars, with continuously welded joints and smooth exposed edges. Use concealed field splices wherever possible. Provide cutouts, fittings and anchorages as required for coordination of assembly and installation with other work.
2. Galvanize miscellaneous steel trim where indicated.

END OF SECTION 05500

SECTION 05530 - ALUMINUM GRATING

PART 1 - GENERAL

1.01 WORK INCLUDED

Provide all labor, materials, equipment and services required to furnish and install metal bar grating where shown on the Drawings.

1.02 RELATED WORK

Section 05500 - Miscellaneous Metal and Fasteners.

1.03 REFERENCES

- A. Design, fabrication and installation of grating shall be in accordance with Standard Specifications and Voluntary Code of Practice in Metal Bar Grating Manual, 1979 Edition, published by National Association of Architectural Metal Manufacturers, Chicago, IL (ANSI A-202.1).
- B. ASTM B-210.
- C. ASTM B-221.
- D. Federal Specification TT-V-51F.

1.04 SUBMITTALS

- A. Submit shop drawings to the Engineer for review before fabrication.
- B. Indicate areas to receive grating, grating details and dimensions, and material specifications.
- C. Show anchorage details and locations.
- D. Indicate coordination with equipment suppliers where openings for such equipment are required.

PART 2 - PRODUCTS

2.01 DESIGN CRITERIA

- A. Support uniform live load of 200 psf.

- B. Deflection not to exceed span of bearing bars (in inches) divided by 240.
- C. Maximum Fiber Stress: 12,000 psi.

2.02 BASIC DESIGN

- A. The gratings shall be riveted aluminum gratings, Type K manufactured by Borden Metal Products Co., Elizabeth, NJ; Reticuline Type M manufactured by IKG Industries, Long Island City, NY; Type D manufactured by Kerrigan Iron Works, Inc., Nashville, TN; or equal. The bearing bars shall be 3/16-inch thick by the depths indicated in the grating span chart in the details. Bearing bar spacing shall be 1-1/8 inch face to face with crimp bars riveted on 7-inch centers. The gratings shall be fabricated in standard size sections and secured in place by at least four (4) acceptable removable-type fasteners per grating panel. The ends of each grating section shall be banded with bearing bars. The top surfaces of all crimp bars shall be serrated for a nonskid surface, and raised slightly above the top surfaces of the bearing bars.
- B. All openings for fixtures or pipes, which require the cutting of three main bars or more, shall be finished in a similar manner as the ends.
- C. Gratings in concrete shall have aluminum angle frames with mitered corners and with welded joints ground smooth where exposed. The frames shall have welded anchors and shall be set in the concrete as it is placed.
- D. Bearing and cross bars shall be flush at surface.
- E. All free and supported bar ends around perimeter and around cutouts shall be banded.
- F. Provide removable sections of grating with suitable end bearing where noted on the Drawings or otherwise required.

2.03 MATERIAL

- A. Bearing Bars: ASTM B-221, 6061-T6 or 6063-T6, aluminum.
- B. Cross Bars: ASTM B-221 (extruded) or ASTM B-210 (drawn) aluminum.
- C. All steel fasteners used with aluminum grating shall be galvanized.
- D. Finish: Aluminum mill finish (as fabricated).
- E. Anchors: Saddle clips of manufacturer's standard design, galvanized.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Grating shall be fabricated as indicated by shop drawings which have been revised to reflect actual field measurements.
- B. Grating shall be set with full and uniform end bearing to preclude rocking; do not use wedges or shims.
- C. Provide 1-inch minimum bearing with maximum erection clearance of 1/4-inch all around.
- D. Anchor grating with saddle clips in accordance with manufacturer's recommendations or as detailed on the Drawings.
- E. Provide cutouts for the passage of pipe, valve and equipment operators, conduit, stems and similar work; cutouts for circular obstructions shall be at least 2 inches larger in diameter than the obstruction.
- F. Protect all surfaces of angles and frames to be in contact with concrete or dissimilar metals with two (2) coats of Fed. Spec. TT-V-51F Asphalt Varnish.

END OF SECTION 05530

Division 9 – Finishes

SECTION 09900 - PAINTING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide all labor, materials, equipment and services required to do all painting including preparation, priming and protection of finished surfaces. An extensive and comprehensive painting job will be required and shall include all surfaces that normally are painted.
- B. The intent of these Specifications is to obtain the material and workmanship necessary to produce an adequate, and acceptable job, and is intended to describe the requirements for both shop and field painting.
- C. The intent of this Specification Section is to include all items that are to receive painting.

1.02 RELATED WORK

- A. Division 1 - General Requirements.
- B. Division 5 - Metals.
- C. Section 07900 - Joint Sealers.
- D. Wherever detailed painting requirements are covered under an equipment or product specification, the Specifications herein govern with respect to surface preparation, paint materials, coats, thickness and coverage.

1.03 REQUIREMENTS

- A. It is the intent of this Specification Section that the Contractor shall paint all exposed structural steel, miscellaneous ferrous metal, lintels, equipment, piping, all exterior masonry walls and all other work obviously required or noted to be painted unless otherwise specified (see also Article 2.01). The omission of minor items in the schedule of work shall not relieve the Contractor of his obligation to include such items where they come within the general intent of the Specifications as stated herein. All interior surfaces and equipment that have been previously painted shall be repainted or recoated following the proper surface preparation.
- B. The Contractor shall review and examine all Divisions and Sections of these Specifications for any additional painting requirements and/or additional surfaces or items to be painted.

- C. Equipment on which the factory paint has been damaged shall require complete repainting or spot painting as directed by the Engineer.
- D. Apply specified finish coats of paint to all pre-primed work and complete finishing system for unprimed work required to be painted.
- E. Backprime, with specified interior first coat material all surfaces of finish trim which will be concealed after installation.
- F. Apply specified finish coats of paint to all prepainted surfaces which are judged by the Engineer as requiring only a finish coat. Otherwise, the complete system (as given in Article 2.01) shall be administered.

1.04 ITEMS NOT REQUIRING FIELD PAINTING

- A. All new galvanized metal surfaces (except where noted on Drawings).
- B. Exposed PVC plastic piping (except where required for color coding).
- C. Valves, fittings, and appurtenances in small diameter plastic piping (less than 3 inches).
- D. Prefinished items except as directed by the Engineer.
- E. Plain copper and stainless steel.
- F. Aluminum except where otherwise designated and required to prevent corrosion at contact with dissimilar materials.
- G. Concrete floors except where noted.
- H. Exterior concrete surfaces except where noted.
- I. Finish hardware.
- J. Concealed from view items (except where required for color coding) and surfaces, except as specified herein or where previously painted.
- K. Packing glands and other adjustable parts and nameplates of mechanical equipment.

1.05 DEFINITIONS

- A. The term "paint" as used herein includes enamels, epoxy, paints, sealers, fillers, emulsions, and other coatings.
- B. ASTM = ASTM International

- C. DFT = Dry film thickness.
- D. SSPC = SSPC: The Society for Protective Coatings.

1.06 SUBMITTALS

A. Manufacturer Name:

1. Immediately after bids are received, the apparent low bidder (Contractor) shall submit the name of paint manufacturer to be used on this project. If, during shop drawing review, the Engineer determines that the proposed manufacturer is acceptable, then that manufacturer's products must be used on the project unless otherwise directed by the Engineer.
2. Contractor shall submit manufacturer's name and brand of coating materials proposed to be used for painting on this project in accordance with Section 01300.

B. Materials List:

1. Before any materials are delivered to the project site, submit to the Engineer a complete list of all materials proposed to be furnished including quantities, types and descriptions of paint for each part of the project. Material list shall make reference to the specified paint systems and the paint schedule for each paint product proposed to be used. In cases where paint materials other than those described in the Specifications are proposed, a materials list will not be considered as acceptance of such substitute materials; further data will be required as specified herein.
2. Two (2) copies of the full range of colors available in each of the proposed products shall be submitted with the materials list.

C. Manufacturer's Data:

In any case where material is of manufacturer other than that listed as an Acceptable Manufacturer's (Article 1.10), the Contractor shall submit the following data to the Engineer for review prior to placing the material order.

1. Example of past performance of paints under similar conditions (case histories).
2. Types of paint.
3. Percentage of solids by volume.
4. Recommended usage.
5. Current recommended method of application published by manufacturer, (Data Sheet and Material Safety Data Sheets).

D. Color Samples:

1. Where standard stock chart colors are not satisfactory, furnish color samples. All tinting and matching shall be to the satisfaction of the Engineer.
2. Color samples shall be provided to the Engineer's office.

1.07 QUALITY ASSURANCE

- A. Qualification of Painters: All painting shall be done by qualified, skilled, experienced craftsmen. In the acceptance or rejection of completed painting, no allowance will be made for lack of skills on the part of the craftsmen.
- B. Paint Labels: Labels on paint containers shall include the following:
 - 1. Manufacturer's name.
 - 2. Generic type of paint.
 - 3. Manufacturer's stock number.
 - 4. Batch Number
 - 5. Color.
 - 6. Instructions for thinning where applicable.
- C. Compatibility:
 - 1. The Contractor shall be responsible for the compatibility of all paints used in the Work. A compatible paint will be considered a paint which precludes adverse effects related to bonding, drying delamination, scaling, lifting, and bleeding.
 - 2. In cases where shop-applied primers and coatings on materials and equipment furnished by suppliers are products different from those described in the Specifications, the Contractor shall verify compatibility with the specified field-applied coating system.
 - 3. Where thinning is necessary, only the products of the manufacturer furnishing the paint, and products for thinning purposes only, will be allowed.
- E. Thickness and Spreading Rates:
 - 1. Paint film thickness shall be subject to measurement by the Engineer in accordance with SSPC-PA2. If dry film thickness is found to be less than specified, or coverage is not uniform, the Contractor shall apply additional paint to correct thickness or appearance at no additional cost to the Owner. Paints shall not be applied in excess of the maximum thickness allowed by the paint manufacturer.
 - 2. Paint shall be applied so as to obtain the dry film thickness per coat specified herein. Concrete or masonry coatings may be applied by spreading rates (square feet per gallon) if so specified. Do not exceed manufacturer's recommended coverage rates.
 - 3. Regardless of the number of coats applied, the total dry film thickness specified herein must be achieved.
 - 4. Check for holidays on steel immersion surfaces using holiday detector in accordance with NACE RPO-188.
- F. Technical Services: The Contractor shall provide assurance that a qualified representative of the paint manufacturer makes periodic visits to the project site during painting to verify proper application procedures, quality and progress of work.

1.08 PRODUCT DELIVERY, HANDLING AND STORAGE

- A. Delivery: All materials shall be brought to the project site in the original sealed and labeled containers of the paint manufacturer. All labels shall be legible and intact at time of use.
- B. Manufacturer's Instructions: Paint manufacturer's written instructions for proper surface preparation, mixing, thinning, application and drying shall be furnished with the paint, and strictly followed.
- C. Storage of Materials:
 - 1. Store only acceptable materials on project site.
 - 2. Store only in a suitable and designated area restricted to the storage of paint materials and related equipment.
 - 3. Comply with all applicable health and fire regulations regarding the storage of paint materials.
 - 4. Storage of material shall comply with the manufacturer's specifications; however, storage shall be at a minimum temperature of 50 degrees F.
- D. Protection of Materials:
 - 1. Take all necessary precautions to ensure the safe storage and use of paint materials and the prompt and safe disposal of waste.
 - 2. Painting wastes shall be properly deposited in containers made for this purpose. Do not use plumbing fixtures for disposing paints wastes.
 - 3. Take all necessary precautions to protect paint materials before, during and after application and to protect the finished work.
- E. Replacement: In the event of damage to paint materials, immediately make all replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

1.09 JOB CONDITIONS

- A. Environmental Requirements:
 - 1. Comply with manufacturer's recommendations as to environmental conditions under which painting systems can be applied.
 - 2. Do not apply finish in areas where dust and/or mist is being generated.
- B. Climatic Conditions: Paint shall not be applied if:
 - 1. The ambient temperature or temperature of the surface to be painted is below 50 degrees F or below the temperature recommended by the paint manufacturer.
 - 2. The surface temperature is less than 5 degrees F above dew point.
 - 3. The relative humidity is above 85 percent.
 - 4. The relative humidity is such that the paint will not dry properly in accordance with

the manufacturer's instructions.

C. Protection:

1. Protect with drop cloths, masking or other acceptable means all surfaces which could be damaged in function or appearance by paint, including surfaces not being painted concurrently and surfaces not to be painted.
2. Hardware, accessories, fixtures and similar items shall be removed and replaced after completion of painting.
3. Spray painting will not be permitted when it will cause damage to adjacent or otherwise located surfaces.
4. All paint splatters on glass shall be wiped off immediately.

1.10 ACCEPTABLE MANUFACTURERS

The paints listed are products of Sherwin Williams and the Tnemec Company, and are specified as a "standard of quality" only. Similar paints and painting systems, of equal or superior quality, may be substituted subject to approval by the Engineer and subject to the provisions contained herein.

PART 2 - PRODUCTS

2.01 PAINT SYSTEMS

A. General:

1. All paints of a system shall be by one (1) manufacturer.
2. Adhesion tests in accordance with ASTM D6677, Standard Test Methods for Measuring Adhesion by Knife Test, may be requested by the Engineer on various surfaces to be painted to assure bonding compatibility. Other test methods may be required as determined by the Engineer.
3. Paints containing lead, or other "dangerous" materials, that surpass federal maximum levels shall not be allowed. Oil shall be pure boiled linseed oil.

B. Paint Systems: See Paint Schedule on following page.

2.02 COLORS

A. The manufacturer shall be able to furnish all paints for exposed surfaces in a wide range of colors and lighter and darker shades of these colors from which the Engineer may select the colors required on the various surfaces, if not included in the following codes.

1. Safety Color Codes: Comply with Occupational Safety and Health Administration Standards, as applicable, regarding safety color codes.
2. Piping Color Codes: Colors for process pipe coding shall be in accordance with the latest edition of Recommended Standards for Water Works and/or Recommended Standards for Wastewater Facilities or as selected by the Engineer. Pumps, meters, valves, etc., shall be painted the same color as the line in which they are a part.

PAINT SCHEDULE FOR CARBOLINE PRODUCTS

System Number	Description	Surface Preparation	Primer Coat		Intermediate Coat		Finish Coat	
			Material	DFT	Material	DFT	Material	DFT
A1	Interior Concrete Block (all areas except A2)	SSPC-SP 13 clean & dry	Sanitile 100	80-100 ft ² /gal.	Carboguard 890	2.0-3.0 mils	Carboguard 890	2.0-3.0 mils
A2	Interior Concrete Block (office type areas)	SSPC-SP 13 clean & dry	Sanitile 100	75 ft ² /gal.	Carbocrylic 3359DTM	2.0 – 3.0 mils	Carbocrylic 3359DTM	2.0 – 3.0 mils
A3	Exterior Concrete Block	SSPC-SP 13 clean & dry	Flexxide	80 - 100 ft ² /gal.			Flexxide	125 ft. ² /gal.
A4	Interior Structural Ferrous Metal and Piping, and Machinery	SSPC SP6	Carboguard 890	2.5 –3.5 mils			Carboguard 890	4.0 – 6.0 mils
A5	Exterior Structural Ferrous Metal and Piping	SSPC SP6	Carboguard 890	2.5 –3.5 mils	Carboguard 890	2.0 -3.0 mils	Carbothane 134 HG	2.0 – 3.0 mils
A6	Submerged Metal	SSPC SP10	Carboguard 890	2.5 –3.5 mils	Carboguard 890	4.0 -6.0 mils	Carboguard 890	4.0 -6.0 mils
A7	Chemical Storage Containment Area (floor, trench, tank pad, and 3-foot 6-inch band on walls)	SSPC-SP 13 (w/ 60 grit sandpaper finish)	Carboseal 720	6.0 – 8.0 mils	Semstone 145	25.0 – 40.0 mils	Semstone 145	8.0 – 12.0 mils
A8	Interior Wood (painted)	clean & dry	Sanitile 100	1.0 - 1.5 mils	Carbocrylic 3359DTM	2.0-3.0 mils	N/A	2.0-3.0 mils
A9	Interior Wood (stained)	clean & dry	5035 Sealer	480 ft ² /gal	1600 Woodmaster Stain	Variable	81 Woodmaster Varnish	450 ft. ² /gal
A10	Exterior Wood (painted)	clean & dry	Sanitile 100	1.0 - 1.5 mils	Carbocrylic 3359DTM	1.5 – 3.5 mils	N/A	1.5 – 3.5 mils
A11	Interior Gypsum Board	clean & dry	Sanitile 100	1.0 - 1.5 mils	Sanitile 555	2.0-3.0 mils	Sanitile 555	2.0-3.0 mils
A12	Concrete Ceiling Board	SSPC-SP 13 clean & dry	Sanitile 100	1.0 - 1.5 mils	Sanitile 555	4.0 - 6.0 mils*	Sanitile 555	4.0 – 6.0 mils
A13	Laboratory Floor	SSPC-SP 13 clean & dry	Carboseal 720	8.0 - 1.0 mils	Semstone 145	10.0 - 12.0 mils*	Semstone 145	10.0 – 12.0 mils
A14	Interior Ceiling Panels	SSPC-SP 13 clean & dry			Carboguard 635VOC	2.0 – 4.0 mils	Carboguard 635VOC	2.0 – 4.0 mils

* Note: Brush and/or roller application will require more than two coats.

PAINT SCHEDULE FOR RUST-OLEUM PRODUCTS

System Number	Description	Surface Preparation	Primer Coat		Intermediate Coat		Finish Coat	
			Material	DFT	Material	DFT	Material	DFT
A1	Interior Concrete Block (all areas except A2)	SSPC-SP 13 clean & dry	Zinsser 2X Block Filler	80-100 ft ² /gal.	9100 Epoxy	2.0-3.0 mils	9100 Epoxy	2.0-3.0 mils
A2	Interior Concrete Block (office type areas)	SSPC-SP 13 clean & dry	Zinsser 2X Block Filler	75 ft ² /gal.	Sierra S60	2.0 - 3.0 mils	Sierra S60	2.0 – 3.0 mils
A3	Exterior Concrete Block	SSPC-SP 13 clean & dry	Watertite Flexible	80 - 100 ft ² /gal.			Watertite Flexible	125 ft. ² /gal.
A4	Interior Structural Ferrous Metal and Piping, and Machinery	SSPC SP6	MetaPrime	2.5 –3.5 mils			9100 Epoxy	4.0 – 6.0 mils
A5	Exterior Structural Ferrous Metal and Piping	SSPC SP6	MetaPrime	2.5 –3.5 mils	9100 Epoxy	4.0 -6.0 mils	9800 UV Urethane	3.0 – 5.0 mils
A6	Submerged Metal	SSPC SP10	9100 Epoxy	2.0 –3.0 mils	9100 Epoxy	4.0 -6.0 mils	9100 Epoxy	4.0 -6.0 mils
A7	Chemical Storage Containment Area (floor, trench, tank pad, and 3-foot 6-inch band on walls)	SSPC-SP 13 (w/ 60 grit sandpaper finish)	Dudick 67LV; fill pockets with Scratch-Coat 300; reinforce corners with fiberglass cloth	6.0 – 8.0 mils	Dudick Protecto-Coat 100XT (flake-filled coating-flakes interbond to give good permeability & resist cracking)	15.0 – 20.0 mils	Dudick Protecto-Coat 100 XT	15.0 – 20.0 mils
A8	Interior Wood (painted)	clean & dry	Acrylic Universal Primer	1.0 - 1.5 mils	Sierra S60	2.0-3.0 mils	Sierra S60	2.0-3.0 mils
A9	Interior Wood (stained)	clean & dry	Rust-Oleum Varathane Wood Stain	480 ft ² /gal	Rust-Oleum Varathane Sanding Sealer (optional)	Variable	Rust-Oleum Varathane Polyurethane Finish	450 ft. ² /gal
A10	Exterior Wood (painted)	clean & dry	Acrylic Universal Primer	1.0 - 1.5 mils	Perma-White Exterior	1.5 – 3.5 mils	Perma-White	1.5 – 3.5 mils
All	Interior Gypsum Board	clean & dry	Acrylic Universal Primer	1.0 - 1.5 mils	Sierra S60	2.0 – 3.0 mils	Sierra S60	2.0 – 3.0 mils
A12	Concrete Ceiling Board	SSPC-SP 13 clean & dry	Acrylic Universal Primer	1.0 - 1.5 mils	Sierra S60	4.0 – 6.0 mils	Sierra S60	4.0 – 6.0 mils
A13	Laboratory Floor	SSPC-SP 13 clean & dry	Acrylic Universal Primer	6.0 - 8.0 mils	Overkote S	10.0 – 12.0 mils	Overkote S	10.0 – 12.0 mils
A14	Interior Ceiling Panels	SSPC-SP 13 clean & dry			9100 Epoxy	4.0 – 6.0 mils	9100 Epoxy	4.0 – 6.0 mils

* Note: Brush and/or roller application will require more than two coats.

PAINT SCHEDULE FOR TNEMEC PRODUCTS

System Number	Description	Surface Preparation	Primer Coat		Intermediate Coat		Finish Coat	
			Material	DFT	Material	DFT	Material	DFT
A1	Interior Concrete Block (all areas except A2)	SSPC-SP 13 clean & dry	130 Envirofill	80-100 ft ² /gal.	N69 Epoxoline II	2.0-3.0 mils	N69 Epoxoline II	2.0-3.0 mils
A2	Interior Concrete Block (office type areas)	SSPC-SP 13 clean & dry	130 Envirofill	80-100 ft ² /gal.	113 H.B. Tneme-Tufcoat	4.0 – 6.0 mils	113 H.B. Tneme-Tufcoat	4.0 – 6.0 mils
A3	Exterior Concrete Block	SSPC-SP 13 clean & dry	130 Envirofill	80-100 ft ² /gal.	156 Enviro-Crete	102-136 ft ² /gal.	156 Enviro-Crete	102-136 ft ² /gal.
A4	Interior Structural Ferrous Metal and Piping, and Machinery	SSPC SP6	1 Omnithane	2.5 –3.5 mils	N69 Epoxoline II	4.0 – 6.0 mils	N69 Epoxoline II	4.0 – 6.0 mils
A5	Exterior Structural Ferrous Metal and Piping	SSPC SP6	1 Omnithane	2.5 –3.5 mils	N69 Epoxoline II	4.0 -6.0 mils	1094 Endura-Shield	2.0 – 3.0 mils
A6	Submerged Metal	SSPC SP10	1 Omnithane	2.5 –3.5 mils	N69 Epoxoline II	4.0 -6.0 mils	N69 Epoxoline II	4.0 -6.0 mils
A7	Chemical Storage Containment Area (floor, trench, tank pad, and 3-foot 6-inch band on walls)	SSPC-SP 13, ICRI CSP 5. Clean & dry	201 Epoxoprime	6.0 – 8.0 mils	239 SC mortar base coat @ 60.0 to 80 dry mils. Embed 211-0215 Fiberglass mat while wet.	239 SC saturant coat at 8-12 dry mils.	282 Tneme-Glaze	8.0 – 12.0 mils
A8	Interior Wood (painted)	clean & dry	151-1051 Elasto-Grip FC	1.0 - 1.5 mils	113 H.B. Tneme-Tufcoat	4.0-6.0 mils	113 H.B. Tneme-Tufcoat	4.0-6.0 mils
A9	Interior Wood (stained)	clean & dry	5035 Sealer	480 ft ² /gal	1600 Woodmaster Stain	Variable	81 Woodmaster Varnish	450 ft. ² /gal
A10	Exterior Wood (painted)	clean & dry	151-1051 Elasto-Grip FC	1.0 - 1.5 mils	1028 Enduratone	2.0 – 3.0 mils	1028 Enduratone	2.0 – 3.0 mils

PAINT SCHEDULE FOR TNEMEC PRODUCTS (cont.)

A11	Interior Gypsum Board	clean & dry	151-1051 Elasto-Grip FC	1.0 - 1.5 mils	113 H.B. Teneme-Tufcoat	4.0-6.0 mils	113 H.B. Tneme-Tufcoat	4.0-6.0 mils
A12	Concrete Ceiling Board	SSPC-SP 13 clean & dry	151-1051 Elasto-Grip FC	1.0 - 1.5 mils	113 H.B. Tenem-Tufcoat	4.0 - 6.0 mils*	113 H.B. Tneme-Tufcoat	4.0 – 6.0 mils
A13	Laboratory Floor	SSPC-SP 13, ICRI CSP 3. clean & dry	201 Epoxoprime	8.0 – 10.0 mils	282 Tneme-Glaze	10.0 – 12.0 mils*	282 Tneme-Glaze	10.0 – 12.0 mils
A14	Interior Ceiling Panels	SSPC-SP 13, ICRI CSP 3. clean & dry	Series 218 MortarClad to fill voids and bugholes as needed.		N69 Epoxoline II	3.0 – 5.0 mils	N69 Epoxoline II	3.0 – 5.0 mils

* Note: Brush and/or roller application will require more than two coats.

(The remainder of this page is intentionally blank.)

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine surfaces scheduled to receive paint and/or coating finishes for conditions that will adversely affect application, permanence or quality of work and which cannot be put into an acceptable condition through surface preparation.
- B. Do not proceed with surface preparation or painting application until conditions are suitable.
- C. If surfaces are not thoroughly dry or if they cannot be put in proper condition to receive paint by customary cleaning methods, the painting applicators shall notify the Contractor in writing, requesting necessary corrections.
- D. Review the specified or approved painting systems and bring any questions or doubts as to the proper performance in writing to the Engineer at least 15 calendar days prior to commencing work. Otherwise, the Contractor shall assume the responsibility for providing the desired results.

3.02 ACCEPTANCE OF SURFACES

The commencement of painting work in any area or space will be construed as acceptance of the surface as being satisfactory.

3.03 SURFACE PREPARATION

- A. General:
 - 1. All surfaces shall be thoroughly cleaned and free of dust, dirt, rust, mill scale, loose paint, or oily materials. Cleaning shall be in accordance with SSPC-SP1 Solvent Cleaning. No painting shall be done until surface is inspected by the Engineer or his designates.
 - 2. Surfaces shall be primed and/or treated, as specified, as soon after completion of surface preparation as practical, but in any event within the same day and before any visible or detrimental corrosion or contamination can occur. A prepared surface, which becomes corroded or contaminated, shall be re-prepared before treating and/or priming.
- B. Non-Submerged Non-Galvanized Structural Steel: All new non-galvanized structural steel for non-submerged service shall have their surfaces prepared according to SSPC-SP6, Commercial Blast Cleaning.
- C. Submerged Non-Galvanized Structural Steel: All new non-galvanized structural steel and fabricated metals for submerged service or high temperature service shall have their surfaces prepared according to SSPC-SP10-Near White Blast Cleaning.

- D. Non-Ferrous Metals: Non-ferrous metals surface preparation shall be not less than that required by the paint manufacturer.
- E. Concrete and Masonry:
 - 1. All concrete to be coated shall have their surfaces prepared by a light blast cleaning in accordance with SSPC – SP 13 or in accordance with the manufacturer's recommendation, to remove loose coating and provide a textured surface to enhance adherence of the new coating. No blast cleaning shall be done on the job in areas containing pumps, motors or other equipment that could be damaged by infiltration of sand particles.
- F. Wood Surfaces: Wood surfaces shall be thoroughly cleaned of all extraneous matter and all cracks, nail holes, and other defects properly filled and smoothed. Wood trim shall be sanded to fine finish and wiped clean of dust.

3.04 SHOP PRIMING

- A. Shop priming shall be done with primers that are guaranteed by the equipment manufacturer to be compatible with the finish paints to be used.
- B. The Contractor shall coordinate all paint materials supplied in the shop and field.

3.05 THINNING

Thinning shall be done strictly in accordance with the paint manufacturer's instructions and only upon notifications to the Engineer. When thinning is acceptable, coats of paint shall be applied as needed to build up to the specified dry film thickness.

3.06 APPLICATION

- A. All weld seams and sharp edges shall be primed by the brush method to ensure all surfaces are sufficiently covered and pinhole free. On metal surfaces apply each coat of paint at the rate specified by the manufacturer to achieve the minimum dry mil thickness required. Deficiencies of film thickness shall be corrected.
- B. On masonry, the application rates will vary according to surface texture; however, in no case shall the manufacturer's stated coverage rate be exceeded.
- C. On porous surfaces, it shall be the painter's responsibility to achieve a protective and decorative finish either by decreasing the coverage rate or by applying additional coats of paint.
- D. Evenly brush out each coat and permit to dry per manufacturer's recommendation before applying any subsequent coats.

- E. All paints and coatings shall be maintained at minimum manufacturer's storage temperature before applying.
- F. Successive coats of paint shall be tinted so as to make each coat easily distinguishable from each other with the final undercoat tinted to a darker shade than the finish coat.
- G. Finish surfaces shall not show brush marks or other irregularities. Undercoats shall be thoroughly and uniformly sanded with No. 00 sandpaper or equal to remove defects and provide a smooth even surface.
- H. Painting shall be continuous and shall be accomplished in an orderly manner so as to facilitate inspection. Materials subject to weathering shall be prime coated as quickly as possible. Surfaces of exposed members that will be inaccessible after erection shall be cleaned and painted before erection.
- I. All surfaces to be painted as well as the atmosphere in which painting is to be done shall be maintained at the conditions recommended by manufacturer by heating and ventilating, if necessary, until each coat of paint has hardened. Any defective paint shall be removed and the surface repainted.
- J. Perform all required back-priming work before items are installed.

3.07 REINSTALLATION OF REMOVED ITEMS

Following completion of painting in each space, promptly reinstall all items removed for painting, using only workmen skilled in the particular trade.

3.08 CLEANING

- A. During the progress of Work, do not allow the accumulation of empty containers or other excess items except in areas specifically reserved for that purpose.
- B. Take all precautions to prevent accidental spillage of paint materials. In the event of spilling, immediately remove all spilled materials and the waste and other equipment used to clean-up the spill, and wash surfaces to their original undamaged condition.
- C. Touch-up and restore finish where damaged.
- D. Remove all trash and accumulated materials of a painting nature from premises at the completion of the Work.
- E. Paint spots, oil or stains upon adjacent surfaces shall be removed. Any damage to Work of other trades or equipment caused from painting shall be made good at no expense to the Owner.

- F. Do not mar surface finish of items being cleaned.
- G. Leave entire job clean (including paint storage space) and acceptable to the Engineer.

3.09 FINAL INSPECTION

- A. Protect all painted surfaces against damage until the date of final acceptance of the Work.
- B. The Engineer will conduct a final inspection of all painting work and the Contractor will be required to repaint or retouch any areas or surfaces found deficient in complying with these Specifications.

3.10 PIPE IDENTIFICATION

- A. All visible piping 3/4-inches and greater which is accessible for maintenance and operations shall be color coded and identified with appropriate stenciling or semi-rigid plastic identification markers equal to SETMARK Pipe Markers as manufactured by Seton Name Plate Corporation, New Haven, CT; T & B/Westline, Los Angeles, CA; or equal. Direction of flow arrows are to be included with each identification mark, unless otherwise specified.
- B. Each marker background or stenciling is to be appropriately color coded and have a clearly printed legend to identify the contents of the pipe in conformance with ANSI 13.1.
- C. Locations for pipe markers to be as follows:
 - 1. Adjacent to each valve and fitting (except on plumbing fixtures and equipment).
 - 2. At each branch and riser take-off.
 - 3. At each pipe passage through wall, floor and ceiling construction.
 - 4. At each pipe passage to underground.
 - 5. On all horizontal pipe runs, marked every 10 feet.

3.11 STENCILING

For visible piping not receiving a semi-rigid identification marker, the Contractor shall supply all materials and labor necessary for stenciling of legends and pipes. The legend shall show the name of the contents of the pipe. Review by the Engineer of legends will be required. Names shall be "plainly visible". Arrows showing direction of flow shall also be stenciled on pipes. "Stick-on" labels are not acceptable.

END OF SECTION 09900

Division 11 – Equipment

SECTION 11281 – ELECTRIC VALVE/GATE ACTUATORS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The Contractor shall furnish all labor, material, and equipment necessary to install valve actuators together with all appurtenances as shown and detailed on the Drawings and specified herein.
- B. The Drawings and Specifications direct attention to certain features of the equipment, but do not purport to cover all the details of their design. The equipment furnished shall be designed and constructed equal to the high quality equipment manufactured by such firms as are mentioned hereinafter, or as permitted by the Engineer. The Contractor shall furnish and install the equipment complete in all details and ready for operation.
- C. The manufacturer of the valve actuator shall coordinate with the manufacturer of the valve to insure that the bolted connection between the valve and actuator is compatible.
- D. Electrical work and equipment specified herein shall conform to the requirements of the applicable electrical sections.
- E. Sizes and capacities not specified herein are indicated on the Drawings.

1.02 RELATED WORK

- A. Section 02640 – Water Valves and Gates.
- B. Section 02642 – Sewage Valves and Gates.
- C. Division 13 – Special Construction
- D. Division 16 - Electrical

1.03 SUBMITTALS

- A. Complete shop drawings of all valves actuators and appurtenances shall be submitted to the Engineer in accordance with the requirements of Section 01300.

PART 2 - PRODUCTS

2.01 ELECTRIC VALVE ACTUATORS

- A. The valve actuators are to be manufactured by AUMA, or equal. Actuators shall contain motor, gearing, manual over-ride, limit switches, drive coupling, integral motor controls, position feedback transmitter (where required) and mechanical dial position indicator (where required).
- B. The actuators shall be suitable for use on a nominal 480 volt, 3 phase, 60Hertz power supply and are to incorporate motor, integral reversing starter, local control facilities, and terminals for remote control and indication connections.
 - 1. Actuators shall be capable of operating in an ambient temperature range of -20 to +175 degrees F (without motor controls) and -20 to +160 degrees F (with motor controls).
 - 2. All wiring shall be terminated at a plug and socket connector.
 - 3. All terminal connections for the customer use shall be located in a sealed terminal compartment that is separated from the controls components by means of a double water-tight seal.
- C. The actuator shall be sized to guarantee valve closure at the specified differential pressure. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal. The operating speed shall be such as to give valve closing and opening at approximately 10-12 inches per minute unless otherwise stated in the job specification.
- D. Actuators shall be as shown on the Plans.
- E. Enclosures:
 - 1. Actuator enclosure shall be NEMA 4 (water-tight).
 - 2. All external fasteners on the electric actuator will be stainless steel.
 - 3. Fasteners on limit switch and terminal compartments shall be captured to prevent loss while covers are removed.
- F. Drive Motor
 - 1. The motor shall be specifically designed for actuator service. The motor shall be of the indication type with class F insulation and protected by means of thermal switches embedded in the motor windings.
 - 2. Motor enclosure will be totally enclosed, non-ventilated.
- G. Travel Limit Switches:
 - 1. Operator shall be furnished with limit switches at each end of travel.
 - 2. Limit switch adjustment shall not be altered by manual operation.
 - 3. Limit switch drive shall be by countergear.
 - 4. Limit switch must be capable of quick adjustment requiring no more than five (5) turns of the limit switch adjustment spindle.
 - 5. A minimum of twelve (12) heavy-duty contacts shall be provided for each actuator.

6. Contacts shall be silver and capable of reliably switching low voltage DC source from the control system furnished by others.
 7. Limit switch adjusting shall be clearly marked as to direction of turn to adjust.
- H. Torque Switches:
1. Each operator shall be furnished with torque switches at each end of travel.
 2. Torque switches will trip when the valve load exceeds the torque switch setting.
 3. The torque switch adjustment device must be calibrated directly in engineering units of torque.
- I. Gearing:
1. The gearing shall be designed to withstand, without failure, the stall torque of the motor.
 2. The final drive shall be of the self-locking worm and wheel type to prevent creeping of the valve disc in intermediate position.
 3. Gear boxes to be cast iron construction and completely filled with lubricant, allowing operator to be installed in any position.
 4. All main drive gearing must be of metal construction.
- J. Motor Controls:
1. All actuators in open/close service will be furnished with integral motor controls consisting of reversing starters, control transformer, phase discriminator, monitor relay (to signal fault conditions such as thermal switch trip, torque switch tripped in mid-travel, wrong phase sequence or phase failure), 'open-stop-close' pushbuttons, 'local-off-remote' selector switch in addition to red and green indicating lights.
 2. An interface with the control system must be furnished with optical isolators to separate incoming voltage signals from the internal motor controls.
- K. Manual Over-Ride:
1. Manual over-ride shall be by hand wheel operator.
 2. Manual operation will be via power gearing to minimize required rimpull and facilitate easy changeover from motor to manual operation when actuator is under load.
 3. Return from manual to electric mode of operation will be automatic upon motor operation.
 4. A seized or inoperable motor shall not prevent manual operation.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Valve actuators shall be installed as nearly as possible in the positions indicated on the Drawings consistent with conveniences of operation. All valve actuators shall be carefully installed and supported in their respective positions free from all distortion

and strain on appurtenances during handling and installation.

- B. All material shall be carefully inspected for defects in workmanship and material, all debris and foreign material cleaned out of openings and seats, all operating mechanisms operated to check their proper functioning, and all nuts and bolts checked for tightness.
- C. Valve actuators and related equipment that does not operate easily or are otherwise defective shall be repaired or replaced at the Contractor's expense.
- D. Valve actuators shall be set plumb and supported adequately in conformance with the instructions of the manufacturer. Valve actuators in the filter control piping shall be installed so as to be easily accessible.

3.02 STARTUP KIT

Each actuator shall be supplied with a startup kit comprising installation instruction, electrical wiring diagram, and sufficient spare cover screws and seals to make good any site losses during the commissioning period.

3.03 PERFORMANCE TEST CERTIFICATE

Each actuator must be performance tested and individual test certificates shall be supplied. The test equipment should simulate a typical valve load and the following parameters should be recorded:

- A. Current at maximum torque setting
- B. Torque at maximum torque setting
- C. Flash Test Voltage
- D. Actuator Output Speed or Operating Time

In addition, the test certificate should record details of specification, such as gear ratios for both manual and automatic drive, closing direction, and wiring diagram code number.

3.04 PAINTING

- A. Valve actuators shall be factory primed and fully coated, inside and out, with fusion bonded epoxy in accordance with the latest revision of AWWA C550 Standard.
- B. Other shop painting shall be as specified in Division 9.
- C. Field painting is specified in Division 9.

3.05 WARRANTY

Each actuator shall be warranted for a minimum of 24 months of operation up to a maximum of 36 months from shipment. This warranty shall be held in effect regardless of pre-commissioning conditions in a typical indoor or outdoor environment as long as the actuator is not abused or disassembled. This warranty shall not require the use of special storage procedures (such as the use of indoor storage, plastic bags, desiccants, and the energization of heater(s) in order to be maintained.

END OF SECTION 11281

SECTION 11400 - ON-SITE GENERATED MIXED OXIDANT SYSTEM (OSGMOS)

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This Section covers the work necessary by the General Contractor, Installation Contractor, On-Site Generation Mixed Oxidant System (OSGMOS) Supplier, Owner and Engineer, to furnish, install, test and prepare for operation an On-site Generation Mixed Oxidant System. The OSMOS package includes what is listed in paragraph B below as well as related testing, start-up and training services.
- B. An On-Site Generation Mixed Oxidant System (OSGMOS) shall be furnished to enable on-site production of a 0.45% (4,500ppm) (+/- 1,000) Mixed Oxidant solution through the electrolysis of brine. The total installed generation capacity of the OSGMOS shall be 120 pounds of free available chlorine (FAC) per day. Each generator will have a capacity of 60 pounds of FAC per day.
- C. The disinfection system shall consist of equipment associated with an onsite generated Mixed Oxidant system. The system shall include the following as required but is not limited to: water preconditioning including cartridge filtration, feed water chilling, heating and inlet pressure boosting, water softener, a salt tank/brine generator suitable for storing and dissolving salt, generator controls, AC to DC power conversion and electrolytic cell located in an operator safe powder coated steel enclosure and a Mixed Oxidant solution holding tank. Each electrolytic cell shall be fully independent and will have its own power supply and controls.
- D. As evidence of mixed oxidant production, the EQUIPMENT SUPPLIER must submit bona fide 3rd party, and independently funded documentation verifying inactivation of *Cryptosporidium parvum* at least 2 logs in excess of what can be accomplished using sodium hypochlorite solution.
1. Due to the fundamental differences in technologies, onsite generation of sodium hypochlorite is not acceptable as a substitute product.
- E. The EQUIPMENT SUPPLIER shall furnish all components of the OSGMOS as specified herein, including:

	Quantity
On-Site Mixed Oxidant Generator (OSGMOS)	Two (2)
Feed Water Filter(s)	One (1)
Feed Water Softener(s)	One (1)
Feed Water Heater(s)	One (1)
Brine Saturator Silo	One (1)
Feed Brine Boost Pump(s)	Two (2)
Oxidant Storage Tank(s)	Two (2)
Passive Hydrogen Venting System (LBS)	Two (2)

Oxidant Injection Feed System	One (2)
Hydrogen Gas Detection Monitor(s)	One (1)

- F. The EQUIPMENT SUPPLIER shall provide the following services to ensure the safe and efficient operation of the OSGMOS:
1. OSGMOS commissioning and installation inspection
 2. OSGMOS startup
 3. OSGMOS testing supervision
 4. Operator training
- G. The CONTRACTOR shall furnish all labor, materials, equipment and appurtenances required to install, test and place into satisfactory operation the OSGMOS furnished by the EQUIPMENT SUPPLIER, including, but not limited to:
1. Mechanical installation of OSGMOS components, interconnecting piping, piping supports, fittings, valves and appurtenances.
 2. Electrical installation of OSGMOS components, motor control centers, motor starters, circuit breakers, raceways, fittings, conduits and cable trays, wires and cables, panel boards, metering devices, grounding systems, power factor correction capacitors, surge protection.
 3. Feed Water supply: 76 gph at a minimum pressure of 25 PSIG to each on-site generator. Provide feed pressure booster pumps if required.
 4. Electrical supply – Dedicated 380-530, three phase WYE, 35 Amps service for each on-site generator.
 5. The enclosure building must provide a building ambient air temperature between 45 °F and 110 °F.
 6. Piping and links interconnecting the equipment components:
 - a. Piping from source water to water filter(s) shall be 3/4" Schedule 80 PVC.
 - b. Piping from source water to the water softener(s) shall be 3/4" Schedule 80 PVC.
 - c. Piping manifold from the generator(s) discharge to the solution tank(s) shall be 2" Schedule 80 CPVC.
 - d. Minimum tank through-wall from manifold shall be 4" schedule 80 CPVC.
 - e. Minimum drop tube diameter shall be 4".
 - f. Piping from the oxidant solution injection feed pump(s) shall be 2" Schedule 80 PVC.
 7. PVC Hydrogen venting, 2" dia. Minimum, exiting highest point of each solution tank to the outside of facility. Requires rain vent cover on top of vent pipe.
 8. PVC vent piping, 2" diameter minimum, from the inlet of the Liquid Barrier Vent Down-Tube (LBS) in each solution tank to the outside of the

facility. Requires rain vent cover on top of vent pipe.

9. One (1) - 4" drain(s) to city sewer or evaporation ponds to handle periodic backwash waste line from water softeners and from house cleaning water spills.

1.2 QUALITY ASSURANCE

A. All OSGMOS components shall be supplied to the CONTRACTOR by a single EQUIPMENT SUPPLIER.

B. OSGMOS Supplier's Qualifications

1. The OSGMOS Supplier shall have experience in furnishing equipment of similar capacity and service capability to the equipment described herein. As part of their submittal package and prior to bid, the OSGMOS supplier shall submit the following:

- a. A list of five (5) installations, within Kentucky where similar equipment by the manufacturer is currently in comparable service; include contact name, telephone number, mailing address of the site installation, engineer, owner and date of installation. If five similar installations do not exist in that state, a comprehensive list of all installations in that state shall be provided in addition to a list of twenty (20) similar installations in other states.
- b. Current NSF/ANSI 61 listing for the Mixed Oxidant generation unit being offered.
- c. Evidence of compliance to UL508A by MET Laboratories or equivalent.
- d. Engineering Design Consideration Guidelines.
- e. Current ISO 9001:2015 Certification applicable to Design, Manufacture, assembly, installation, service and repair of Electrochlorination Systems for Water and Sewage Treatment and Water Treatment equipment.

2. The generation skid shall be pre-assembled, and factory tested in accordance with section 1.2-C below.

C. Factory Acceptance Test (FAT)

1. The OSGMOS System Supplier shall test pre-plumbed assemblies, control panels and junction boxes prior to shipment.

- a. The test shall consist of the following:
 - (i) Visual inspection of general workmanship.
 - (ii) Visual verification that the arrangement and dimensions of the assembly matches the fabrication and schematic drawings.
 - (iii) Visual verification of nameplates information.

- (iv) Hydrostatic Leak test. The OSGMOS System Supplier shall perform a hydrostatic leak test on the OSGMOS Skid assembly by filling the unit with water, venting all air, and pressurizing the entire system to 30 psig and holding it for 15 minutes.
- (v) Continuity test to verify wiring.
- (vi) Simulation of I/O's to verify correct wiring and correct software.
- (vii) Measure the concentration of Mixed Oxidant solution (as chlorine equivalent) generated by the OSGMOS unit.
- (viii) Confirm and document all instruments' set-points, system alarms and faults as shown on the electrical control panel drawings and control philosophy
- (ix) Document all test data on a Test Record Form.

D. Salt Quality Requirements, containing no organic binders, flow control agents or resin cleaning material, and meeting the following specifications:

Sodium Chloride (NaCl) – Minimum Quality Requirement	
Sodium Chloride – dry basis	99.5% minimum
Impurity	Percent Maximum
Calcium (in all forms)	0.01%
Magnesium (in all forms)	0.01%
Manganese	0.00002%
Iron (as Fe)	0.0005%
Insoluble	0.005%
Additives	0.0001%
Limit Aluminum, Silicon, Barium, Strontium, Titanium, Suspended Solids, Heavy Metals, Complexing Agents (i.e. Sugars, EDTA, and CN-)	

E. Approved EQUIPMENT SUPPLIER(S) is:

- 1. De Nora Water Technologies, Sugar Land, TX.

1.3 SUBMITTALS

A. Shop Drawings – The OSGMOS System Supplier shall submit One (1) electronic set of the documents listed below to the General Contractor and/or the Engineer for information only or for approval.

- 1. Manufacturer/Supplier's literature, illustrations and specifications for the major components. The literature shall include detailed descriptions and specifications of the component to permit comparison with the technical specifications.
- 2. Equipment dimensions, materials, size and weight: Equipment anchor bolts layout but not including anchor bolts size, length, material and embedment.

3. Equipment general arrangement drawings with dimensions and locations of inlet and outlet connections.
 4. Electrical documentation shall include panel layouts, schematics, and interconnecting field wiring diagrams.
 5. Hydrogen dilution blower data sheet and performance curve.
 6. For each supplied pump, a pump data sheet indicating head, capacity and horsepower as applicable shall be provided.
 7. Piping and Instrumentation Diagram.
 8. Design Operating Specifications including acceptable range of water pressure, water and brine flow rates, water temperature, and water quality (hardness, pH, heavy metals, TOC, etc.) to On-Site Electrolyzer(s) for proper system operation.
 9. Evidence of compliance to UL508A by MET Laboratories or equivalent and NSF/ANSI 61 listing.
- B. The OSGMOS System Supplier shall submit One (1) electronic final copy and One (1) paper final copy of the Operation and Maintenance manual as described below to the General Contractor or the Engineer for information only or for approval:
1. Installation and operating instructions for each major piece of equipment.
 2. Explanations for all safety considerations related to operations.
 3. Startup Procedures.
 4. Delivery, Handling and Short & Long-Term Storage Instructions.
 5. As-built drawings.
 6. OSGMOS System Building Installation and Design Consideration Guidelines.
 7. Maintenance Procedures shall include proper instructions required by plant personnel to keep equipment properly cleaned, lubricated and adjusted to manufacturer's specifications. The following shall be provided:
 - a. Preventative Maintenance Schedule Checklist
 - b. Troubleshooting guide (instructions)
 - c. Basic Testing Guide
 - d. Acid Wash Guide
 - e. Recommended spare parts list

1.4 DELIVERY, STORAGE AND HANDLING

- A. During long-term storage or long shut-down period, the General Contractor shall be responsible for periodically preserving and maintaining each piece of equipment of the OSGMOS System and re-conditioning them prior to startup.

1.5 SPARE PARTS AND SPECIAL TOOLS

- A. Included in the proposal, the EQUIPMENT SUPPLIER shall furnish spare parts required to ensure adequate operation of the OSGMOS. Spare parts shall include

as a minimum.

1. One (1) brine dilution pump
 2. Six (6) 5-micron filter brine cartridges
 3. Six (6) 5-micron filter water cartridges
 4. One (1) brine solenoid
 5. One (1) rupture disk
 6. One (1) electrolytic cell Water inlet temperature transmitter assembly
 7. One (1) electrolytic cell Oxidant outlet temperature transmitter assembly
 8. One (1) set of pump spare kit for each type of pump
 9. One (1) lot of assorted items recommended by manufacturer.
- B. The EQUIPMENT SUPPLIER shall furnish all special tools required for the proper installation, operation and maintenance of any component of the OSGMOS.
- C. Spare parts shall be packed and consolidated in a single box with clear indelible identification markings and shall be stored in a dry and warm location until transferred to the Owner at the completion of the contract along with a packing list for future re-order.
- D. The OSGMOS System Supplier shall furnish One (1) maintenance kit which includes chlorine test kit, water hardness test kit, hydrometer, dial thermometer, graduated cylinder, salinity chart, cartridge filter, tools and the Operation & Maintenance Log Book.

1.6 WARRANTY

- A. The OSGMOS Supplier shall inspect the installation after completion and confirm that the OSGMOS System's supplied equipment and installation is free from faults and defects and is in conformance with the OSGMOS Supplier's approved submittal drawings and documents.
1. The first inspection shall be a visual one using the digital pictures and pre-startup checklist completed by the Installation Contractor.
 2. The second inspection shall be done before startup and shall be a visual site inspection of the mechanical and electrical installation of the OSGMOS Supplier's provided equipment only.
- B. The OSGMOS Supplier shall provide the following After Market Services:
1. 24-hour, 365-day toll free service.
 2. Standard parts availability.
- C. The OSGMOS System shall be warranted against defects in materials and workmanship under normal use and service of which its products were designed as defined by the manufacturer's requirements.
1. The On-Site Generator skid warranty shall be for a period of 18 months after OSGMOS equipment start-up and commissioning sign-off by customer or 24 months from shipment of the goods from the factory, whichever comes first

2. The Electrolytic Cell warranty shall be for a period of 60 months from shipment of the goods from the factory. The cell warranty covers the complete cell assembly, not just the electrodes. The warranty is valid only for properly maintained Electrolytic Cell assembly per the OSGMOS Supplier's operation and maintenance manual and maintenance logbook.
 3. The On-Site Generator supplier shall warranty other equipment and services included in its scope of supply for the project for 12 months from shipment of the goods from the factory or with original equipment manufacturer's warranty, whichever comes first.
- D. This warranty only includes parts and does not cover labor, expenses, consumable maintenance items, "Acts of God", theft and vandalism, intentional or accidental abuse, misuse, neglect or operator error, failure to perform preventative maintenance, abuse by abnormal system conditions, improper storage and long-term preservation, alteration of equipment/programming, and normal wear and tear.

PART 2 - PRODUCTS

2.1 PRE-APPROVED MANUFACTURER

- A. The OSGMOS shall be the MIOX® V-Series as manufactured by De Nora Water Technologies, LLC, or equal.

2.2 GENERAL OSGMOS SYSTEM OPERATION AND DESIGN REQUIREMENTS

- A. The Mixed Oxidant Generator shall require salt, water and electricity.
- B. The Brine Silo shall produce a saturated brine solution using softened water and salt.
- C. The water softener resin shall be automatically regenerated with Brine solution from the Brine Silo.
- D. The Mixed Oxidant Generator skid shall be equipped with safety devices/instruments such as pressure, temperature and flow sensors in order to ensure a safe and reliable generation process.
- E. A diluted brine solution shall pass through the electrolytic cell(s) located on the On-Site Generator unit and produce a consistent 0.45% ($\pm 1,000$ mg/L) weight Chlorine equivalent as Mixed Oxidant solution.
- F. Recirculation of the Mixed Oxidant solution shall not be allowed to avoid decomposition, reduced and inconsistent concentration of Mixed Oxidant, Hydrogen bubbles entrapment and increased hypochlorite solution temperature leading to increased concentration of by-products such as chlorate and perchlorate.
- G. The generated Mixed Oxidant solution shall be stored in chemical resistant storage tank(s).

- H. The Mixed Oxidant storage tank(s) shall be equipped with level controls for operation of the Hypochlorite generation equipment and alarm initiation. The Hypochlorite generator shall automatically start and stop based on the high and low level in the Mixed Oxidant storage tank.
- I. The OSGMOS shall have no waste products associated with its use other than hydrogen gas which shall be vented to atmosphere and softener backwash.
- J. The hydrogen venting system shall be completely passive without any moving parts or active components. Piping shall be sized according to the DNWT Hydrogen Safety White Paper (HSWP).
- K. Under normal operating conditions, the stored Mixed Oxidant solution shall be injected into the process at locations shown on the contract drawings for disinfection.

2.3 GENERAL OSGMOS SYSTEM DESIGN REQUIREMENTS

- A. The Mixed Oxidant Generation System shall produce 120 (minimum) pounds per day of chlorine equivalent calculated based on 26.7 gallons per day of 4,500 mg/L (+/- 1,000) Mixed Oxidant through the electrolysis of brine.
- B. The system shall include the following generator(s):
 - 1. Capacity per generator skid: 60 lbs/day
 - 2. Total number of generator skid(s): Two (2)
 - 3. Quantity of generator skid(s) running as Duty: One (1)
 - 4. Quantity of generator skid(s) as Standby: One (1)
- C. Water, brine or generated solution recirculation design shall not be allowed as it causes repeat breakdown and degradation of the generated solution strength, increase product temperature and increase by-product (such as chlorate and perchlorate) formation.
- D. The Electrolytic Cell(s) shall be periodically cleaned In-Place for Safety of the operating/maintenance personnel. Removal of the electrolytic cell assembly from the hypochlorite generation system for periodic acid cleaning maintenance shall not be required.
- E. The Engineer shall provide the following supplied water quality and temperature information to properly size the OSGMOS.
 - 1. Lowest water temperature: _____ (degrees F) for _____ days per year
 - 2. Highest water temperature: _____ (degrees F) for _____ days per year
 - 3. Annual average water temperature: _____ (degrees F) for _____ days per year
 - 4. Water quality analysis
- F. Salt quality shall comply with the minimum requirements listed in the table below.

Sodium Chloride (NaCl) – Minimum Quality Requirement	
Sodium Chloride – dry basis	99.5% minimum

Impurity	Percent Maximum
Calcium (in all forms)	0.01%
Magnesium (in all forms)	0.01%
Manganese	0.00002%
Iron (as Fe)	0.0005%
Insoluble	0.005%
Additives	0.0001%
Limit Aluminum, Silicon, Barium, Strontium, Titanium, Suspended Solids, Heavy Metals, Complexing Agents (i.e. Sugars, EDTA, and CN-)	

G. Feed water quality shall comply with the minimum requirements listed in the table below.

Feed Water – Minimum Quality Requirement	
Temperature (Recommended)	55-80°F
pH	5 – 9 Recommended
Hardness (Ca/Mg)	<1 gpg (<17.1 mg/L) Out of softening equipment
Total Organic Carbon (TOC)	<2 mg/L
Iron	<200 µg/L
Manganese	<50 µg/L
Nickel	<5 µg/L
Fluoride	< 1 mg/L
Silica (SiO₂)	< 20 mg/L
Copper	< 5 µg/L
Chlorine (Cl₂)	<2 mg/L
Barium	<1 mg/L
Strontium	<10 mg/L
Polyphosphates	<5 mg/L
Magnesium	< 50 mg/L
Limit Aluminum, Silicon, Barium, Strontium, Titanium, Suspended Solids, Heavy Metals, Complexing Agents (i.e. Sugars, EDTA, and CN-)	

H. The Mixed Oxidant Generator shall shut down for the following conditions:

1. Common Critical Alarms
 - a. Hydrogen Alarm
 - b. Hardness Alarm
 - c. Dilution Air System Alarm
2. OSGMOS Process Critical Alarms
 - a. Cell High Temperature [Not to exceed 130 °F (54.4 °C)]
 - b. Low Feed Water Temperature to the cell [40 °F (4.4 °C)]
 - c. Power Supply Fault

- d. Low Feed Water Flow
- e. Low Feed Water Pressure
- I. The On-Site Generator shall alarm for the common and critical alarms listed above including the following conditions:
 - 1. Oxidant Level Transmitter Loop Fault
 - 2. Power Supply Voltage & Current outside allowable operating range
- J. The Oxidant storage tank level controls shall provide the following two (2) specific level conditions to the OSHGS control panel:
 - 1. Generator Stop
 - 2. Generator Start

2.4 GENERAL OSGMOS REQUIREMENTS

- A. The Mixed Oxidant electrolytic cell is required to have the capability to reverse polarity in a self-cleaning cycle in order to decrease the frequency of manually acid washing the cell.
- B. Each generator shall produce 60 (minimum) pounds per day of FAC at 4,500 mg/L (+/- 1,000) through the electrolysis of brine.
- C. Each generator production capacity shall be achieved without exceeding the maximum raw material usages listed below.
 - 1. The electrolytic cell shall consume a maximum of 3.0 pounds of salt per pound of chlorine equivalent output, using salt containing no organic binders, flow control agents or resin cleaning material, and meeting the following specifications listed under SECTION 2.3-F.
 - 2. The electrolytic cell shall consume a maximum of 3.0 kilowatt-hours AC of electricity per pound of chlorine equivalent output.
 - 3. The electrolytic cell shall consume a maximum of 26.7 gallons of water per pound of chlorine equivalent generated. The water supply to the softener shall be potable and free of polymer additives, flocculants, coagulants, anti-scalants, organics, oil & grease, and suspended solids and shall meet the following specifications listed under SECTION 2.3-G.
- D. Each generator shall operate at 200 mA/cm² (2 kA/m²) (1.29 A/in²) maximum.
- E. Each generator shall receive a process stream of saturated brine.
 - 1. The dilution of the concentrated brine will take place at each electrolytic cell through the use a of a variable speed brine pump.
 - 2. Conductivity probes shall not be allowed.
 - 3. Manual controlled brine feed to electrolytic cell shall not be allowed.
- F. Each Generator shall receive a processed stream of dilution water.
 - 1. Water hardness shall be no more than 17 mg/L.
 - 2. The soft water feed shall be monitored using a pressure sensor and a flow meter.

3. Water flow shall be automatically controlled by the generator PLC via integrated pulsed width modulated (600 Hz minimum) control valve for each electrolytic cell.
 4. Flow sensing shall be performed using a high-speed counting functionality with an accuracy within +/- 15%.
 5. Manual water flow control shall not be allowed.
- G. All electrolytic cell module(s) shall be plumbed and operated in a parallel flow arrangement. Electrolytic cells and/or modules installed in series shall not be allowed.
- H. Recirculation of water and brine through individual and/or multiple cells shall not be allowed.
- I. The Generator shall operate at constant capacity, and automatically start and stop based on the low and high liquid level setpoints in the Oxidant Storage Tank.
- J. All OSGMOS functions performed by the generator control platform shall use PID loops where applicable.
- K. At a minimum, the Generator shall have the following safety features:
1. Rupture disk with burst sensor on outlet of cell
 2. Rupture Disk Fail
 3. Flow switch on the feed water inlet
 4. Pressure switch at the inlet to the cell
 5. Cell - High Temperature
 6. Cell - Low Flow
 7. Cell - Very High Current
 8. Power Supply - Low Voltage
 9. Power Supply - Low and High Current
 10. Automatic current regulation
 11. Low Feed Water Temperature
 12. Delta temperature fault
 13. Very High Oxidant temperature
- L. The above safety features shall be interlocked to prevent or alarm operation if any of the normal parameters are exceeded. In the event of a trip condition, an alarm contact set will be made signaling an alarm condition.
- M. Generator Skid
1. The self-contained On-Site Mixed Oxidant Generator (OSGMOS) skid shall be factory pre-plumbed and pre-wired. The generator skid shall include all valves, piping and instrumentation necessary to dilute saturated brine before it enters the electrolytic cell.
 2. The generator skid shall be configured to allow easy access to all components for ease of operation & maintenance and shall adhere to standard equipment height and reach requirements.
 3. The generator skid shall be mounted on a wall frame assembly.

4. Each generator assembly dimensions shall be:
 - a. Width: Wall: 49.6in
 - b. Depth: Wall: 19.0in
 - c. Height: Wall: 73.6in
5. Electrical, non-wetted components shall be mounted on the skid frame, inside an electrical control panel located above the plumbing compartment.
6. The plumbing compartment shall be mounted on the skid, in a separate corrosion resistant all plastic enclosure to prevent exposing electrical controls to water, brine or generated solution.
7. All inter-enclosure wirings shall be pre-wired and tested at the factory.

N. Integral Power Supply

1. The Power Supply(ies) shall be air cooled and installed within the skid control panel.
2. Each power supply shall be mounted as a pre-assembled bloc for ease of access, maintenance and/or replacement as needed.
3. The power supply(ies) shall function to provide constant current to the cell within the specified voltage ranges.
4. The power supply(ies) shall be controlled by the OSGMOS internal PLC. All monitored/controlled information related to the power supply(ies) shall be available on the OSGMOS Human Machine Interface (HMI).

O. Integral Control System

1. The OSGMOS Supplier shall provide a control panel which complies with UL 508A requirements for Enclosed Industrial Control panels.
2. The control panel material shall be either:
 - a. NEMA 3R or 12, 304 stainless steel.
3. The control panel shall house the Human Machine Interface (HMI), Programmable Logic Controller (PLC), memory card, Ethernet network switch with Ethernet I/P for communication and associated components and terminal strips for field devices to fully support the functions of the OSHG operation.
4. The PLC shall be Allen Bradley ControlLogix Programmable Logic Controller (PLC) with Serial Ports/Protocol, Ethernet Ports/Protocols, built-in digital I/Os, memory for application updates and data logging capabilities.
5. The HMI shall be an Allen Bradley PanelView Plus 5,7" TFT Color Touch-Screen to show all relevant operating parameters and/or alarm conditions.
6. All controls and operation logic to control the OSGMOS internal components and select related peripherals specified herein shall be programmed in the PLC. The control panel logic shall function at the PLC level where operating parameters will be scaled, measured and controlled.

7. At a minimum, each OSGMOS shall have the following Alarms and Status shared over the Ethernet I/P network:
 - a. Master Switch Off – Status
 - b. Power Supply Thermal Switch – Status
 - c. Oxidant Tank Level Low – Status
 - d. Oxidant Tank Level High – Status
 - e. Low Water Flow – Alarm
 - f. Inlet Water Pressure Low – Alarm
 - g. High Oxidant Temperature – Alarm
 - h. High Power Supply Temperature – Alarm
 - i. Low Cell Current – Alarm
 - j. High Cell Current – Alarm
 - k. Low Cell Voltage – Alarm
 - l. Very High Cell Current – Alarm
 - m. Low Brine Pump Voltage – Alarm
 - n. Low Feed Water Temperature – Alarm
 - o. High Feed Water Temperature – Alarm
 - p. High Oxidant Shutdown Temperature – Alarm
8. Control system shall have, but not be limited to, the following I/O shared over the Ethernet I/P network:
 - a. Inputs
 - 1) Oxidant Tank Level Low
 - 2) Oxidant Tank Level High
 - 3) Hydrogen Monitor Alarm
 - 4) Hardness Monitor Alarm
 - 5) Dilution Air Flow Switch Alarm
 - b. Outputs
 - 1) Auxiliary Dilution Air System – 24VDC Run signal
 - 2) Water boost pump relay
 - 3) Brine boost pump relay
 - 4) General alarm output relay
9. External control panel shall not be allowed to control a single generator.
10. All controls and operation logic for the chemical dosing system shall be supported by a separate control panel or by Plant's SCADA and/or Variable Frequency Drive(s) (VFD) as described in Divisions 13 and/or 16.
11. The Installation Contractor shall coordinate with the OSGMOS System Supplier and Instrumentation Supplier for proper system/SCADA integration.
12. The control panel shall be equipped (as an option) with all provisions to facilitate Remote System monitoring and troubleshooting for multiple operators' access.

P. Electrolytic Cell

1. The electrolytic cell shall be located within the OSGMOS skid assembly. Remote cell(s) and/or rack(s) shall not be allowed.
2. The electrolytic cell casing shall be constructed of high quality-CPVC material, which has superior chemical and temperature compatibilities with generated chlorine-based oxidant solution.
3. The electrolytic cell shall be mounted in such a way to prevent pure horizontal or vertical flow through it in order to maximize the use of the electrode available active surface. No pure vertically oriented cells shall be allowed.
4. The electrolytic cell shall be mounted for clear and easy access.
5. Cell construction shall be rectangular to minimize gas head space inside of the electrolytic cell, and modular allowing electrodes to be removed as a single assembly.
6. Any necessary joining of electrolytic cell materials shall be by solvent welding or mechanical compression. Thermal welding will not be allowed.
7. The electrodes shall be Titanium and the anodes coated with a mixed metal oxide catalytic coating for electrical efficiency and maximum longevity. The electrodes shall be solid flat plate and shall be constructed in a bipolar configuration to facilitate current distribution and minimize voltage drop through the electrodes.
8. The electrolytic cell shall be of modular design with a total of one (1) inlet and one (1) outlet regardless if the electrolytic cell is composed of a single module or multiple modules. Multiple cells design will not be allowed.
9. The electrolytic cell shall generate a solution of Mixed Oxidant below 120 °F (49 °C).
10. The electrolytic cell shall be able to reverse polarity in a self-cleaning cycle in order to decrease the frequency of manually acid washing the electrolytic cell. A high velocity recirculation loop that creates a scouring action or automatic chemical feed system is not an acceptable substitute for a self-cleaning electrolytic cell.

Q. OSGMOS Skid Integral Brine Filter

1. Each generator skid shall include an integral brine filter assembly. The assembly shall be pre-installed and pre-plumb at the factory.
2. Brine filter assembly shall include at a minimum:
 - a. One (1) Pentek 10 inch long standard housing, clear, with 3/4in NPT connections
 - b. One (1) 5-microns nominal rating cartridge filter

2.5 WATER FILTER

- A. One (1) feed water filter with wall bracket adapter.
- B. Filter housing shall be
 1. Pentek Products Filter Housing

2. 10" Long
 3. Integrated pressure relief valve
 4. 3/4" FPT inlet/outlet connection
- C. Filter cartridge shall be
1. 5-micron
 2. pleated disposable cartridge
- D. Two (2) pressure gauges shall measure pressure drop across filter assembly.
1. Pressure gauge shall be
 - a. WIKA copper alloy Bourdon tube
 - b. Polycarbonate window
 - c. Glycerin Filled
 - d. 1/4" NPT connection
 - e. 0-100 PSI range
- E. Two (2) isolation valves
1. Spears true union standard ball valves
 2. 3/4" NPT
 3. Viton seal

2.6 WATER SOFTENER

- A. Water for use in generating the mixed oxidant will be softened using one (1) set of twin tank ion exchange water softeners with a hydraulically-driven, flow-controlled switchover valve. When the ion exchange capacity of one resin tank is nearly exhausted, the softener control mechanism will automatically divert flow to the alternate tank while initiating a brine backwashing of the first tank for regeneration of the ion exchange resin. Minimum efficiency will be 3,723 grains exchange per pound of salt.
- B. Capacity the softeners shall be appropriate for continuous use with water of the following quality:
- | | |
|---|---------------|
| 1. Water Pressure (min – max): | 15 to 125 PSI |
| 2. Water Temperature (min – max): | 35 to 120 °F |
| 3. Water pH (min – max): | 5 to 10 |
| 4. Water Hardness mg/L as CaCO ₃ : | 170 mg/L Max |
| 5. Chlorine Residual: | 2 mg/L Max |
- C. Connections associated with each water softener will include 1-1/4 inch inlet/outlet pipe fittings, a 3/8-inch-high density polyethylene tube with in-line check valve for feeding brine to regenerate the water softener, a 1/2-inch-high density polyethylene tube for draining backwash waste.
- D. The water softener will be a highly efficient, regeneration design as manufactured by Kinetico Corporation. The regeneration process and frequency will be accomplished by the water supply hydraulic pressure, no electric power required. Regeneration shall be based on total volume of water flow since the last regeneration cycle rather than on a fixed time interval.

- E. Each softener shall use brine from the saturator tank for the regeneration cycle. The regeneration waste shall be disposed to a sanitary drain.
- F. Water Softener model: Kinetico CP208s or equal.

2.7 FEED WATER HEATER

- A. One (1) industrial grade instantaneous electric water heater unit shall be supplied, and wall mounted as indicated on the drawings to heat soft water entering the water/brine flow panel to above 50 °F.
- B. The entire unit shall be packaged ready for plumbing and electrical service connections and shall bear the cULus listing mark certifying the entire unit to UL499, UL EPH Sanitation listed to ANSI/NSF Standard 5 and CSA C22.2 No. 64-M91.
- C. The tankless heater shall be designed to operate at 208 volts, 1 phase, 50/60Hz. The heater will draw 38 amps only when operating at full power. The immersion heating elements shall be high quality Incoloy sheathed and sized to obtain the rated capacity. Each element is to be operated using zero cross over solid-state controls. The heating elements shall be fully modulated from 0-100% to provide precise temperature control through the full range of flows. A Hi-Limit thermostat with automatic reset shall be factory installed to disconnect each heating element in the event of an over-temperature condition. An electronic digital display temperature controller shall be user adjustable in 1° increments in either °F or °C and shall display flow rate, outlet temperature, inlet temperature and provide error indication. A turbine-type flow meter shall be factory installed to provide precise temperature control for water flows as low as 0.2 GPM up to a maximum flow of 8 GPM. Heaters that require greater than 0.2 GPM flow for actuation or restrict flow shall not be acceptable.
- D. The heating chamber shall be all Sil-brazed copper and bronze construction. A plastic heating chamber shall not be acceptable. Water heater heating chamber shall be rated for a maximum allowable working pressure of 150psi. The heating chamber and all electrical controls shall be completely enclosed in a heavy gauge Type 304 stainless steel case.
- E. Each heater unit shall be properly sized for the soft water flow required by each electrolyzer train.
- F. Each Heater shall have the following minimum capacity:
 - 1. GPM of Flow: 1.82 GPM
 - 2. Temperature (from): 40 °F
 - 3. Temperature (to): 65 °F
 - 4. Heater Temperature Delta: 30 °F
- G. One (1) Model TX008-2RS:
 - 1. 8 kW, 208 VAC, 1 Phase, 60 Hz
 - 2. Dimensions (WxDxH): 16-3/16" X 3-9/16" X 17"
 - 3. Inlet/outlet Connections: 3/4" NPT

H. Water Heater shall be Hubbell Electric Heater Co.

2.8 BRINE SATURATOR TANK

- A. The Contractor shall furnish and install one (1) bulk salt storage brine making system in accordance with the Drawings and the following specifications.
1. Dimensions
 - a. 8' 0" Inside Diameter
 - b. 15' 0" Straight Sell Height
 2. Designed to receive bulk salt via delivery truck.
- B. The brine vessel shall be capable of storing approximately 22 tons of dry salt, depending on what salt is used. The vessel shall be NSF-61 approved.
- C. The salt brine process vessel shall be constructed of fiberglass reinforced plastic (FRP). Resin shall be Aropol 7241T-15 by Ashland or approved equal. All nozzles shall have insulation replaced around lay-up areas.
- D. The brine maker shall be installed outdoors and designed to accept salt by blowing it in from the transfer truck.
- E. Current demands will be determined by a temperature probe installed against the tank wall under the foam insulation. System shall be able to maintain 60°F at a minimum temperature of 0°. The first six feet of the brine vessel is to be insulated with 2-inch thick Polyisocyanurate foam or approved equal with FRP protective covering. The top of the insulation will be capped to seal out any moisture.
- F. The chemical surfacing veil shall be type "C" glass surfacing mat 10-roll thickness. Chopped strand mat woven roving and continuous roving shall be type "E" glass wide a saline finish and styrene soluble binder. Continuous roving for filament winding is to type "E" glass with a saline finish.
- G. The laminate shall consist of an anterior surface, an interior layer, a structural layer and an exterior protective surface. The interior surface shall be reinforced layer of 100-mil thickness (0.10"). Resin content is to be greater than 80%. The interior surface shall be free from cracks and crazes; it shall have a smooth finish with an average of no more than two pits per square foot, providing such are no greater than 0.25 inches in diameter, are not over 0.031 inches deep, and are sufficiently covered with resin to protect the interior surface reinforcement. The interior layer shall back the interior surface to a minimum thickness of 0.80 inches and will have a content of twenty to thirty percent non-continuous glass strands. The finished laminated shall such as dry spots, foreign inclusions, pinholes and delamination. The structural layer shall consist of continuous strand filament winding to satisfy longitudinal strength requirements, chopped glass is to be applied prior to the first cycle of winding and interspersed between subsequent cycles. The exterior surface shall consist of resin blended with 0.6 percent of paraffin wax to provide a full surface cure and a tack-free corrosion-resistant surface. The translucent vessel shall have 2% ultra-violet inhibitors. If portion will be finished with a white exterior gel coat.

- H. Standard flanged nozzles shall be entirely of hand lay-up construction with the flange and pipe neck molded as one integral unit. Nozzle wall and flange thickness are to be fabricated for 25 psi pressure rating. The face degree shall be flat to within 1/16 inch. The location of the nozzle will be held to $\pm 1/4$ inch. All nozzles shall be conically gusseted.
- I. Brine vessel accessories will include:
1. Four tie-down lugs and four lifting channels both made of 304 stainless steel.
 2. 4-inch conically gusseted flanged nozzle with 4-inch diameter 304 stainless steel Schedule 40 Salt unloading pipe with 3/4-inch water injection port, aluminum Kamlock fitting and cap.
 3. 3/4-inch NPT connection nozzle with internal Brine Guard assembly.
 4. 2-inch conically gusseted flanged nozzle with 1 $\frac{3}{4}$ -inch PVC water inlet ring.
 5. Water Inlet shall have a 2 GPM Dole Vale
 6. 3/4-inch NPT connection to fill pipe for accommodation of a water hose to inject up to 5 gpm of water during track unloading to wet the conveyed salt, to minimize dust emissions.
 7. 8-inch 90-degree elbow vent with PVC vent extension, clips to attach to vessel wall, polyester dust bag, rubber connection foot.
 8. 24-inch top flanged, manway with cover spring loaded for emergency pressure relief of 0.105 psi, pressure on salt delivery will be approximately 15 psi.
 9. 24-inch side flanged manway with cover, neoprene gasket, and 304 stainless steel fasteners.
 10. Instrumentation and controls
 - a. Controller shall be ABB Control Master CMF 160 Series. Indicator shall be equipped with multiple I/O including, but not limited to:
 - (i) Analog 4-20 mA level indication output for SCADA system
 - (ii) Analog 4-20mA input for salt level reading
 - (iii) 24VDC output for salt reading command
 - (iv) 120VSC relay for water feed solenoid valve control
 - (v) Analog 4-20mA input for liquid level reading
 - b. Soft water feed solenoid valve shall be ASCO Red Hat II series. Power shall be 120VAC.
 - c. Yo-Yo type salt level indication system to measure salt level. Manufacturer and model shall be BinMaster SmartBob AO.

- d. Liquid level pressure transmitter shall be Yokogawa EJA530E Series
- 11. FRP ladder with safety edge.
- 12. The brine generator will include a water inlet distributor to prevent uneven distribution of water. This shall consist of a schedule 80 PVC ring induction header around the inside circumference of the tank. The brine generator will include a pneumatic salt inlet/air venting system to facilitate rapid loading and minimize dust emissions. The 4-inch ID fill pipe shall be fabricated from 304 stainless steel and mounted for center fill using a long radius turn to minimize particle attrition and dust. The air will be exhausted through an 8-inch 90-degree elbow vent at the top of the vessel.
- J. Approved Manufacturer: Plas-Tanks Industries, Hamilton Ohio.

2.9 BRINE BOOST

- A. The EQUIPMENT SUPPLIER shall provide a brine boost pump system in accordance with the Drawings and the following specifications.
 - 1. Number of pump(s): Two (2)
 - 2. Max output head capacity (each) 20.5 ft
 - 3. Max output flow capacity (each) 10 gpm
- B. The pump system shall be able to maintain a flooded feed brine line with 3psi minimum pressure at each OSGMOS unit.
- C. The booster pumps shall be powered directly from the plant electrical system.
- D. Each brine boost pump shall be the following design features:
 - 1. Pump Housing: Polypropylene
 - 2. Impeller: Polypropylene
 - 3. O-Ring: Viton
 - 4. Shaft, Thrust Washer: Ceramic
 - 5. Power: 115 VAC, 1 phase, 60 Hz
 - 6. Connection Size: 3/4" FPT inlet
1/2" FPT outlet
 - 7. Motor: 1/14 HP electrical motor
- E. Each brine boost pump system shall have a Local Control Panel which includes the following features:
 - 1. NEMA 12 minimum powder coated epoxy electrical panel
 - 2. HOA selector switch
 - 3. Duty/Standby pump selector switch
 - 4. Green running pilot light
 - 5. Designed for 115 VAC, 1 phase, 60 Hz pumps
 - 6. 24VDC relay input connection
- F. The following accessories shall be furnished with each brine boost pump system:
 - 1. One (1) Pressure Relief Valve, PVC Schedule 80

2. One (1) pressure gauge with gauge guard
 3. One (1) Self-Closing Check Valve for each pump, PVC Schedule 80
 4. Required inlet/outlet pump isolation valves, PVC Schedule 80 true union ball valves.
- G. Pump shall be model BC-3CP-MD as manufactured by March Manufacturing Inc. or approved equal.

2.10 OXIDANT PRODUCT TANK

A. General

1. Oxidant tanks shall be 1,500 gallons, closed top, rotationally-molded, vertical, cross-linked high density polyethylene one-piece seamless construction, cylindrical in cross-section and vertical with flat bottom. Tanks shall be adequately vented. Where indicated, tanks shall be provided with ancillary mechanical fittings and accessories.
2. Tanks molded in cross-linked polyethylene shall be Schulink XL 350 or equivalent.
3. All tanks used for outdoor installation shall contain a suitable ultraviolet stabilizer, minimum 0.3% 2-hydroxy-4-n-Octoxy-benzophenone or equivalent. The stabilizer shall be compounded into the polyethylene.
4. No fillers shall be added to the resin.
5. Tank dimensions:
 - a. 64" diameter
 - b. 108" straight shell
 - c. 121" overall height

B. Design Requirements

1. The minimum required wall thickness of the cylindrical straight shell at any fluid level shall be determined by the following equation but shall not be less than 3/16-in. thick. The tolerance indicated in section 7.3 applies to these dimensions.

$$T = \frac{P \times O.D.}{2 SD} = .433 \times S.G. \times H \times \frac{O.D.}{2.SD}$$

T = Wall thickness, inches

SD = Hydrostatic design stress, psi

P = Pressure (.433 x S.G. x H), psi

S.G. = Specific gravity of fluid

O.D. = Outside diameter, inches

H = Height, feet

2. The hydrostatic design shall be determined by multiplying the hydrostatic design basis (determined by ASTM D2837 using rotationally molded samples) by a service (design) factor selected for the application. The standard product line of tanks is engineered using a maximum hydrostatic design stress, 600-psi for Cross linked and 550 psi for Conventional, respectively.
3. The vessels shall be designed and molded with a uniform wall thickness equal to or greater than the minimum thickness requirement per the Barlow Formula shown in this specification.
4. Top head shall be integrally molded (one piece) with the cylinder shell. The minimum thickness of the top head shall be 3/16-in.
5. Tank shall be designed with top mounting flats to enhance fixture assemblies.
6. The bottom head of a tank shall be integrally molded (one piece) with the cylinder shell. The minimum thickness for a fully supported flat bottom head shall be 3/16-in. All parting lines shall be located within the top 1/3 of the vertical sidewall.
7. Vents will be provided as agreed, to prevent pressure or vacuum from damaging the tank when filling or draining. Vents shall be sized to maintain atmospheric pressure under normal filling and discharge operations. Some applications or service conditions may require larger vents.
8. All piping shall be supported independently of the tank. Flexible expansion joints are required to allow the tank to expand and contract when filling and draining.
9. The finished tank wall, so far as is commercially practical, shall be free of visual defects such as foreign inclusions, air-bubbles, and pinholes that may impair the serviceability of the vessel.
10. The inner surface shall be smooth and free of cracks, crazing or pits. Waviness is a characteristic of the molding process for large tanks and is acceptable, provided the surface is smooth and free of cracks.
11. Each tank shall be marked with a quality and routing control number. This number will be used to trace the vessel and shall be common to all required documentation.
12. Product identification label with installation and use instructions will be applied to each tank.

C. Approved Manufacturers

1. Assmann Coporation of America, Garrett, IN.

2.11 LEVEL TRANSMITTER

- A. The oxidant tank level transmitter shall utilize a pressure transducer to measure each tank liquid level. The system shall be able to measure tank levels to a liquid height of twenty (20) feet with an accuracy of $\pm 1\%$ of full scale or 2.5-inch.
- B. The output signal shall be S³L. The transducer shall be constructed of PVDF material with a ceramic diaphragm.
- C. The process connection shall be ½" male NPT. The transducer shall be mounted at an elevation of 3 inches from the bottom of the tank. The transducer shall be mounted on a separate tank penetration from the oxidant discharge port on the oxidant storage tank.
- D. The transducer shall be isolated from tank with a manual 2-way ball valve, installed horizontally to prevent air entrapment.
- E. The pressure transducer shall be GF Signet Model 3-2450-3U or equal. The pressure transmitter shall be capable of receiving S³L input and transmitting two (2) relay outputs and a 4-20 mA optional output signal.
- F. The transmitter shall be housed on a NEMA 4X/IP65 housing and shall incorporate a Dot matrix LCD display.
- G. Power to the transmitter shall be 24 VDC.
- H. The transmitter shall be GF-Signet model 3-9950-2.
- I. The transmitter modules included shall be:
 - 1. Two (2) Relay module with 2 mechanical relays and 2 solid state relays
- J. Approved Manufacturers
 - 1. George Fisher LLC, Irvine, CA

2.12 LIQUID BARRIER SYSTEM

- A. EQUIPMENT SUPPLIER shall provide a liquid barrier system (LBS). No systems requiring dilution air blower(s) will be accepted.
- B. On-Site generated solution will flow into the oxidant product tank(s) through fittings and into an internal tank mounted Liquid Barrier Vent drop tube that extends to within 1" of the bottom of the tank.
 - 1. The drop tube diameter shall be 4 inches to ensure that the bubble rise velocity is significantly greater than the liquid flow velocity, thereby ensuring that hydrogen is force vented to the top of the drop tube and out of the hydrogen vent plumbing.
 - 2. The hydrogen vent plumbing will be connected to a tee fitting immediately on the exterior of the oxidant product tank extending upward and plumbed to exterior of the facility.
 - 3. Each tank's Liquid Barrier System through-wall into the solution tank shall be 4-inch-diameter CPVC.

4. Each tank's Liquid Barrier vent tee shall be vented to outdoors with a minimum 2-inch-diameter CPVC.
5. Each tank shall have a 2-inch vent, at the highest possible point of each tank, to be vented outside.
6. Connecting/combining vent piping together shall be strictly prohibited.
7. The proposed system shall be submitted for approval by the ENGINEER.

2.13 OXIDANT INJECTION FEED SYSTEM

A. General requirement

1. The metering pump(s) operating configuration and conditions shall be as follows:

a. Number of injection points:	Three (3)
b. Number of pump(s) required:	Three (3)
c. Pump(s) operation configuration:	Pre-, TOF-, Post-
d. Flow rate capacity (max) per pump:	1.0 gpm
e. Flow rate capacity (min) per pump:	0.1 gpm
f. Operating flow rate per pump:	0.5 gpm
g. Rated Discharge pressure (max) per pump:	20.0 psig
h. Operating discharge pressure:	5.0 psig
i. Turndown Ratio (min)	10:1
j. Maximum motor horsepower:	1 HP
k. Power requirements	115 VAC/ 1 PH/ 60 Hz
2. All metering pump(s) shall be NSF/ANSI 61
3. All metering pump(s) shall be designed for 24 hours per day operation.
4. The metering pump materials shall be completely suitable for and inert to liquid sodium hypochlorite up to 12 percent solution and at ambient, outdoor temperatures.
5. All wetted surfaces of feed pumps and appurtenances and all sealing gaskets shall be suitable for continuous exposure to sodium hypochlorite (12 percent solution, specific gravity = 1.23 maximum concentration). Pumps shall operate under suction lift and flooded suction conditions.
6. Each pump shall have the capabilities of manual speed control, automatic speed control from an external signal or automatic stroke length control. Signals shall be at a minimum:
 - a. Run/Stop command
 - b. Analog Speed Adjustment
 - c. General Alarm
 - d. Fault

B. Diaphragm Pump(s)

1. The injection metering pump(s) shall be reciprocating, positive displacement and motor driven.

2. The pump shall be driven by a TEFC Duty electric motor.
3. Stroke volume shall be freely adjustable between 0 and 100% via a micrometer (manual knob).
4. The suction and discharge check shall be able to be removed and disassembled for inspection, cleaning or replacement.
5. The pump liquid end shall be constructed of PVDF, with PVDF check valves and PTFE O-Ring material.
6. The metering pumps shall be controlled by one of the following options:
 - a. **Manually (Option 1):** When dealing with diaphragm metering pumps, the dosage flow rate shall be manually adjusted by turning the 0-100% stroke length knob on the side of the pump.
 - b. **Manually (Option 2):** Each pump shall be supplied with an integrated control system or a standalone variable frequency drive in a NEMA 4 enclosure mounted next to the metering pump stand or skid. The pump speed shall be manually adjusted by the operator on the pump's integrated controls or standalone VFD. A start signal shall be provided from the plant's SCADA system or the operator shall manually start the pump. For added turn-down ratio, the stroke length shall be manually adjusted on diaphragm pump(s) only.
 - c. **Flow Pacing:** Each pump shall be supplied with an integrated control system or a standalone variable frequency drive in a NEMA 4 enclosure mounted next to the metering pump stand or skid. The plant's SCADA system shall provide a start signal and a speed input to the pump's integrated controls or standalone VFD based on an analog flow signal to adjust the pump speed automatically. For added turn-down ratio, the stroke length shall be manually adjusted on diaphragm pump(s) only.
 - d. **Compound Loop:** Each pump shall be supplied with an integrated control system or a standalone variable frequency drive in a NEMA 4 enclosure mounted next to the metering pump stand or skid. The Plant's SCADA System shall provide a Start/Stop and speed signal to the pump's integrated controls or standalone VFD based on a flow and chlorine residual analog input signal to adjust the pump speed automatically. For added turn-down ratio, the stroke length shall be manually adjusted on diaphragm pump(s) only.

C. Pre-assembled skid

1. Each skid assembly is complete, including chemical pump(s), all necessary piping, valves, fittings, supports, electrical controls and accessories as specified herein. The skid piping design shall minimize the use of glued joints in the system.
2. Skid hydraulic connections
 - a. Each skid shall have one (1) inlet manifold connection.
 - b. For single pump skid/panel, assembly shall have one (1) outlet connection

3. For Dual pump skid with a single injection point, skid shall have a single outlet connection.
4. For multiple pump skid, assembly shall have One (1) outlet connection per pump.
5. The skid shall contain the following items:
 - a. Single Pump Floor skid:
 - 1) One (1) Non-metallic skid with built in containment area
 - 2) One (1) backpressure valve.
 - 3) One (1) main inlet strainer
 - 4) One (1) pressure gauge with gauge isolator
 - 5) One (1) pressure relief valve.
 - 6) One (1) pulsation dampener.
 - 7) One (1) calibration column
 - 8) One (1) NEMA 4X junction box
 - 9) One (1) set of isolation valves, true union PVC SCH80 with VITON seals
6. For redundant duty/standby dual pump skid, the following item quantity shall match the pump quantity:
 - a. Backpressure valve
 - b. Pressure relief valve
 - c. Pulsation dampener
 - d. NEMA 4X Junction Box (adjust I/O to match quantity of pump installed)
7. All components of the chemical metering system shall be contained within the skid/panel.
8. Interconnect piping, fittings and support(s) outside of pre-assembled skid shall be supplied by installing contractor or by others.

2.14 HYDROGEN GAS MONITOR

- A. The EQUIPMENT SUPPLIER shall supply One (1) complete Hydrogen gas detector and the CONTRACTOR shall mount the hydrogen gas detectors at the highest point in the room above the generator assembly and above the Hypochlorite storage tanks (if indoor).
- B. This specification details the attributes and operating characteristics of the RKI Instruments Inc. sensors/transmitters.
- C. The RKI Instruments inc. sensors consist of Series Models 61-1001RK-04. The sensor shall be composed of four (4) main components: Gas Sensor, Junction Box, Splash Guard and Calibration Adaptor.
- D. The RKI Instruments Inc. transmitter consists of Series Model Beacon 110.
- E. Sensor
 1. Enclosure
 - a. Surface-mounting cast aluminum enclosure with screw-on cover.
 - b. Wiring access through ¾" NPT female opening on enclosure.
 - c. Sensor mounted to opposite opening.

2. Hydrogen Sensor
 - a. Catalytic bead type combustible sensor.
 - b. Range: 0-100% LEL.
 - c. Encapsulated in stainless steel enclosure.
 - d. Sensor shall be special formulation that will only respond to hydrogen gas. Sensor will not respond to any other flammable gases and vapors.
 - e. Sensor to be supplied with screw-on adaptor that allow remote application of calibration gas for testing and also protects sensor from dust/splash.
3. Wiring
 - a. Internal field wiring terminal block, capable of receiving 14 AWG wire. Terminal block is for sensor lead wire (4terminal, pre-wired to sensor from factory) connection to controller.
 - b. Wiring from sensor assembly to controller should be shielded, provided by contractor.
4. Input Power
 - a. Operates from controller supplied DC power, approximately 4.5 VDC. Current draw is approximately 100 mA.
5. Calibration
 - a. On site calibration shall be accomplished through use of Zero (combustible-free air) and Span (known concentration of hydrogen gas in air) gases.
- F. Controller
 1. The Controller shall be type wall-mounting single-channel controller for combustible gas, toxic gas or oxygen detection. The controller shall be configurable using internal controls, no hardware changes or jumper selection required.
 2. Enclosure
 - a. Wall mounting gray polycarbonate NEMA-4X enclosure with hinged cover.
 - b. Wiring access through two (2) conduit hubs mounted to bottom of enclosure.
 3. Display
 - a. Backlit LCD display with adjustable contrast control for variation in ambient lighting.
 4. Signal input
 - a. Capable of either direct input from RKI sensors or 4-20 mA signal input from remote transmitter, two (2) or three (3) wire format.
 5. Audible alarm
 - a. An audible alarm device shall be attached to bottom of enclosure, rated at 94 db.
 - b. The audible alarm shall be capable of being silenced or reset using

external sealed pushbutton switch, coded for low and high gas alarms (pulsing tone) or malfunction (steady tone).

6. Visual indicator
 - a. Three (3) color coded LEDs shall be visible on the front of the controller enclosure
 - b. LED
 - (i) First LED, Yellow for low alarm condition
 - (ii) Second LED, Red for high alarm condition
 - (iii) Third LED, Yellow for fail condition
 - (iv) All LEDs Green for normal (pilot) condition
7. Wiring
 - a. Field wiring terminal blocks top access type capable of receiving 14 AWG wire.
 - b. Separate terminal blocks for AC power, relay outputs, sensor or transmitter input and controller wiring connections.
8. Input power
 - a. Two (2) options:
 - (i) 115 VAC or 230VAC
 - (ii) 24VDC
 - b. If 24VDC is selected, this connection provides trickle charge to back-up battery (optional) while AC power is connected, and automatically switches to back-up power if AC power is lost. If backup battery option is used, the unit will display a warning message on the display in the event of low battery voltage condition, and the Fail LED will be illuminated.
9. Controls, external
 - a. Sealed pushbutton switch for alarm silence or reset.
10. Control Internal
 - a. Shall have relay for low, high and fail alarm condition.
 - b. All contacts shall be Form C, rated 10A-250VAC resistive.
 - c. All relay outputs (except fail) shall be programmable using internal pushbuttons for normally de-energized or normally energized (fail-safe) operation and latching or self-resetting.
 - d. Fail relay shall be normally energized (fail-safe) and self-resetting only.
11. Analog outputs
 - a. Shall have 4-20 mA output (1000 ohms impedance maximum), corresponding linearly to 0-100% full scale.
12. Transmitter output
 - a. Shall be 24VDC, 350 mA maximum, for two (2) or three (3) wire connection.
 - b. Shall be capable of operating diffusion or sample-draw transmitter without use of auxiliary power.

13. Min/Max readings
 - a. The minimum and maximum values shall be stored automatically and can be displayed as required through use of the Reset button, which is also used to reset the Min/Max readings.
 14. Calibration
 - a. The calibration mode shall be entered through use of the programming buttons.
 - b. Access to the calibration program shall be protected through use of a coded sequence of button operation to enter the calibration program.
 - c. Automatic exit shall be provided from the calibration menu to prevent the unit from inadvertently being left in the calibration mode.
 - d. The calibration mode shall accommodate and automatically recognize and distinguish between direct connected sensors and remote amplifier (4-20 mA) type transmitters. If direct connect sensor is used, a fresh air adjust capability shall be included.
 - e. The unit shall allow selection of calibration gas concentration during the calibration sequence.
 - f. A provision for aborting the calibration and retaining old calibration data shall be provided.
 15. Channel setup and configuration
 - a. Channel setup and configuration mode shall be entered through use of the programming buttons.
 - b. Access to the Channel setup and configuration program shall be protected through use of a coded sequence of button operation to enter the Channel setup and configuration program.
 - c. Automatic exit shall be provided from the Channel setup and configuration mode to prevent the unit from inadvertently being left in the Channel setup and configuration mode.
- G. The setup and configuration mode shall allow the user to enable and disable the channel for maintenance or service purposes, and to configure settings for alarm levels and activation type (increasing or decreasing), alarm time delay, relay logic (latching/non-latching, normally energized/normally de-energized), noise filter selection, and zero suppression selection.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. The Owner shall inspect all equipment and materials against the OSGMOS System Supplier's approved Shop Drawings at time of delivery. Equipment and materials damaged or not meeting requirements of the OSGMOS System

Supplier's approved shop drawings shall be immediately returned to the OSGMOS System Supplier for replacement or repair. Equipment and materials damaged during shipment shall be replaced or repaired based on the terms of the insurance.

- B. Equipment and materials shall be stored in a cool dry location and protected from the elements according to the OSGMOS Supplier's instructions.
- C. Equipment and materials shall be handled in an approved manner according to the OSGMOS Supplier's instructions.

3.2 INSTALLATION

- A. Installation of the OSGMOS, metering pumps, tanks and appurtenances shall be performed by the Installation Contractor and shall be in accordance with the OSGMOS Supplier's approved drawings. Any deviations from the approved drawings shall be repaired at the contractor's expense. Conflicts of information shall be called to the attention of the Engineer.
- B. As applicable, all equipment or assemblies shall be installed on concrete bases and secured with anchor bolts provided by the Installation Contractor. The Installation Contractor shall determine the anchor bolts size, length, material and make. Only the equipment bolt pattern shall be in accordance with the OSGMOS Supplier's approved drawings. The concrete bases shall be poured up to 1-inch below the metal bases, legs or soleplates. Equipment legs or base plates shall be accurately shimmed to grade and the spaces between filled with an approved non-shrink grout. After the grout has reached its initial set, exposed edges shall be cut back 2 inches and the edges neatly finished with 1:2 cement mortar.
- C. The Installation Contractor shall provide a drain for each piece of equipment as required.
- D. The Installation Contractor shall support piping independent of equipment. Equipment shall be free from all loads and stresses induced by the piping. No vibration or movements are allowed.
- E. All equipment including motors, belts and drives shall be aligned to the best industrial standards by the Installation Contractor. The Installation Contractor shall conduct field check and adjust all equipment alignments in the presence of the Owner or the Owner's designated representative.
- F. The Installation Contractor shall inspect all equipment before installation. If damaged, the Installation Contractor shall notify the OSGMOS System Supplier promptly. The Installation Contractor shall not install damaged equipment.
- G. The Installation Contractor shall have an authorized inspector as designated by the tank manufacturer to validate the proper installation of all tanks.
- H. The Installation Contractor shall install flex couplings or flexible hoses at the bottom inlet, the bottom outlet of any plastic tank, and any other location as noted by sticker(s) on the tank by the tank manufacturer. The flex connections shall be in accordance with the tank manufacturer's specifications.

- I. The Installation Contractor shall install CPVC SCH80 pipe material, fittings and accessories in between each OSGMOS unit(s) and the intended storage tank(s). PVDF shall be allowed on specific fittings and/or accessories.
- J. The Installation Contractor shall install disconnect switches for each transformer/rectifier, blower, water heater, water chiller, water booster pump, hypochlorite metering pump and/or any other electrical equipment requiring it per code.

3.3 COMMISSIONING AND START-UP

- A. The Installation Contractor shall complete the OSGMOS Supplier's pre-startup checklist after the installation of the OSGMOS System is complete and provide digital pictures of the installation from the beginning to end of the process as reflected in the P&ID and defined in the scope to schedule the OEM representative.
- B. The Installation Contractor shall verify that all Health & Safety related installations such as electrical grounding/bonding, Safety guards and warning signs in place, Eyewash stations are installed.
- C. The Installation Contractor shall verify whether OSGMOS was stored properly for short or extended period per OSGMOS supplier's guidelines.
- D. The Installation Contractor shall verify and confirm the following items for the efficient operation of the OSGMOS System:
 - 1. Water, brine and salt quality per OSGMOS Supplier's specifications;
 - 2. Plumbing connections to and from all equipment, components, and instruments are completed;
 - 3. Plumbing material for all equipment, components, and instruments are as per manufacturer's recommendations/requirements.
 - 4. Plumbing connections to drains are available;
 - 5. Plant SCADA wired from skid(s) PLC to control room;
 - 6. Plant SCADA is ready and active
- E. The Installation Contractor shall coordinate commissioning of the system and verify that each component of the OSGMOS System is ready for operation.
- F. The Installation Contractor shall, after the installation of the storage tank(s) is complete but before the piping connections are made, block all outlets and fill each tank with water (not air) to check for leaks. No leakage shall be permitted.
- G. If required, the Installation Contractor shall furnish two (2) layers of gravel at the bottom of the brine tank(s) before start-up. The height of the gravel layers, the gravel sizes and the gravel specifications shall be per the brine tank manufacturer's specifications and approved submittal drawings.
- H. The Installation Contractor shall test and verify SCADA communications in the presence of the OSGMOS Supplier at the time of system start-up. The presence of the site SCADA integrator is required at the time of start-up to ensure that all data are being sent and received

3.4 PERFORMANCE TEST

- A. The Installation Contractor and OSGMOS Supplier shall make equipment adjustments such as adjusting plant water pressure required to place system in proper operating condition.
- B. Necessary pre-requisites for the performance test are:
 - 1. System must be running and stabilized before the test period starts.
 - 2. Incoming water temperature is higher than 55°F, and lower than 80°F.
 - 3. Incoming water hardness after water softeners is less than 17 mg/L.
- C. Two performance parameters shall be measured:
 - 1. Mixed Oxidant Solution Concentration
 - a. Mixed Oxidant solution samples shall be taken at the outlet of the Mixed Oxidant Generator.
 - b. One sample shall be taken.
 - c. Samples shall be analyzed for available chlorine concentration in accordance with *Standard Methods* Method 4500-Cl G. DPD Colorimetric Method as adapted by Bradford (2010) for concentrated neat solutions to use the Hach Company Method 8201 Chlorine, Free by the DPD Method.
 - d. The test shall be deemed successful if the average chlorine concentration is between 0.35 and 0.55% (3,500 to 5,500 mg/L).
 - 2. Generation Capacity
 - a. The generating capacity of the unit shall be calculated by multiplying the system flow rate (GPH) with the free available chlorine concentration times .0002 using a 15 second graduated cylinder flow measurement.
 - b. The generator capacity shall be reported in equivalent pounds per day.
 - c. The test shall be deemed successful if the generator capacity is greater than 60 lbs/day.
- D. Once both performance tests are successful, the CONTRACTOR shall issue a Final Acceptance letter to the EQUIPMENT SUPPLIER.
- E. If the Mixed Oxidant feed system fails to meet any of the specified performance requirements, the Installation Contractor and/or OSHGS Supplier shall modify and/or replace defective equipment until it meets specified requirements. Re-test system to verify satisfactory operation.

3.5 TRAINING

- A. Site Technical Training
 - 1. The EQUIPMENT SUPPLIER shall provide operator training at the site for a period no less than three (3) eight (8) hour day(s). Training shall

include operation, maintenance and troubleshooting for each component of the OSGMOS.

END OF SECTION 11400

SECTION 11401 – WATER ONLY BACKWASH LOW PROFILE UNDERDRAIN SYSTEM

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. The work under this section includes furnishing, and testing a filter system consisting of:
 - 1. Filter underdrain system complete with underdrain blocks, anchor rods, and grout retainer.
 - 2. Rotary surface agitators
 - 3. Filter media
 - 4. Washwater troughs
- B. One manufacturer shall supply the above equipment. The installation contractor shall install all equipment. Concrete, bonding agent, grout, sealant, anchor adhesive, mechanical equipment anchor bolts, filter system piping and electrical conduit/wire shall be furnished and installed by the installation contractor.

1.02 SUBMITTALS

Provide the following in conformance with applicable requirements of Division 1.

- A. Product Data: Manufacturer's descriptive and illustrated literature, catalogues or catalogue cuts, technical specifications, wiring diagrams and installation instructions for all items of media, valves, process equipment, electrical equipment, and for all accessories.
- B. Shop Drawings: Prepare and submit shop drawings for equipment. Submit with the shop drawings a complete parts list and list of manufacturer's recommended spare parts.
- C. Non-Conformance: In event that it is impossible to conform to certain details of the specifications due to manufacturing techniques or supplier component changes, describe completely all non-conforming aspects.
- D. Operation and Maintenance Manuals: One (1) copy of operations and maintenance manuals (which shall include installation and start-up instructions) shall be furnished for all components provided as part of this project. One (1) copy shall be with the equipment when shipped.

1.03 MANUFACTURER

- A. The underdrain system shall be a standard product of a filter manufacturer who has been actively providing air/water backwash filter underdrain systems for at least 10 years. Upon request, the filter manufacturer will provide the engineer with an installation list of backwash filter underdrain systems which totals not less than 100.

- B. The manufacturer of the filter underdrain system shall be De Nora Water Technologies, LLC. in Pittsburgh, Pennsylvania, or equal.

1.04 PERFORMANCE REQUIREMENT AND DESIGN BASIS

The filter system shall be designed to operate under the following conditions:

Number of filters	1
Filter Size	14'-10" x 17'-10"
Filtration Rate, Design, gpm per ft ²	<u>4.0</u>
Water Only Backwash Rate, gpm per ft ²	20 maximum

PART 2 – EQUIPMENT DESCRIPTION

2.01 UNDERDRAIN SYSTEM

A. General

1. The filter underdrain system shall be designed and installed to ensure long-term stability in its operating characteristics. It shall be resistant to changes in headloss, flow uniformity, and any other effects, which would in time cause loss of efficiency or effectiveness in its operation.
2. The underdrain system shall meet National Sanitation Foundation (NSF) Standard 61 “Drinking Water System Components - Health Effects”.

B. Underdrain Block

1. The underdrain system for the filters shall be of the “Dual-Parallel Lateral” type whereby two feeder and two compensating laterals are provided in a single block system. The cross-section of the underdrain shall be so arranged that the feeder (or primary) laterals are adjacent and connected to the compensating (or secondary) laterals through a series of orifices. The orifices shall be located at four different elevations and sized to provide uniform distribution of air at a rate in the range of 3-5 scfm/sq.ft. and water up to 25 gpm/sq.ft. The feeder primary laterals should provide at least 60 square inches of cross sectional area per block to minimize flow velocity during backwash. The height of the block shall be approximately 8” and the width approximately 17”.
2. The compensating laterals shall provide essentially uniform pressure and flow distribution from the top of the blocks. The discharge flow from the top of the blocks into the filter bed shall be provided by a minimum of twenty-two (22) dispersion orifices per square foot of filter area. The orifices shall be not less than 1/4” diameter and shall be recessed from the surface by approximately 1/8”. The top of each orifice shall be encircled by a depression approximately 3/8” x 3/4” which shall act to prevent the gravel support media from resting directly on and thereby blocking the dispersion orifice.
3. The individual blocks used in the system shall be of impervious high-

strength, completely corrosion resistant high-density polyethylene material, having uniform smooth surfaces and all orifices properly molded. The blocks shall have ridges and pockets for structural rigidity and to key into surrounding grout. The block dimensions and weight shall permit ease of handling and installation. The blocks shall be mechanically joined to form a continuous lateral run equivalent to the length of the filter cell. The joints shall be single gasketed, snap lock, bell and spigot type with internal registers, and the joints are to be air and watertight.

4. The plastic underdrain shall be suitable for use with backwash air temperatures to 200°F.
5. The filter underdrain system, when installed, shall be designed to withstand a burst pressure equal to twice the maximum headloss experienced at maximum backwash rates. No credit shall be taken for the weight of gravel or filter media.
6. The filter underdrain system shall be able to withstand a net downward loading of not less than 2500 psf, plus its own deadweight.
7. Each block shall have wedge shaped ribs on the bottom of the block to key into the floor grout and provide uplift resistance. Manufacturers that provide blocks without this feature shall provide 304 stainless steel hold down angles, spaced every three feet along the laterals. The angles shall be minimum 2" x 2" x 3/16". Threaded rod shall be inserted between each block lateral and embedded a minimum 5" in to the filter floor and fastened by suitable epoxy adhesive.
8. Accessories required to complete the underdrain lateral shall be provided. These shall be, as applicable, the bridging over the flume for grout retention, end caps to close the ends of the laterals, sealant for the end caps and block joints, and carbon steel anchor rods for the flume block.

2.02 MEDIA RETENTION CAP

- A. A porous cap constructed of sintered HDPE beads shall be mounted to the underdrain block. This cap will eliminate the need for any gravel layers.
- B. The cap shall be fastened to the underdrain with a minimum of (18) 316 stainless steel screws and sealed with an NSF approved sealant.
- C. The cap shall have an average pore size of 500 microns and shall be no more than 1" thick.

2.03 FILTER MEDIA

- A. A layer of silica sand filter media, at least 12" finished depth, after backwashing, scraping, and removal of fines, shall be placed on filter underdrain. The sand shall have an effective size of 0.45 mm to 0.55 mm, with a maximum uniformity coefficient of 1.40. The hardness shall be 6 to 7 on the MOH scale and the specific gravity shall be 2.6 or greater. The hydrochloric acid solubility shall not exceed 5% when tested in accordance with AWWA

Specification B100.

- B. A layer of anthracite, at least 18" finished depth, after backwashing, scraping, and removal of fines, shall be placed on top of the filter sand media layer. The anthracite shall have an effective size of 0.95 to 1.05 mm with a maximum uniformity coefficient of 1.4. The hardness shall be not less than 2.7 on the MOH scale and the specific gravity shall be 1.5 or greater. The hydrochloric acid solubility shall not exceed 5% when tested in accordance with AWWA Specification B100.

2.04 WASH WATER TROUGH

- A. All necessary wash water troughs shall be supplied and installed as shown on the plans. Troughs shall be laminated of fiberglass reinforced polyester resin to an average thickness of 1/4" inch. The inside surface of each trough shall have a smooth blue green gel coat finish. The outside surface of each trough shall be resin sealed with no exposed glass fibers. Color shall be molded in and an ultra-violet inhibitor shall be used.
- B. Troughs shall have round bottoms and vertical sides. Top edges of the troughs shall be straight with no more than 1/8-inch deviation from a true plane. Longitudinal stiffening ribs shall be integrally molded on the outside of the troughs to assure rigidity. Sufficient plastic spacer rods shall be included to maintain a uniform width over the length of each trough.
- C. Spacer rods shall be spaced to prevent buckling, and to provide maximum resistance to water loading on the sidewalls of the trough. The troughs shall be fabricated of fiberglass reinforced polyester resin, with fiberglass constituting a nominal 30% by weight. The resin shall be of a general purpose high quality. The glass reinforcement shall be random chopped-strand type with a minimum strand length of 1-inch, and adequate contact molding pressure to provide complete wet-out of the glass fibers. The material shall have the following minimum physical properties: Tensile strength—14,000psi; Flexural strength—25,000psi; Flexural modulus— 1.0×10^6 psi. The troughs shall be fabricated to ANSI/AWWA F101-91 standards.
- D. Trough layout, outlet, and support system shall be as shown on the drawings. All anchors and fasteners shall be Type 304 stainless steel. The support system shall allow 1-inch minimum adjustment of the trough, horizontally and vertically, and shall allow no greater than L/1000 upward deflection with the trough empty and water to the weir edge. Stabilizers shall be provided where necessary to restrict lateral movement (oscillation).

2.05 ROTARY SURFACE AGITATORS

- A. Furnish rotary surface agitators and header piping as shown on the drawings suitable for pressures up to 100 psig.

- B. The installation of the rotary surface agitators and header piping shall be in strict accordance with the radial surface agitator manufacturer's written instructions.
- C. The rotary surface agitators shall operate during the backwash cycle to scour the filter media and remove particles adhering to the media.
- D. The center bearing assembly shall be suitable for connection to the surface wash piping and shall be constructed of 304 stainless steel with a ball bearing type central housing stabilized for vertical and horizontal bearing pressure, containing a stainless steel ball bearing assembly which is packed in grease and sealed from the water passageway by means of non-adjustable, self-compensating, Buna-N O-ring seals.
- E. The distributor arm shall be suspended from the center bearing and shall be made of a unitized welded assembly of Type 304 Schedule 5 stainless steel.
- F. The rotating distributor arm shall extend outward from the vertical centerline of the bearing in a horizontal strait manner and then commence to a bend 90° in the horizontal plane in a smooth continuous manner so that the end jets give additional impetus to the counter clockwise rotation.
- G. At each end of the curved distributor arm shall be located an end cap containing four (4) additional nozzles for effective agitation in the filter corners. The end caps shall be welded to the ends and be made of stainless steel.
- H. Nozzles shall be attached to the trailing edge of the strait portion of the lateral arms, the forward leading edge of the curved end section, and the end cap in such a manner as to impart four distinct agitating actions to each corner area of the filter during one complete revolution.
- I. Nozzles shall be spaced on the distributor arm to most effectively distribute water to the filter surface and shall be set 15° downward from the horizontal plane. Nozzles shall be affixed to the distributor arm by means of threaded connections (retaining collars molded into the nozzle are not acceptable). Agitator nozzles shall be made of molded Delrin, 2" overall length with 7/8" hexagon wrench flat provided. Nozzles shall be color coded to distinguish orifice sizes.
- J. Nozzles shall be designed to accommodate and retain a snap-on flexible synthetic rubber cap provided with a four-way cross opening which shall open under pressure and close automatically when pressure is turned off to prevent backflow. The flexible synthetic rubber cap shall be 1" nominal diameter and shall be provided with an internal shoulder to snap into a matching groove in nozzle to retain cap in position on nozzle under all operating conditions.
- K. Header piping shall be supplied within the filter cell up to a flanged wall nozzle. Piping shall be Schedule 5 (minimum), type 304 stainless steel with flanged, welded or threaded joints as required.

- L. The header support brackets, angles, bolts and attachment hardware shall be type 304 stainless steel. Structural members shall be 3/16" minimum thickness and "U" bolts shall be 3/8" minimum diameter.

PART 3 – EXECUTION

3.01 UNDERDRAIN AND MEDIA INSTALLATION

- A. The grout used in installing the blocks shall have a minimum compressive strength of 2500 psi after 30 days of curing. All grout used in installing the blocks shall be made of one part cement and two parts clean sand. The grout shall be furnished by the contractor.
- B. Care shall be exercised in preparing the filter floor slab that it is level in elevation.
- C. Anchor rods shall be installed across water distribution flumes to hold the underdrain block against uplift force during filter backwash. They shall therefore be properly installed and grouted as recommended by the underdrain manufacturer. Height of the anchor rods shall be measured from the high point of the filter floor and the top of each anchor rod shall be at the same elevation within $\pm \frac{1}{4}$ - inch.
- D. The filter blocks shall be set in relatively level rows on a bed of bonding agent and grout over the filter floor slab. Plates for closing the ends of each row of blocks shall be furnished by the filter manufacturer. After setting and aligning the blocks, all spaces between the rows of blocks and walls shall be filled with grout so that the entire bed is totally sealed and held firmly in place. Care shall be taken to prevent any grout from entering the lateral channels, orifices or from being deposited in any manner which would interfere with flow.
- E. Following the installation, the system shall be completely cleaned and washed free of all loose materials and debris. The underdrain shall be allowed to set for three days before applying internal water pressure.
- F. The system shall be checked by following the backwash procedures. The uniformity of distribution, and factors such as structural stability of the installation, shall be observed. The system shall be installed and tested completely in accordance with the specifications of the filter manufacturer, and under the direction of an experienced superintendent provided by the filter manufacturer.
- G. Place filter media and support gravel in strict accordance with the filter media supplier's recommendations, and under the supervision of his authorized field supervisor.
- H. Wash each layer of media by backwashing. Each media layer shall have fines

scraped after backwashing.

3.02 MANUFACTURER'S SERVICES

The filter manufacturer shall furnish the services of a competent and experienced representative who has complete knowledge of proper operation and maintenance of the equipment. The manufacturer's representative shall be on site 100% of the time during underdrain installation and testing. Services shall be provided on-site for a period up to 4 days in 2 separate trips to train the contractor's crews and inspect the installation of the filter underdrain and to perform the backwash tests on the underdrain. Additional days and trips, if required by the contractor, shall be reimbursed by the contractor to the manufacturer at the manufacturer's per diem rate.

END OF SECTION 11401

Division 12 – Furnishings

SECTION 12345 – LABORATORY FURNISHINGS AND FIXTURES

PART 1 - GENERAL

1.01 WORK INCLUDED

Furnish and install laboratory equipment in accordance with the Plans and these Specifications. The Work shall include the furnishings of all materials, accessories, equipment, tools, transportation, services, labor and the performance of all operations for a complete installation. All furnishing, equipment, materials and apparatus specified herein shall be supplied by the same manufacturer.

1.02 SCOPE OF WORK

The Work shall also include furnishing the following items:

- A. Complete roughing-in drawings showing dimensions, sizes and capacities of all service connections required.
- B. Description of all work within the equipment and casework required to bring service lines to the points of final connections.
- C. Layout of final connections to water, waste and vent lines and similar service lines.

1.03 FAMILIARITY WITH JOB SITE

The Contractor shall become familiar with all job conditions relative to the laboratory equipment, and shall be responsible for all necessary building measurements and condition to properly coordinate the planning, design, connections, delivery and installation of the laboratory equipment with other related and associated work.

1.04 RELATED WORK

- A. Division 15 – Mechanical.
- B. Division 16 – Electrical.

1.05 SUBMITTALS

- A. Shop Drawings: Shop drawing submittals shall include the layout of

cabinets and counters and listing of apparatus and equipment hereinafter specified. Clearly indicate existing space dimension of proposed location. Show in the submittals construction details for equipment and casework by shop drawings and catalog cuts.

- B. Samples: Samples may be requested as listed below. Component parts of samples shall have materials of full thickness and shall show fully all details of construction.

1. Countertops.
2. Drawer construction, with drawer guides.
3. Cabinets, showing detailed construction.
4. Door construction.
5. Wall cabinet construction.
6. Finished hardware.
7. Color samples, of all material types.

1.06 EXPERIENCE

The laboratory equipment manufacturer shall have been in successful operation for at least five (5) years and have a factory for and specifically devoted to the manufacturer of equipment specified herein, exclusive of mechanical and electrical fittings.

1.07 QUALITY ASSURANCE

Furniture to be provided for this laboratory and laboratory office shall conform to the Specifications listed herein. The equipment and furnishings shall be new and of the highest grade in material furnishings shall be new and of the highest grade in materials, finish and workmanship. All materials shall be the best of their kind and all construction details shall be in conformity with the best practices in the industry.

PART 2 - PRODUCT

2.01 GENERAL

Laboratory equipment shall be furnished in accordance with these Specifications and as shown on the Drawings. Laboratory equipment shall be manufactured by Hamilton Laboratory Solutions, Superior Laboratory Systems, or equal.

2.02 MATERIALS

Steel shall be of furniture quality, the best mild, cold rolled, level stock, free from rust, scale, scratches and all physical defects. All gauges shall be U.S. Standard.

2.03 CONSTRUCTION

- A. All welded construction shall be used throughout, except where construction details makes it impractical. Welded joints shall be ground flush with the adjacent material and neatly polished. No bolts, rivet heads or screw shall show on the finished surfaces. Where units are jointed in assemblies, they shall be fastened by bolting through cabinet sides.
- B. All furniture required shall be furnished in strict accordance with the description and details provided herein. The metal furniture shall be rigidly constructed and shall be assembled so that it can be relocated at any subsequent time. Doors and drawers shall be sound-deadend and be readily removable for purposes for decontamination, cleaning and repair. All hinges shall be applied to case and door bodies with 8-32 by 3/8 inch flat head machine screws to allow replacement of hinge. Welding of the hinges either to door or case shall not be permitted. Standard cabinet units shall be in place of a standard depth drawer, without the use of drills or machinery. Only the purchase of the necessary parts shall be required, thereby assuring the laboratory against possible future problems in case of change of use of the area. All support frames, bases, curbs and partitions shall be integrated into a completely assembly.

1. Base, Floor and Wall Units:

- a. End uprights shall be formed construction at front, top, back and bottom. Upright shall be keyed to mating horizontal members which shall be both heliarc and spot welded at all junctures.
- b. Bottom front horizontal toe space rails shall be formed to provide a rectangular recessed toe space fully enclosed, having a channel formation at the face and bottom. Toe space shall be integral with cabinet, 3 inches deep by 5 inches high, and dustproof.
- c. Cupboard bottom shall be full depth and width of unit on all cases to prevent dirt from entering the cabinet. Bottom shall be both heliarc and spot welded in place to provide rigidity in the base of the unit. Four 7/8-inch diameter holes shall be punched in the cupboard bottom directly over and for access to unit leveling bolts located in the case corner gussets to provide ease of installation. Provide button plugs for dustproofing bottom.
- d. Backs of all units shall be designed with a top and bottom rail, and the section between the rails shall be left open for simple access to plumbing lines without disassembling the entire unit. All units shall be supplied with removable backs (removable

from the inside of the case without the use of tools) to close this space between the top and bottom rails.

- e. Roll-out shelves shall be provided on all single cupboard units, 18-inch or 20-inch width, to provide safe access to rear of the shelves. Shelves shall be constructed with a rolled front edge for use as a strengthener and shelf pull, and allow shelf to be used as tote-tray. All other cupboard units shall have 1/2 depth adjustable shelves.
- f. Drawers shall operate on a nylon roller and ball-bearing channel suspension, with the front nylon ball-bearing rollers set into drawer channels. Drawer channels shall have indentations that make the drawers self-closing to protect contents from undue shock. Removal of drawer shall be possible without the use of tools. The drawer body shall be provided with a screwdriver slot for removal and installation of various colored work areas. Both inner and outer drawers heads shall have all parts which will be concealed, thoroughly phosphate coated and painted on all surfaces before assembly so as to provide the fullest protection against concealed corrosion. All parts of the door assembly shall also be completely painted before door is assembled. The door shall be assembled so that it may be readily taken apart for decontamination when necessary. Each door and drawer shall be provided with a waffle-type sound-deadener, cut to correct size and thickness, and installed before the door or drawer is assembled. All doors, when mounted on the case, shall swing 180 degrees and support, without sagging, a 200-pound weight suspended at the outer edge of the door while the door is being swung. The catches shall be of magnetic design, attached in such a manner that catches shall not wear on any painted surface or edge.
- g. The frame assembly shall be readily removable as a unit for complete and unhindered access to base unit interior. The frame shall have cushioning neoprene gasketing against which all drawers and doors will close to prevent dust gaps, to sound-deaden, and to seal out spillage from the cabinet. The frame shall be designed so that all drawers and doors are separated by concealed horizontal support rails. There shall be no metal-to-metal contact.
- h. The welded assembled cabinets shall receive a 6-stage phosphating process to insure excellent paint adhesion and to aid in the prevention of corrosion. The finishing process shall consist of an epoxy acrylic resin prime coat and an acrylic finish, both baked at 390 and 400 degrees F for twenty minutes and then cooled to produce optimum coating properties. Total paint film thickness shall be 1.25 mil, minimum. Finish shall show no effect from application up to 1 hour of the following reagents:

Sulfuric 85%

Hydrochloric	37%
Nitric	25%
Formic	88%
Phosphoric	75%

- i. **Drawer Front Panels:** The interior and exterior of all base units, Versa-Tables, apron units, and special purpose units shall be painted shell White. All drawer front panels, interior and exterior panels, cupboard doors shall be painted as selected by the Engineer from the manufacturer's standard colors. All drawer front panels shall be painted both front and back and receive same finish process as required for base units. Adequate replacement stacks shall be maintained on all drawer front panels (all sizes and all colors according to the laboratory furniture color selected by the Engineer) for the length of the warranty period to assure immediate replacement in cases of defective workmanship or damage.
2. **Table Top and Working Surfaces:** Solid epoxy tops shall be molded, oven-cured, modified epoxy resin with a 3/16-inch high and 1-inch deep drip guard front edge. Backsplashes shall be modified solid epoxy integrally molded with the top and be 3-3.4" high by 3/8" thick with a 3/4" radius at the junction with the top. Epoxy resin surfaces and backsplash shall sat Epoxy resin surfaces and backsplash surface shall satisfactorily pass performance tests for resistance to chemical attack. Surfaces shall show no effect from hydrochloric acid (37%), sulfuric acid (70%), nitric acid (70%), Aqua Regia, sodium hydroxide (50%), ethyl alcohol, benzene, exlene, aqueous surface. Reagents and solvents shall be covered in such a manner as to maintain a wet surface for the 24-hour test period. At the end of the test, the surface shall be washed with soap and water, rinsed and dried before examination and evaluation. Surfaces also shall satisfactorily pass performance tests for heat, char, impact and moisture resistance.
3. **Service Shelves:**
 - a. The service shelves shall be of high density particle board construction with laboratory grade, high pressure, melamine plastic surface. Shelves shall be manufactured to provide an overlap joint between the backsplash of the shelf and the backsplash of the top.
 - b. All necessary shelf support brackets shall be supplied with the shelves for support of shelves, fixtures, and piping. The service shelves shall be installed complete with service fixtures before the base units are installed, enabling a faster installation time.
4. **Sinks:** Sinks shall be composed of solid epoxy resin.
5. **Hardware:**

- a. Metals pulls for drawers and doors shall be of extruded aluminum. 6" wide, 7/8" high and project 1" from drawer to front door, or shall be of recessed design with label-holding capability.
- b. Hinges shall be of 14 guage steel, 2-1/2" high, institutional type, tight pin, 5-knuckle with satin chrome finish. Hinges shall be attached to both door and case with two (2) heavy steel screws through each leaf. Welding to doors and cases is not acceptable. Doors under 36" in height shall be hung on one (1) pair of 2-1/2" hinges; doors over 36" in height shall be hung on three (3) 2-1/2" hinges.
- c. Door catches shall be magnetic design. Use of an active knob and up-and-down bolt assembly shall not be acceptable.
- d. Shelf clips for adjustable shelves shall be nickel plated steel. Channels shall be provided to support the half depth shelves.
- e. Base molding shall be 4" high coved black vinyl, sufficiently plastic to permit cementing tightly against cabinet base and floor line to provide a watertight seal.

6. Mechanical Service Fixtures:

- a. All mechanical service fixtures, as shown and/or specified, shall be provided in proper packaging. All plumbing fixtures and turret-type mountings (except fixtures using brass forgings) shall be cast from red brass, an alloy of 85 % copper, 5% tin, 5% lead, 5% zinc. All water handles shall be the four-arm type, forged from high-grade brass with recessed snap-in index buttons. Buttons shall be clearly marked and colored in accordance with Scientific Apparatus Manufacturers Association (SAMA) color coding system.
- b. Water fixtures shall be designed so that all workings parts shall be removable and interchangeable with fixtures of the same type and number. Valve stems shall be held in place by a large packing nut with brass and fiber washer and preformed long-life packing. The valve stem assembly shall be removable without disturbing the installation of the fixture. Valve stems and fixture body shall have double Acme threads. All seats shall be changeable and of bronze with seating surface highly polished.
- c. Goosenecks shall be of brass with highly polished surface, 11/16" OD and shall be threaded to accommodate 3/8" ips accessories. Fixtures shall be furnished with hose connections and vacuum breakers as shown on the Plans.

PART 3 – EXECUTION

3.01 INSTALLATION

Installation shall be in accordance with the manufacturer's recommendations.

3.02 TECHNICAL ASSISTANCE

The Contractor shall furnish the services of an experienced and qualified manufacturer's technician to supervise the installation.

END OF SECTION 12345

Division 13 – Special Construction

SECTION 13410
BASIC INSTRUMENTATION MATERIALS AND METHODS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The CONTRACTOR shall furnish all materials, labor, tools, equipment, supplies and services necessary to install all process control and instrumentation equipment complete as specified herein and shown on the Drawings. The CONTRACTOR shall be responsible for the expense of changing Drawings or structures, or any other expense necessitated by reason of installing alternative equipment. The CONTRACTOR will assume the responsibility for the satisfactory operation of any and all equipment offered.
- B. The following equipment specification is included to establish the quality of equipment to be obtained. It is the intent of these Specifications to obtain industrial quality instrumentation and control equipment. Equipment furnished shall be accepted by the ENGINEER, prior to purchase by the CONTRACTOR.
- C. Auxiliary and accessory devices necessary for system operation or performance, such as transducers or relays to interface with existing equipment or equipment provided under other Sections of this Specification, shall be included whether specified or not, at no extra cost.
- D. In order to ensure proper integration and compatibility of the plant instrumentation and control systems, the systems must be supplied by a single provider of instrumentation and control equipment. This is not to say that all equipment being supplied shall be manufactured by a single manufacturer, but rather that a single provider of instrumentation and control equipment shall be responsible for supplying the complete system. To facilitate the OWNER'S future operation and maintenance, products performing the same function shall all be of the same manufacturer, type, and model number.
- E. In order to ensure the interchangeability of parts, the maintenance of quality, the ease of interfacing between the various subsystems, and the establishment of minimums with regard to ranges and accuracy, strict compliance with the requirements herein shall be maintained. In order to ensure compatibility between all equipment, it shall be the responsibility of the system supplier hereunder to coordinate all interface requirements with mechanical and electrical system suppliers and furnish any signal isolation devices that might be required.
- F. Equipment shall be fabricated, assembled, installed, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer as accepted by the ENGINEER.
- G. The instrument supplier for this Contract shall be responsible for making the modifications shown on the Drawings and for recalibrating all instruments (existing and new) and placing them in proper working order.

- H. The Contractor, through the use of the pre-approved instrumentation and control system supplier and qualified electrical and mechanical installers, shall be responsible to the Owner for the implementation of the instrumentation and control system, and the integration of the control system, and all the appurtenant work, being provided under this Section of these Specifications and the integration of the instrumentation and control system and control devices provided under this project all in accordance with the requirements of the Contract Documents. In addition, the instrumentation system supplier shall install and place into service the PLC based control system specified herein. The pre-approved instrumentation and control system supplier for this project is Rawdon Myers, Inc.
- I. Due to the complexities associated with the interfacing of numerous control system devices, it is the intent of these specifications that the instrumentation system supplier be responsible to the Contractor for the integration of the instrumentation and control system with devices provided under other sections with the objective of providing a completely integrated control system free of signal incompatibilities.

1.02 RELATED WORK

- A. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

DIVISION 1 - GENERAL REQUIREMENTS
DIVISION 11 - EQUIPMENT
DIVISION 16 - ELECTRICAL

1.03 QUALITY ASSURANCE

- A. The system supplier shall be required to demonstrate a minimum of 5 years recent, past experience in the design, manufacture, and commissioning of instrumentation and control systems of comparable size, type, and complexity to the proposed project. Further, the manufacturer must have at least 10 similar systems in operation currently. The system supplier shall be required to have his own in-house capability to handle complete system engineering, fabrication, and testing. In lieu of 5 years experience, system suppliers shall provide direct to the CONTRACTOR a 5 year performance bond in an amount equal to the installed cost of the system. The CONTRACTOR shall include a copy of the executed bond in the shop drawings submittal books.
- B. The system supplier shall have in his employ the capable personnel for detail engineering, coordination, drafting, procurement and expediting, scheduling construction, testing inspection, installation, start-up service for calibration and commissioning, and warranty compliance for the period specified.

1.04 REFERENCES

- A. The CONTRACTOR is referred to Standards and Practices for Instrumentation published by the Instrument Society of America (latest edition), for terminology,

symbols, methods and practices used or described herein or on the Drawings.

1.05 SUBMITTALS

A. Detailed Requirements - Instruments/Hardware

- a. Detailed information for each instrument or control device shall be submitted, including manufacturer's descriptive literature and a specific data sheet for each device which shall include as a minimum:
 1. Tag number assigned by the manufacturer.
 2. Product (item) name used herein and on the Contract Drawings.
 3. Manufacturer's complete model number.
 4. Location of the device.
 5. Input - output characteristics.
 6. Range, size, and graduations.
 7. Physical size with dimensions, enclosure NEMA classification, and mounting details.
 8. Materials of construction of all components.
 9. Instrument or control device sizing calculations where applicable.
 10. Certified calibration data on all flow metering devices.
- b. Submit a detailed loop diagram, for each monitoring or control loop, each on a single 8 ½ in. X 11 in. sheet. The format shall be the Instrument Society of America, Standard for Instrument Loop Diagrams, ISA-S5.4.
- c. The data sheets shall be provided with an index and proper identification and cross-referencing. Partial submittals will be rejected.
- d. Submit detailed drawings concerning control panels and/or enclosures including:
 1. Cabinet assembly and layout drawings to scale.
 2. Fabrication and painting specifications.
 3. Point to point wiring diagrams depicting wiring within the panel as well as connections to external devices.
 4. Color samples for paint selection by the ENGINEER and/or OWNER.
- e. Exceptions to the Specifications or Drawings shall be clearly defined by the system supplier. Data shall contain sufficient details so a proper evaluation may be made by the ENGINEER.
- f. Prior to final acceptance, the final shop drawing submittal, which is to include Installation, Operation, and Maintenance instructions, shall be updated to reflect "As Constructed" status, and shall provide at least the following as a minimum:
 1. A comprehensive index.
 2. A complete "As Constructed" set of accepted shop drawings.
 3. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.
 4. Full specifications on each item.
 5. System schematic drawings "As Constructed", illustrating all components, piping and electrical connections of the systems supplied under this Section.
 6. Detailed service, maintenance, and operation instructions for each item supplied.

7. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
8. The operating instructions shall also incorporate a functional description of the entire system, with reference to the systems schematic drawings and instructions.
9. Complete parts lists with stock numbers and name, address, and telephone number of the local supplier.

B. See Section 13450 for submittal requirements for system software.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Shipping Precautions:

- a. After completion of shop assembly, factory test, and acceptance, all equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weights shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.
- b. Special instructions for proper field handling, storage and installation required by manufacturer for proper protection, shall be securely attached to each piece of equipment proper to packaging and shipment.

B. Identification:

- a. Each component shall be tagged to identify its location, tag number and function in the system. Identification shall be prominently displayed on the outside of the package.
- b. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment supplied under this Section.

C. Storage:

- a. Equipment shall not be stored out-of-doors. Equipment shall be stored in dry permanent shelters including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the CONTRACTOR at his own cost and expense. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through such tests as directed by the ENGINEER. This shall be at the cost and expense of the CONTRACTOR, or the apparatus shall be replaced by the CONTRACTOR at his own expense.

1.07 WARRANTY

A. A written total instrument maintenance contract shall be provided to the OWNER,

executed by the system supplier as a part of the work under this Section. The maintenance contract shall include all labor, parts, and emergency calls providing on-site response within 48 hours, to provide complete instrument system maintenance for a period of one year after the date of final acceptance of the system. The maintenance contract shall also include a minimum of 2 semi-annual preventive maintenance visits by a qualified serviceman of the supplier who is familiar with the type of equipment provided for this project. Each preventive maintenance visit shall include routine adjustment, calibration, cleaning, and lubrication of all system equipment and verification of correct operations. Emergency maintenance procedures or plant visits may coincide with a scheduled preventive maintenance visit, however, they shall not replace the work intended to be performed during a preventive maintenance visit. The system supplier shall have full responsibility for the preventive and corrective maintenance including replacing of defective components, maintaining sufficient spare parts on-site, and complete calibration of all components under this section, all at no cost to the OWNER. The maintenance contract shall not begin until both the instrumentation training course and the system acceptance test have been successfully completed, at which time the OWNER shall be capable of performing necessary preventive maintenance, and all instruments shall be functional.

- B. During the one-year maintenance period, observation of maintenance operations by designated OWNER personnel, and the instruction of said personnel in the details of the maintenance work being performed shall be provided.
- C. A complete written report, shall be furnished the ENGINEER and OWNER after each scheduled and unscheduled visit, giving problems corrected, systems needing recalibration, and recommendations to prevent recurrence, if applicable.
- D. The costs for the one-year maintenance service contract shall be included in the Contract price.

1.08 TRAINING

- A. A training program shall be set up and conducted by the major equipment manufacturer furnishing the instrumentation package. The training session shall be for a minimum period of 2 days uninterrupted and shall be conducted at the treatment plant.
- B. A course outline showing the material to be covered shall be submitted to the ENGINEER for review. The training program shall include both classroom and “hands-on” instruction for each instrument supplied under this group of the Specifications and shall furthermore include operational training, maintenance training, and training on use of calibration equipment.
- C. As the equipment installed at the plant shall be used for the “hands-on” training, the training program shall not be conducted until all of the systems are operational, and operational related “punch list” items are corrected.
- D. Training on equipment supplied by a manufacturer other than the major equipment manufacturer shall be by the original equipment manufacturer, and shall be scheduled in the training programs by the major equipment manufacturer.

Exceptions may be granted if the instructor demonstrates adequate knowledge on the care and operation of the other manufacturers' equipment.

- E. The training programs shall be conducted at a time mutually agreeable to the ENGINEER, OWNER, CONTRACTOR, and Supplier. The OWNER shall decide how many of his personnel shall attend the training. A representative of the ENGINEER may observe the training in progress. The OWNER shall have the right to videotape all training as it is conducted.
- F. The supplier shall make use of audio-visual aids in the training courses and shall provide the OWNERS staff his undivided attention (i.e., shall not conduct his company business during training hours) for the full 2 days. The supplier shall furnish training participants with written handouts, preferably copies of the shop drawing submittal books, up to a maximum of 6 copies, for purposes of familiarization with the shop drawings, and to assist in explanations.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All instrumentation supplied shall be of the manufacturer's latest design and shall produce or be activated by signals which are established standards for the water industry.
- B. All electronic instrumentation shall be of the solid-state type and shall utilize linear transmission signals of 4 to 20 mAdc (milliampere direct current), however, signals between instruments within the same panel or cabinet may be 0-10 V.d-c (volts direct current), or other manufacturer standard.
- C. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero based signals will be allowed for remote transmission.
- D. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings or as required.
- E. All indicators and LED readouts shall be linear, direct reading in process units, unless otherwise noted. Percentage scales and indicators are prohibited.
- F. All transmitters shall be provided with either integral indicators or conduit mounted indicators in process units, accurate to two percent, unless otherwise noted.
- G. Electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and suitably coated to prevent contamination by dust, moisture and fungus. Solid state components shall be conservatively rated for their purpose, to assure optimum long term performance and dependability over ambient atmosphere fluctuations and 0 to 95 percent relative humidity. The field mounted equipment and system components shall be designed for installation in dusty, humid, and slightly corrosive service conditions.

- H. All equipment, cabinets and devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, in-so-far as possible, and shall consist of equipment models which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion.
- I. All equipment shall be designed to operate on a 60 Hertz alternating current power source at a nominal 115 volts, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.
- J. All analog transmitter and controller outputs shall be 4-20 milliamperes into a load of 0-750 ohms, unless higher load capacity is required.
- K. All switches shall have double-pole double-throw contacts rated at a minimum of 600 VA, unless specifically noted otherwise.
- L. Materials and equipment used shall be UL listed (or other independent lab listed) wherever such listed equipment and materials are available.
- M. All equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting when power is restored.
- N. All circuit boards in instruments mounted in damp locations or mounted outdoors shall be fungus proofed. All field transmitters mounted outside shall be equipped with sunshields and shall be capable of operation to -20o Fahrenheit.

2.02 INSTRUMENTS AND ACCESSORY EQUIPMENT

- A. Refer to other Division 13 Instrumentation Specification Sections for equipment requirements for field mounted primary devices, transmitters and secondary instruments, receivers and central control equipment.

PART 3 - EXECUTION

Not applicable.

END OF SECTION - 13410

SECTION 13421 FLOW MEASUREMENT DEVICES

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The CONTRACTOR shall furnish and install all primary devices, transmitters, primary and secondary receivers, analyzers and accessory items as shown on the Contract Drawings and as specified herein.

1.02 RELATED WORK

- B. Additional Division 13 Sections of this Specification contain requirements on instrumentation and control equipment and software which are considered to be covered by applicable requirements of this section (and shall be included in the bid by a single Instrumentation Supplier for this Project).
- C. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

DIVISION 1 - GENERAL REQUIREMENTS
DIVISION 11 - EQUIPMENT
DIVISION 16 - ELECTRICAL

PART 2 - PRODUCTS

2.01 INSTRUMENTS AND ACCESSORY EQUIPMENT

- A. Magnetic Flowmeter
 - a. Meter shall be full bore with the magnetic field traversing the entire cross-section of the flow tube. Output signal produced shall be directly proportional to the liquid flow rate based on Faraday's law, using pulsed dc type coil excitation with high impedance electrodes. The metering tube shall be 304 stainless steel. Housing shall be epoxy coated cast aluminum, with 150 pound carbon steel ANSI flanged end connections. Liner shall be Teflon for meter sizes ½" to 3"; polyurethane for meter sizes 4" to 24"; and elastomer for meter sizes over 24." The electrodes shall be self-cleaning, Hastelloy-C. The meter shall have complete zero stability.
 - b. The temperature of the process shall not exceed 135 degrees Fahrenheit and the meter primary shall be capable of accidental submersion in 30 ft. of water (NEMA 6P). The meter shall be provided with 115 V, 60 Hz, single phase AC power and drip proof enclosure with provisions for electrical connections.
 - c. The transmitter shall be designed for use in connection with the magnetic flowmeter primary devices supplied and shall receive its signal from the primary device and convert it to a corresponding pulse and current signal, via a

manufacturer-supplied primary cable. Indication, totalization and output signal shall be for either forward or reverse flow, with flow direction indicated by contact closure.

- d. The meter shall provide a constant zero output during conditions of false flow signals are possible. An empty pipe detection feature shall drive the output signals to zero when electrodes become uncovered. Adjustable low flow cutout shall also be provided.
- e. The transmitter shall be constructed for field mounting in a NEMA 4X polypropylene enclosure with polycarbonate window. The transmitter shall include two-line, 16 character back-lit display indicating flow and totalizers. Integral keypad shall allow for external configuration without removing the cover. Three totalizers, nine digits each, shall be provided for forward, reverse, and net. Output shall be 4-20 mADC, and two programmable contact outputs. Where indicated, provide RS-232 or RS-484 serial interface connection. The output shall be provided with HART™ digital communications, with provides a digital process variable superimposed on the 4-20 mADC signal.
- f. Power to the transmitter shall be 120VAC, 60 Hz. Line voltage and frequency variations of $\pm 10\%$ shall have no effect on instrument calibration.
- g. The accuracy, including the primary, shall be $\pm 25\%$ of rate. Repeatability shall be $\pm 0.05\%$. Calibration shall be eight point traceable to NIST.
- h. All magnetic flow meters shall be provided with grounding rings. All interconnecting signal cable between the magnetic flow meter and signal converter, shall be provided by the meter manufacturer and be of sufficient length as required for the installation as shown on the Drawings. Any special cable terminations/fittings to replace the meter body should removal be necessary.
- i. Calibration
 - a. The meter shall include a test mode which provides the ability to verify the accuracy of the unit and the integrity of the current loop without any external equipment.
 - b. Meter self diagnostics shall provide internal checks of all outputs and displays.
 - c. Meters to be designed, manufactured, and calibrated in an NIST certified facility. Flow facility must be certified by volume or weight certified provers. Facility must have the capability to hold the flow rate at the specified calibration points for a minimum of five minutes to allow stabilization for flow and repeatability point checks.
 - d. The flow meter shall be WaterMaster series as manufactured by ABB, or equal.

B. Flow Tube (Plastic Insert)

- a. The insert flow element shall consist of an entrance section, throat, holding flange and recovery cone. The entrance shall consist of a uniform arc or partial circle, the radius of which shall be continuous with the throat section. There shall not be any protrusion or exposed sharp edge to allow solids to accumulate. The upstream entrance section shall be of cast silica-filled epoxy and designed for insertion between standard 125 pound flanges.
- b. The throat shall be made of bronze ASTM B584 alloy 844 or SAE 660, and shall have: internal annulus from which low pressure tap, drain and vent taps are located; or a single low pressure tap located in the throat.

- c. The high and low pressure metering taps shall be made a part of the holding flange, requiring no drilling or tapping of the pipeline itself.
- d. The recovery cone section shall be designed to minimize unrecoverable head loss. The primary element shall have the capability of being designed with any beta ratio in the range of 0.35 to 0.85 to maintain the permanent pressure loss to 70% or less of the maximum differential pressure.
- e. The accuracy of the uncalibrated flow element shall be within +0.5% of the actual flow or +0.25% for the calibrated device over the flow range specified.
- f. The manufacturer shall submit bore calculation sheets and certified flow versus differential curves for present and future flows to the Engineer for review, indicating permanent pressure loss at both flow rates. For purposes of calculations standard temperature shall be 68F and standard pressure 14.7 psi.

C. Intelligent Differential Pressure (Flow) Transmitter

- a. The transmitter shall sense differential pressure across the primary device (a venturi tube) and shall transmit a linear 4 - 20 mADC (or digital signal) in proportion to the differential developed. The transmitter shall have microprocessor based electronics, compact size and be a true two wire device and operate on the principle of resonant frequency. The transmitter shall be provided with normal response time of 1.0 second and electronically adjustable setting of 0.00, 0.25, 0.50, 1, 2, 4, 8, 16 or 32 seconds, which ever is greater, for a 90 percent recovery from an 80 percent input step as defined in ANSI/IEEE S51.1. The transmitter shall be capable of 60:1 turndown ratio.
- b. The range is to be fully adjustable throughout the span limit. Accuracy shall be ± 0.23 percent of span for a 4 - 20 mADC square root output of calibrated span. The unit shall be provided with automatic, continuous self-diagnostics.
- c. The body of the instrument shall be stainless steel. The sensor wetted parts material shall be AISI 316 stainless steel. The capsule fill fluid shall be silicone oil.
- d. The top works section shall consist of two compartments; one for field terminal connections (clearly marked such) and one to house the electronics.
- e. The transmitter shall be completely encapsulated in a weatherproof enclosure providing environmental protection for NEMA 4X (i.e. IP65). Connections between the electronics and the field terminal strip shall be hermetically sealed.
- f. Radio frequency interference protection shall be ± 0.1 percent error for frequencies in the range of 27 to 1000 MHZ with field intensities of 30 volts/meter shall be provided.
- g. The transmitter shall be provided with HART TM digital communications, which provides a digital process variable superimposed on the 4-20 mA signal, with protocol based on Bell 202 FSK standard.
- h. The transmitter shall withstand a transient surge of 2500 volts (in accordance with ANSI/IEEE Standard C37.90.1-1989) without permanent damage or calibration shift. Its output signal shall be protected against RFI by hermetically sealed filters between the field terminals and electronics section in the electronics housing. EMI, reverse polarity, voltage surge and over range protection shall also be provided.
- i. The transmitter shall have built in elevated and suppressed zero capability having limits equal to the upper and lower range limits. Zero and span adjustments shall be non-interacting.

- j. The transmitter shall be provided with internal damping with selectable time constant of 0, 0.25, 0.5, 1, 2, 4, 8, or 16 seconds.
- k. When utilized for flow measurement, the transmitter shall be supplied with an integral square root extractor, 316 SS three valve manifold assembly and direct reading integral indicator in engineering units.
- l. The Intelligent Differential Pressure Transmitter shall be 266 series as manufactured by ABB, or equal.

PART 3 - EXECUTION

Not applicable.

END OF SECTION - 13421

SECTION 13422 LEVEL MEASUREMENT DEVICES

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The CONTRACTOR shall furnish and install all primary devices, transmitters, primary and secondary receivers, analyzers and accessory items as shown on the Contract Drawings and as specified herein.

1.02 RELATED WORK

- A. Additional Division 13 Sections of this Specification contain requirements on instrumentation and control equipment and software which are considered to be covered by applicable requirements of this section (and shall be included in the bid by a single Instrumentation Supplier for this Project).
- B. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

DIVISION 1 - GENERAL REQUIREMENTS
DIVISION 11 - EQUIPMENT
DIVISION 16 - ELECTRICAL

PART 2 - PRODUCTS

2.01 INSTRUMENTS AND ACCESSORY EQUIPMENT

- A. Non-Contact Radar Level Measurement
 - a. Where non-contact radar measurement is indicated, the system shall consist of a sensor and transmitter assembly complete with housing, transmitter, microwave module and wave-guide (antenna). The radar assembly shall transmit energy in the form of microwave pulses, target the microwave pulses returning to the antenna, measure the transit time of the microwave pulses and calculate the distance to the target.
 - b. The unit shall include remote level indicator available for field calibration and display of process variable. The display shall include a liquid crystal display for measured and totalized flow. The enclosure shall be NEMA 4X. The remote indicator shall include required power supply for the sensor. Cabling between the transmitter and the sensor shall be provided with the unit.
 - c. The device shall include a 3-10" ANSI 150# 316SS process connection with 316SS cone antenna. Horn size shall be as indicated, or as required for the application.
 - d. Voltage as indicated, either 2-wire loop-powered (HART) 24VDC or 4-Wire universal power supply (24VDC or 120VAC) with 4-20mA HART output.

- e. Programmable electronics shall provide up to three linear 4-20mA output signals proportional to level, as well as three configurable SPDT relay contact outputs, 20-250 VAC or VDC.
- f. Radar assemblies shall be Ohmart Vega Vegapuls 66 series, or equal.

PART 3 - EXECUTION

Not applicable.

END OF SECTION - 13422

SECTION 13429 MISCELLANEOUS INSTRUMENTS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The CONTRACTOR shall furnish and install all devices, accessory items as shown on the Contract Drawings, as specified herein, and as required for proper system operation.

1.02 RELATED WORK

- A. Additional Division 13 Sections of this Specification contain requirements on instrumentation and control equipment and software which are considered to be covered by applicable requirements of this section (and shall be included in the bid by a single Instrumentation Supplier for this Project).
- B. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

DIVISION 1 - GENERAL REQUIREMENTS
DIVISION 11 - EQUIPMENT
DIVISION 16 - ELECTRICAL

PART 2 - PRODUCTS

2.01 INSTRUMENTS AND ACCESSORY EQUIPMENT

- A. Transient/Lightning Suppressors
 - a. Lightning protectors shall be of 2 types - those for protection d-c wires (current protectors) and those for protecting a-c wires.
 - b. The d-c protectors shall be of the fast-acting metal oxide varistor type (MOV) designed to fit and protect all typical 4-20 mA, field mounted transmitters from damaging transients induced by lightning or heavy electrical equipment, and shall provide protection each line to ground, and line-to-line.
 - c. The a-c protectors shall be the fast-acting MOV type in combination with a gas tube type secondary protector designed to provide protection against lightning and other high voltage surges for any a-c line-to-ground system.
 - d. The lightning protectors shall be installed at each end of each metering loop, and on all power supplies, as shown on the Drawings.
 - e. See control panel specifications for additional requirements for panel mounted surge protection devices.
- B. Solenoid Valves

- a. Solenoid valves shall be packless piston type direct acting, 2-way or 3-way valves as indicated on the Drawings and shall be ASCO Valve Red Hat as manufactured by Automatic Switch Co., MAC, or equal.
- b. Valves on water seal lines and for flushing water shall be of the normally closed type.
- c. Valves on the plant water seal lines shall have forged brass bodies, NPT end connections of the size shown on the Drawings, 300 or 400 series stainless steel internal parts, and Burna-N or Ethylene Propylene valve seats. Valves shall have a 150 psig (minimum) safe working pressure and zero minimum operating pressure differential. Valves for the polymer feed system shall be similar except for having stainless steel bodies. Pipe connections shall be threaded with nipples for the plant water lines and flanged with threaded stainless steel adapters for the PVC lines.
- d. Except as otherwise specified herein, valves shall have NEMA 4 solenoid enclosures, shall be suitable for operation on a 120V, 60 Hz, single phase power supply, and shall be provided with a continuous duty Class F coil and a manual operator.

PART 3 - EXECUTION

Not applicable.

END OF SECTION - 13429

SECTION 13430
BOXES, PANELS AND CONTROL CENTERS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The CONTRACTOR shall furnish and install all boxes, panels and control centers and accessory items as specified herein.

1.02 RELATED WORK

- B. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

DIVISION 1 - GENERAL REQUIREMENTS
DIVISION 11 - EQUIPMENT
DIVISION 16 - ELECTRICAL

PART 2 - PRODUCTS

2.01 FABRICATION

A. Instrument Panels

- a. The project includes modifications to two existing PLC based SCADA panels to be performed under this Division. An additional PLC based control panel shall be furnished with the MIOX equipment package and networked over Ethernet I/P. The master PLC panel will also be networked with the existing cellular based distribution system telemetry over Ethernet I/P. Each of the PLC panels shall include programmable logic controller as specified herein, expansion I/O, network switch as specified herein, and all required appurtenances.
- b. A new rack mounted server shall be furnished and installed in the existing network equipment rack. Two new client workstations shall be furnished and installed.
- c. Panels shall be of construction as specified in 16900.
- d. All conductors running from the field to the panels shall be a single, continuous length, without splices, except at accepted junction boxes. The junction boxes shall have terminal blocks with 20 percent spares in addition to terminals for all wires including spare wires. Special care shall be exercised to carry grounding lines through such junction boxes with the least possible resistance.
- e. All panel equipment shall be mounted and wired on or within the cabinet. Wiring shall comply with the latest National Electrical Code. All wiring within the panel shall be grouped together with harnesses or ducts and secured to the structure. All wiring shall be numbered in accordance with the numbering system used on the wiring/connection diagrams. Wiring and connection diagrams shall conform to ISA S5.4 Instrument Loop Diagrams and shall be

submitted by the manufacturer as part of the shop drawings for review by the ENGINEER. Power and low voltage d-c signal wiring shall be routed in separate wire ways. Crossing of the 2 system wires shall be at right angles. Parallel troughs of different systems shall be separated by a minimum of 12 inches. Power wire shall be 16 AWG type THWN stranded, insulated for not less than 600 volts, unless specified otherwise. Wire color shall be Line Power - Black; Neutral or common - White; AC Control - Red; DC Control - Blue; Equipment or Chassis Ground - Green; specified externally powered circuits - Yellow.

- f. All wiring shall terminate in a master terminal board, rigid type and numbered. All field wiring to and from the panel shall be fused. The master terminal board shall have a minimum of 25 percent spares. Terminal blocks shall be arranged in vertical rows and separated into groups (Power, AC control, DC signal, alarm). Terminal blocks shall be barrier type with the appropriate voltage rating (600 volts minimum). They shall be the raised channel mounted type. Wiring trough for supporting internal wiring shall be plastic type with snap-on covers. The side walls shall be open top type to permit wire changing without disconnecting. Wire connectors shall be the hook fork type with non-insulated barrel for crimp type compression connection to the wire. Wire and tube markers shall be the sleeve type with heat impressed letters and numbers. Terminal strips shall be provided for the purpose of connecting all control and signal wiring. Direct interlock wiring between equipment will not be allowed. Only one side of a terminal block row shall be used for internal wiring. The field wiring side of the terminal shall not be within 6 inches of the side panel or adjacent terminal. Wiring troughs shall not be filled to more than 60 percent visible fill. Wiring trough covers shall be match marked to identify placement. If component identification is shown on covers for visibility, the ID shall also appear on the mounting sub-panel.
- g. All wiring to hand switches and the like which are live circuits independent of the panel's normal circuit breaker protection shall be clearly identified as such.
- h. PLC outputs shall be wired through control relays as specified herein. Where required, Increase contact ratings to accommodate the load switched, with appropriate horsepower rating if applicable.
- i. Nameplates shall be provided for all panels. The nameplates shall be approximately 1 inch by 3 inch constructed of black and white laminated, phenolic material having engraved letters approximately 1/4 inch high, extending through the white face into the black layer. Nameplates may be omitted if a nameplate of approximately the same dimension is more conveniently and suitably located on the instrument door or face. Nameplates shall be attached to panels by self tapping screws.
- j. Print storage pockets shall be provided on the inside of each panel. Its size shall be sufficient to hold all of the prints required to service the equipment.
- k. The instrument panel shall be factory-tested prior to shipment. Field installation by the Owner shall consist only of setting the panel in place and making necessary electrical connections.
- l. All components shall be mounted in a manner that shall permit servicing. Adjustment, testing and removal without disconnecting, moving or removing any other component. All gages, meters, receivers, switches, pushbuttons and accessories shall be flush mounted.
- m. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable

unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Component mounting shall be oriented in accordance with the component manufacturer's and industries' standard practices. All internal components shall be identified with suitable plastic or metal engraved tags attached with drive pins adjacent to (not on) each component identifying the component in accordance with Drawings, Specifications, and Supplier's data.

- n. Relays shall be three pole, octal plug-in type with a transparent dust cover. The relay shall be equipped with an indicating light to indicate when its coil is energized. The relays shall have 5 amperes, 120 volt a-c contacts. The mechanical life of the relay shall be 10,000,000 operations minimum (ampere rating shall be increased as necessary for load handling capacity where needed.)
- o. The instrument panels shall be furnished by the instrumentation and control system supplier. Complete shop drawings, including wiring diagrams and panel structural drawings, shall be required for review prior to shipment.
- p. Furnish Cutler-Hammer Oxidation Inhibitors and install one in each panel at time of start-up.
- q. Instrument panel power supply shall wire to a cord end inside the panel. A properly sized UPS system as specified herein shall be rack mounted inside the enclosure and be plugged into the receptacle. UPS output shall power all equipment within the instrument panel for up to 30 minutes.
- r. Loop isolators called out or intrinsic safety barriers shall mount inside the instrument panels.
- s. PLC panels shall be designed to include rack space for 20% future expansion.
- t. Uninterruptable power systems as specified herein shall be furnished in all panels specified, sized to serve the connected load of the panel for a minimum of three minutes.

2.02 PROGRAMMABLE LOGIC CONTROLLERS - COMPACTLOGIX L330ER SERIES

A. Construction

- a. The programmable automation controller (PAC) shall be a modular design with expansion capability. The available expansion shall be local I/O modules or distributed (remote) I/O connected through a network.
 - i. A single local chassis shall house CPU, memory and communications interface options. A separate power supply shall supply necessary power to the local bank that houses the chassis.
 - ii. The PAC shall be DIN rail or panel mounted.
 - iii. All system modules, and local and remote chassis shall be designed to operate in:
 - 1. An industrial environment with an ambient temperature of 0° to 60°C (32° to 140°F), and with a relative humidity range of 5% to 95%, non-condensing.
 - 2. A free airflow environment (convection cooling only, no fans or other air moving devices shall be required).
 - 3. Conformal coating of the PAC shall be offered as an option for use in corrosive/hazardous applications.
 - iv. All system modules, and local and remote chassis shall be designed and tested to operate in high electrical noise environments.

- b. The system shall support up to 30 local expansion modules in up to 3 banks, along with remote I/O expansion via network.
 - i. Local expansion modules shall be installed in the local bank or in bank(s) vertically or horizontally adjacent to the local bank.
 - ii. The local expansion modules shall mechanically lock together by means of a tongue and groove design and have an integrated communication bus that is connected from module to module by a movable bus connector.
 - iii. Each module shall have a built-in removable terminal block behind a door at the front of the module with a finger-safe cover. I/O wiring shall be routed from beneath the module to I/O sensors and actuators.
 - iv. The manufacturer shall have available a variety of I/O modules, including AC digital, DC digital, contact output, analog, RTD, thermocouple and high-speed counter.
 - v. Each bank in the system shall have its own power supply.
 - vi. Expansion cables shall connect the banks (in multiple-bank installations).

B. CPU

- a. The CPU shall be a self-contained unit, and will be capable of providing control program execution, supporting remote and local programming, controlling all I/O scanning and inter-controller and peripheral communication and diagnostic functions.
 - i. 32 tasks (100 programs per task):
 - ii. Continuous - 1 allowed.
 - iii. Periodic - Run via an interrupt at a user-defined interval in 1 μ s increments from 1 ms to 2000 s.
 - iv. Event - Triggered by consumed tag or EVENT instruction.
 - v. 256 controller connections
 - vi. Network connections:
 - vii. 256 EtherNet/IP
 - viii. 120 TCP
- b. The PAC shall organize user applications as tasks, which can be specified as continuous, periodic or event based. Tasks can be triggered by input point or instruction.
- c. Programming instructions shall include the following:
 - i. Relay-Type (bit)
 - ii. High-Speed Counter
 - iii. Counter and Timer
 - iv. Data Comparison (for example: Equal, Greater than or Equal, Less than or Equal)
 - v. Data Manipulation (for example: Copy, Move)
 - vi. Logical (for example: And, Not, Or)
 - vii. Integer and Floating Point Math (for example: Add, Subtract, Multiply, Log 10)
 - viii. Advanced Math and Trigonometric Functions (for example Sine, Cosine, Tangent)
 - ix. Statistical
 - x. Matrix and Array (for example: COP, CSP, FIFO)
 - xi. BCD Conversion

- xii. Program Flow Control (for example: Jump, Subroutine)
- xiii. Application Specific (for example: Sequencer)
- xiv. Diagnostic
- xv. Communication
- xvi. Recipe
- xvii. Proportional Integral and Derivative (PID)
- xviii. Block Read and Write
- xix. Immediate I/O and Communication Update
- d. The system must be capable of storing the following data:
 - i. External Output Status
 - ii. External Input Status
 - iii. Timer Values
 - iv. Counter Values
 - v. Boolean Values (0 or 1)
 - vi. Short Integer Numbers (-128 to 127)
 - vii. Integer Numbers (-32,768 to 32,767)
 - viii. Double Integer Numbers (-2,147,483,648 to 2,147,483,647)
 - ix. Floating Point Numbers to 8 significant digits (for 8+ digits, conversion to exponential form from $\pm 1.1754944 \text{ E } -38$ to $\pm 3.402823 \text{ E } +38$)
 - x. Long Integer Numbers (-9,223,372,036,854,775,808 to 9,223,372,036,854,775,807)
 - xi. Internal Processor Status Information
- e. Data shall be distinguishable to the CPU by address and sub-element mnemonic.
 - i. Management of the data into memory subsections shall be an automatic function of the CPU operating system.
 - ii. Data can be displayed in ASCII, Binary, Octal, Hexadecimal or Decimal.
 - iii. Function-specific data such as PID, Axis, Axis Group or Message shall have dedicated displays available that annotate the meaning of specific control bits and words within them and allow for selective control where appropriate.
- f. When the main power supply is removed, the CPU shall have the ability to back up user program and all data.
- g. The front of the CPU shall have a USB port.
- h. The front of the CPU shall have an integrated latching mechanism for securing the Secure Digital (SD) memory card. The PAC shall operate with the memory card removed.
- i. The CPU shall have a Real Time Clock.
- j. the processor module shall have green, red and yellow LED indicators with sequences for OK (module status), Force, Run, SD, I/O (I/O status), NS (network status), Link 1 and Link 2 (EtherNet/IP port status).
- k. The processor module shall have mode switch positions for Remote, Program and Run.

C. Memory

- a. The PAC shall have 2 MB of user memory.
- b. The program storage medium shall be a solid-state, non-volatile type.
- c. The PAC shall include a 1GB SD memory card to store the user program and the firmware of all other modules residing in the same chassis to protect against memory loss. The card shall be rated for use in SIL 2 applications.

- i. When memory is restored, a user-selectable option to restore in Run mode or Program mode shall be provided.
- ii. The PAC shall be able to be configured for automatic download from the card on power-up.
- iii. The PAC shall be able to be manually triggered to save to or load from the card.

D. I/O Circuitry

- a. The system shall support 3 banks of up to 30 local expansion modules.
- b. The supplier shall configure each expansion module to the optimum requested packet interval (RPI) for the application.

E. Programming Environment

- a. Programming shall be through the USB 2.0 port or through the EtherNet/IP network.
- b. The programming software shall run on. Available programming languages shall be:
 - i. IEC 61131-3 compliant ladder diagram (LD)
 - ii. Structured text (ST)
 - iii. Function block diagram (FBD)
 - iv. Sequential function chart (SFC)

F. Communication

- a. The PAC shall have at a minimum:
 - i. USB 2.0 port to support upload and download, online edits, firmware updates and bridging to other modules at full speed (12 Mbps).
 - ii. EtherNet/IP switch and dual 10/100 Mbps EtherNet/IP ports with 1 IP address. The interface shall support:
 - 1. IEEE 802.3 Physical and Data Link Standard
 - 2. Common Industrial Protocol (CIP), the protocol that provides real-time I/O messaging and information/peer-to-peer messaging
 - 3. Standard TCP/IP and UDP/IP communication
 - 4. 10/100 Mbps auto sensing and auto switching
 - 5. Standard Ethernet media
 - 6. Subnet masking
 - 7. BOOTP and DHCP support
 - 8. Manual configuration using specified software
 - 9. Programmable Automation Controller messaging to peer controllers and workstations
 - 10. I/O data, real-time interlocking and information
 - 11. Full or half-duplex communication
 - 12. Built-in Web access to diagnostics
 - 13. I/O control
 - 14. Device level ring (DLR)
 - 15. Precision Time Protocol (CIP Sync, IEEE 1588)

G. Power Supply

- a. The PAC shall operate in compliance with electrical service of 85 to 265 VAC (120 to 220 VAC nominal), single phase, in the frequency range from 47 to 63 Hz, or 19.2 to 31.2 VDC (24 VDC nominal).
- b. A single, main power supply shall be capable of supplying all necessary power to the local bank housing the CPU and local I/O modules. Additional power supplies shall provide power to other local and remote banks.
- c. The power supply shall be capable of converting AC standard low voltage line power to the DC power required to operate the PAC system.
- d. The power supply shall include an easily viewed indicator to show status of the DC power applied to the backplane.
- e. The power supply shall provide electronic protection:
 - i. At the time of power-up, the power supply shall inhibit operation of the controller and I/O modules until the DC voltages are within specifications.
 - ii. The power supply shall automatically shut down the PAC when its output power exceeds 125% of its rated power.
 - iii. The power supply shall provide surge protection, isolation and outage carry-over of up to 6 cycles of the AC line (120-240 VAC, 50/60 Hz) or 40 ms at 24 VDC.
 - iv. The power supply shall be fused.
- H. The programmable logic controller shall be Allen Bradley CompactLogix 5069-L330ER.
- I. Input/output modules shall be as follows:
 - a. Discrete Input Module: 5069-IA16
 - b. Discrete Output Module: 5069-OA16
 - c. Analog Input Module: 5069-IF8
 - d. Analog Output Module: 5069-OF8

2.02 PANEL COMPONENTS

- A. Layer 2 Managed Switch
 - a. General
 - 1) Switches for fiber networking applications shall be modular, layer 2 switches for industrial Ethernet applications.
 - 2) Integrated device level ring (DLR) connectivity
 - 3) CIP interface
 - 4) Switch shall include RSLogix 5000™ add-on profile for integration into the Rockwell Automation Integrated Architecture™
 - 5) Switch shall include Predefined Logix tags for diagnostics
 - 6) Switch shall include FactoryTalk® View Faceplates for status monitoring and alarming
 - b. Software features shall include the following:
 - 1) Virtual LAN (VLAN) with trunking
 - 2) Quality of Service (QoS)
 - 3) Bandwidth threshold alarming
 - 4) STP/RSTP
 - 5) MAC ID port security
 - 6) SNMP support

- 7) DHCP per port
- 8) Internet Group Management Protocol (IGMP) snooping and querier
- c. The base switch shall be available in a 6-port, 10 port, 18 port or 20-port version. Model supplied shall be as indicated on the Drawings, or as required to accommodate the required network connections.
- d. The switch shall also be available with 100 Mbps and 1GB SFP fiber optic uplink transceivers, single mode or multimode as indicated on the Drawings.
- e. Product certifications shall include c-UL-us, CE, C-Tick, Ex, EtherNet/IP, Marine, IEC 61850, and IEEE1613.
- f. Layer 2 managed switches shall be Allen Bradley Stratix 5200.

B. Lightly Managed Switches

- a. Lightly managed switches shall be industrial Ethernet switches requiring minimal configuration.
- b. Switches shall allow for logical segmentation in a single switch.
- c. Switch shall enable network link redundant and fast link recover with STP.
- d. Switch shall support SNMP, alarm relay, and syslog.
- e. Switch shall secure network using Port Security.
- f. Switch shall provide secure connectivity with SSH and HTTPS.
- g. Switches shall operate on 20V AC or 24V DC power.
- h. Switches shall be provided with automatic cable cross-over detection.
- i. Switches shall be available with five or eight 10/100 Mbps, full or half duplex copper ports.
- j. Certifications shall include c-UL-us, CE, C-Tick, and Ex.
- k. Lightly managed switches shall be Allen Bradley Stratix 2500.

C. Loop Isolator/Signal Converter:

- a. Loop isolators or signal converters shall be furnished and installed where indicated, to isolate signals or to increase the load capacity of a system required to have many devices in the loop. The device shall also provide transmitter excitation, 24 VDC. Isolators shall provide 3-way isolation, and shall have a power supply voltage of 115 VAC unless otherwise indicated. Two wire style isolators are not acceptable. Isolators shall be Moore FCT-TX, AGM, or equal, enclosed as appropriate for the application, or as indicated.

D. Power Supplies - General

- a. Power supplies shall be provided as required for panel mounted equipment, in addition to the PLC and I/O power supplies specified elsewhere. Input voltage, output voltage, and amperage ratings shall be selected by the panel supplier to match the load and application.
- b. Power supplies shall provide the rated output voltage $\pm 1\%$. The power supplies shall be furnished with transient surge protection varistor and internal fusing. The power supplies shall be 90% efficient, and be designed for connection in parallel, and shall include power failure bypass.
- c. The unit shall include LED status display for "DC OK."
- d. Power supplies shall meet UL 508, EN 60204, IEC 61558-2-17, IEC 60950, and EN 50178.

E. Uninterruptible Power System

- a. This specification defines the electrical and mechanical characteristics and requirements for a continuous-duty single-phase, solid-state, uninterruptible power system. The uninterruptible power system, hereafter referred to as the UPS, will provide high-quality AC power for sensitive electronic equipment loads.
- b. The UPS shall be designed in accordance with the applicable sections of the current revision of the following documents. Where a conflict arises between these documents and statements made herein, the statements in this specification shall govern.
- c. UL Standard 1778 (Suitable for Computer-Room Applications)
c-UL
FCC Part 15, Subpart B, Class A
IEEE C62.41, Category A & B
ISTA Procedure 1A
- d. The UPS shall be designed to operate as a true on-line double conversion system in the following modes:
 1. Normal - In normal operation incoming AC power is fed to the input power factor corrected (PFC) rectifier that converts the AC power to DC power for the inverter. In this mode, power is also derived from utility power for the battery charger. The inverter derives DC power from either the PFC rectifier or the battery and regenerates filtered and regulated AC sinewave power for the connected load. The battery will be charged once the unit is connected to utility power, regardless of whether the UPS is ON or OFF. In the event of a utility outage or severe abnormality (sag or swell), the inverter will support the connected load from battery power, until the battery is discharged or the utility returns; whichever occurs first.
 2. Battery - Upon failure of utility / mains AC power, the critical AC load is supplied by the inverter, which obtains power from the battery. There is no interruption in power to the critical load upon failure or restoration of the utility / mains AC source.
 3. Recharge - Upon restoration of utility / mains AC power, after a utility/ mains AC power outage, the input converter automatically restarts and assumes supplying power to the inverter and the battery charger to recharge the battery.
 4. Automatic Restart - Upon restoration of utility / mains AC power, after a utility mains AC power outage and complete battery discharge, the UPS automatically restarts and assumes supplying power to the critical load and the battery charger automatically recharges the battery. This feature shall be capable of being disabled by the user.
 5. Bypass - The integral bypass performs an automatic transfer of the critical AC load from the inverter to the bypass source, in the event of an overload, PFC failure, over temperature, DC Bus over voltage, or inverter failure conditions.
- e. Input/output voltage shall be 0-140 VC, 60/50 Hz, single-phase.
- f. Internal Battery shall be valve regulated, non-spillable, flame retardant, lead acid cells.
- g. The UPS shall operate at these values without drawing power from the batteries. 120 VAC; single phase, 2 wire plus ground nominal; variable based

upon output loading:

500/700/1000 VA 120 VAC MODELS

LOAD	TRANSFER VOLTAGE	COMEBACK VOLTAGE
100 - 70%	80 VAC	87 VAC
70 - 30%	70 VAC	77 VAC
30 - 0%	60 VAC	67 VAC

1500/2000/3000 VA 120 VAC MODEL

LOAD	TRANSFER VOLTAGE	COMEBACK VOLTAGE
100 - 90%	90 VAC	97 VAC
90 - 70%	80 VAC	87 VAC
70 - 30%	70 VAC	77 VAC
30 - 0%	60 VAC	67 VAC

- h. Frequency: UPS auto senses input frequency when first powered up and shall operate within the following frequency specifications. UPS is capable of Cold Start with default frequency of 60 Hz/ 120 VAC.
- i. Input Power Factor: >0.97 lagging at rated load.
- j. Input Current reflected distortion: 25% THD maximum.
- k. Inrush Current (initial start up, no load): The UPS has a maximum inrush current of 6 times the full load peak input current.
- l. The UPS shall conform to an input line transient conforming to IEEE C62.41, Category A & B tests for 120 VAC & 208 VAC models. The 230 VAC models meet EN61000-4-5, Level 3, Criteria A.
- m. Surge Protection:
120 and 208 VAC units: MOV ratings will be 175 Volt, 90 Joules minimum connected L-N. The MOVs will be rated 300 Volt, 150 Joules minimum connected L-G and N-G. The L-G and N-G connected MOVs will have the capability of being disconnected and reconnected easily.
- n. AC Output, UPS Inverter
 1. Voltage Configuration:
120 V Units: 120 VAC, 60/50 Hz, single-phase, 2-wire-plus ground, configuration program selectable (100V, 110V, 115V, 120V, 127V).
 2. Voltage Regulation: $\pm 3\%$ steady state.
 3. Frequency Regulation: $\pm 5\%$ Synchronized to utility/ mains. ± 0.1 Hz free running or on battery operation.
 4. Frequency Slew Rate: 1.0 Hertz per second maximum
 5. Voltage Distortion: $\leq 3\%$ total harmonic distortion (THD) typical into a 100% linear load, $\leq 5\%$ THD typical into a 100% non-linear load with crest factor ratio of 3:1.
 6. Load Power Factor Range: 0.65 lagging to 1.0 (unity).
 7. Output Power Rating: 500VA/350 Watts, 700 VA/490 Watts, 1000 VA/700 Watts, 1500 VA/1050 Watts, 2000 VA/1400 Watts, 2700 VA/1890 Watts, and 3000 VA/2100 Watts at 0.7 lagging power factor.
 8. Inverter Overload Capability: 112 - 130%, $\pm 10\%$ for 10 seconds then transfer to bypass, 131 - 200%, $\pm 10\%$ for 2 seconds then transfer to bypass, > 201%, $\pm 10\%$ for 96 msec. minimum then transfer to bypass.
 9. Voltage Transient Response: $\pm 7\%$ in line mode 0-100-0 % loading of the UPS, $\pm 7\%$ in battery mode for 0-100-0 % loading of the UPS rating.

10. Transient Recovery Time: To nominal voltage within 90 milliseconds.
11. Efficiency: $\geq 88\%$ AC-AC, minimum.
- o. Environmental Conditions
 1. Ambient Temperature:

Operating: 0°C to $+40^{\circ}\text{C}$ ($+32^{\circ}\text{F}$ to $+104^{\circ}\text{F}$) for altitudes 0 to 1500 meters (0 to 5,000 ft.) above sea level.

0°C to $+30^{\circ}\text{C}$ ($+32^{\circ}\text{F}$ to $+95^{\circ}\text{F}$) for altitudes 1500 to 3000 meters (5,000 to 10,000 ft.) above sea level.

25°C ($+77^{\circ}\text{F}$) for optimum battery performance

Storage: -15°C to $+50^{\circ}\text{C}$ ($+5^{\circ}\text{F}$ to $+122^{\circ}\text{F}$) with batteries removed.

20°C ($+68^{\circ}\text{F}$) for optimum battery storage.
 2. Relative Humidity:

Operating: 0 to 95% non-condensing.

Storage: 0 to 95% non-condensing.
 3. Altitude:

3,000 m / 10,000 ft. max., without power derating when operated within the temperature specified in section 1.4.A. Ambient temperature will be derated 5°C for each additional 500 meters.
 4. Audible Noise:
 5. Noise generated by the UPS under normal operation shall not exceed 50dBA when measured at 1 meter from the surface of the UPS.
 6. Electrostatic Discharge:
 7. The UPS shall be able to withstand an electrostatic discharge compliant to EN61000-4-2, level 4, for 120 VAC, 208 VAC, and 230 VAC units (15 kV through air, 8 kV contact) without damage and will not affect the connected load.
- p. Wiring practices, materials, and coding shall be in accordance with the requirements the standards listed in section 1.2 and other applicable codes and standards. All wiring is copper.
- q. The UPS unit shall be comprised of: input converter, battery charger, inverter, and battery consisting of the appropriate number of sealed battery cells; and is housed in a rack - tower NEMA type 1 enclosure and meet the requirements of IP20.
- r. The UPS shall be forced air cooled by an internally mounted, continuous fan. Fan power is provided from the internal DC supply. Air intake is through the front of the unit and exhausted out the rear of the unit.
- s. Input Converter Components
 1. Incoming AC power shall be converted to a regulated DC output by the input converter for supplying DC power to the inverter. The input converter provides input power factor correction and input current distortion reduction.
 2. The input converter shall be provided with AC input current limiting whereby the maximum input current is limited to 125% of the full load input current rating.
 3. The UPS shall have built-in protection against undervoltage, overcurrent, and overvoltage conditions including low-energy lightning surges, introduced on the primary AC source. The 120 and 208 VAC models can sustain input surges without damage per criteria listed in IEEE 587 CAT. A & B. The 230 VAC UPS can sustain input surges without damage per criteria listed in EN61000-4-5, Level 3. The 120V model UPS have input fuses.
 4. The UPS shall contain a battery recharge rate designed to prolong battery

life. The battery is constant current charged to restore capacity, then shall be constant voltage charged to maintain the battery in a fully charged state. Recharge time for the internal UPS batteries shall be five (5) hours maximum to 95% capacity (full load discharge rate). There is DC overvoltage protection so that if the DC voltage exceeds the pre-set limit, the UPS will shutdown automatically and the critical load is transferred to bypass.

t. Inverter Components

1. The UPS inverter shall be a pulse-width-modulated (PWM) design capable of providing the specified AC output. The inverter converts DC power from the input converter output, or the battery, into precise sine wave AC power for supporting the critical AC load.
2. The inverter shall be capable of supplying current and voltage for overloads exceeding 100% and up to 200% of full load current. A visual indicator and audible alarm indicates overload operation. For greater currents or longer time duration, the inverter has electronic current-limiting protection to prevent damage to components. The inverter is self-protecting against any magnitude of connected output overload. Inverter control logic senses and disconnects the inverter from the critical AC load without the requirement to clear protective devices.
3. The inverter shall be protected by the following DC shutdown levels:
 - DC Overvoltage Shutdown
 - DC Undervoltage Shutdown (End of Discharge)
 - DC Undervoltage Warning (Low Battery Reserve); factory default set at 2 minutes (user configurable 2 to 30 minutes).
4. The inverter shall hold the output frequency to ± 0.1 Hz of nominal when not synchronized to the utility/mains source.
5. The UPS inverter employs electronic current limiting circuitry.
6. To prevent battery damage from over discharging, the UPS control logic shall automatically raise the shutdown voltage set point; dependent upon output load at the onset of battery operation.

u. Display and Controls

1. The UPS shall be provided with a microprocessor based unit status display and controls section designed for convenient and reliable user operation. The monitoring functions such as status and alarm indicators are displayed on an LED display.
2. The UPS shall contain a row of LED's to indicate UPS load and battery capacity and five single LED's to indicate UPS status as described below:
3. The "Fault" LED indicator illuminates red to indicate a UPS fault condition.
4. The "Battery" LED indicator illuminates amber to indicate the UPS is operating from battery power.
5. The "Bypass" LED indicator illuminates amber to indicate the UPS is operating on Bypass power.
6. An audible alarm is provided and activated by any of the above alarm conditions.
7. The "UPS ON" LED indicator illuminates green to indicate the UPS inverter is operating and supplying power.
8. The "AC Input" LED indicator illuminates green to indicate the UPS is operating from utility / mains power.
9. UPS start-up and shutdown operations shall be accomplished by the "ON" and "OFF" push buttons located on the front panel of the UPS. The "ON"

push button is a means to turn the UPS on and also serve as a means to manually test the battery and to reset active visual and audible alarms. The "OFF" push button allows manual transfers of the load from the inverter to bypass power. Pressing the "OFF" push button twice within a four second time period will completely shutdown the UPS and its connected load in normal and battery mode.

v. On-Line Battery Test

1. The UPS shall be provided with an automatic biweekly battery test feature (factory default). Via the set-up configuration program on a Windows based PC the automatic battery test can be disabled or configured to operate every 7, 14, 21, or 28 days.
2. The battery test will ensure the capability of the battery to supply power to the inverter while loaded. If the battery fails the test, the UPS will display a warning message to indicate the internal batteries need replaced. The battery test feature is user accessible by the push button located on the front of the unit and with Communications Software. The Automatic Battery test feature is capable of being disabled through the GXT2 User Configuration Program.

w. Bypass

1. A bypass circuit shall be provided as an integral part of the UPS. The bypass control logic shall contain an automatic transfer control circuit that senses the status of the inverter logic signals, and operating and alarms conditions. This control circuit provides a transfer of the load to the bypass source if available, and if the inverter is capable of powering the load (i.e. overload condition, if your unit is in Manual Bypass Mode, or if the voltage and or frequency is out of tolerance).
2. The transfer control logic shall automatically activate the bypass, transferring the critical AC load to the bypass source, after the transfer logic senses one of the following conditions:
 - UPS overload
 - UPS over temperature
 - PFC failure
 - Inverter failure
 - DC Bus Overvoltage
3. Once overload condition is reduced, the load shall be automatically transferred back to inverter power.

- x. Valve regulated, non-spillable, flame-retardant lead acid cells shall be used as a stored-energy source for the specified UPS system. The battery shall be housed internal to the UPS cabinet, and sized to support the inverter at rated load and power factor, with ambient temperature of 25° C (77° F) for a minimum of 7 minutes reserve time. The expected life of the battery shall be 3 - 5 years or a minimum 250 complete discharge cycles. The UPS units have the capability to allow the operator to replace the internal battery.
- y. The UPS shall have a minimum of four (4) NEMA 5-15R receptacles on the back of the unit.
- z. The UPS shall contain a DB9F (9 pin female) connector on the rear panel to allow UPS status communications to a computer system. The DB9F contains photo couplers to signal on battery and low battery operational status. The UPS shall also be capable of receiving a signal from the connected host system to initiate a UPS shutdown. This signal shall be a + 5 VDC to +12 VDC (RS232 level) that must remain for > 1.6 second duration. Additionally, it shall also

communicate via serial communications using Liebert ESP II protocol. Communications protocol shall be Liebert ESP II, level 1 compliant, version 7.0 or later. The pin out configuration of the DB9F connector shall be:

1	Low Battery (Open Collector: +V)
2	UPS TxD
3	UPS RxD
4	Remote Shutdown (5-12V DC,10.0-24.0 mA max.); on battery operation
5	Common
6	Remote shutdown (Short to Pin 5); any mode operation
7	Low Battery (Open Emitter: -V)
8	Utility /Mains Fail (Open Emitter: -V)
9	Utility/Mains Fail (Open Collector: +V)

NOTE: Maximum voltage and current on pins 1, 7, 8, 9 shall be 80 VDC, 10.0 mA maximum.

F. AC Surge Protection

- a. All AC power circuits within the panel shall be provided with surge protection. Surge protective devices shall be DIN rail mounted, designed for protection of the AC voltage of the system.
- b. For 120V AC protection, the surge protection shall be designed with three arrestors for line, neutral, and ground protection, with a surge voltage III category.
- c. Protection level shall be as follows: L-N 620V; L-G 850V; N-G 850V.
- d. Nominal discharge current shall be 2.5 kA.
- e. Response time shall be less than 25 nanoseconds for L-N and less than 100 nanoseconds for L-G.
- f. Surge protective devices shall meet UL 1449, and IEC 61643-1.

G. Surge Protection Devices for Communications and Data Wiring

- a. Warranty
 1. Surge protection devices shall be warranted against failure due to results of lightning or switching transients for a period of 5 years.
 2. General
 3. I/O protection shall be accomplished by either a two or three stage protection circuit, depending upon the application.
 4. All wiring, grounding, hardware, and connection means shall be in compliance with the National Electrical Code and/or applicable local codes.
 5. Transient Voltage Suppression (Surge Protection Device) equipment shall be supplied by Phoenix Contact Inc., or equal.
- b. Mounting
 1. All surge protection devices shall have integral mounting brackets to attach to 35mm DIN rail conforming to DIN EN50022, with the exception of conduit mounted devices.
 2. The surge protection device shall be mounted as close as possible to the

- equipment it is protecting.
- 3. Mounting guidelines will be followed as indicated in installation instruction provided by manufacturer.
- 4. The surge protection device mounting foot shall also function as the surge protection device grounding foot (thereby minimizing impedance and increasing performance).
- 5. Pluggable surge protection devices shall use a DIN rail mounted base with one of the following options:
 - i. For shield and / or return termination at the surge protection device, a base with a direct electrical connection between the ground terminal and the DIN rail.
 - ii. For shield and / or return termination elsewhere, a base with a gas tube between ground terminal and DIN rail.
- c. Wire Connections
 - 1. Wires shall be attached to the surge protection device by means of a cable-clamping terminal block activated by a screw. Connections shall be gas-tight, and the terminal block shall be fabricated of non-ferrous, non-corrosive materials.
 - 2. All wiring points and plug connections shall be "touch safe" with no live voltages that can make contact with a misplaced finger in accordance with IEC 529.
- d. Equipment - Communication And Data Surge Protection Devices - Non-Pluggable / High Density
 - 1. Protection For Analog And Digital I/O And Industrial Data / Bus Signals
 - i. Surge protection shall consist of a multistage hybrid circuit with staging inductors or resistors to properly coordinate the components. Series resistance shall not exceed 4.7 ohms (+/- 10%).
 - ii. DIN rail mounted surge protection housing width shall not exceed 6.2mm.
 - iii. Surge protection for analog and digital I/O shall be designed to withstand a 5 kA test current of an 8/20 μ s waveform according to IEC 1024 Application Guide A and IEEE C62.41.1-2002 (Line to Ground). Surge handling capability of Line 1 + Line 2 shall be 10 kA of 8/20 μ s waveform.
 - iv. Operating temperature range shall be at least -40°C to +85°C.
 - v. Maximum load current through the surge protection module shall not exceed 250 milliamps for analog and digital signal protection.
 - vi. Cutoff frequency for analog modules shall be 3 MHz for a 50 ohm system and 1 MHz for a 150 ohm system. Cutoff frequency for digital modules shall be 2 MHz for a 50 ohm system and 600 KHz for a 150 ohm system.
 - vii. Wire size range shall between 24 and 14 AWG.
 - viii. Ex-I modules shall contain only diode and gas tube (no MOV) and shall be isolated from ground by 500VDC as required by EN 50 020.
 - 2. Protection for Ethernet, Token Ring, CDDI (FDDI) Data Interfaces
 - i. The surge protection device shall have RJ45 sockets for both input and output connections.
 - ii. For installation on a DIN rail, the surge protection device shall have a snap-on foot.
 - iii. For non-DIN rail mounted "inline" installations, the surge protection device shall have a short connection line (approximately 10 cm) with RJ45 plug for the data line connection to the terminal.

- iv. A separate connection line marked with “ground” shall be provided as part of the surge protection device housing.
- v. The protection circuit shall have fine protection diodes between all the signal wires, as well as coarse protection between shield and ground.
- vi. Surge protection device shall have an operating temperature range of at least -40°C to +80°C.
- vii. The maximum continuous operating voltage from signal to ground shall be ± 7 V DC.
- viii. The nominal discharge surge current I_N (8/20) μ s shall be at least 350 A signal to signal and 2.5 kA signal to ground.
- ix. The input attenuation a_E (symmetrical) in a 100 ohm system shall be not higher than 1dB up to 100 MHz.
- x. The cut-off frequency f_g (3 dB) (symmetrical) in a 100 ohm system shall be ≥ 100 MHz.

PART 3 - EXECUTION

(Not Applicable)

END OF SECTION 13430

**SECTION 13440
INDICATORS, RECORDERS, AND CONTROLLERS**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The CONTRACTOR shall furnish and install all primary devices, transmitters, primary and secondary receivers, analyzers and accessory items as shown on the Contract Drawings and as specified herein.

1.02 RELATED WORK

- A. Additional Division 13 Sections of this Specification contain requirements on instrumentation and control equipment and software which are considered to be covered by applicable requirements of this section (and shall be included in the bid by a single Instrumentation Supplier for this Project).
- B. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

DIVISION 1 - GENERAL REQUIREMENTS
DIVISION 11 - EQUIPMENT
DIVISION 16 - ELECTRICAL

PART 2 - PRODUCTS

2.01 MICROPROCESSOR BASED ELECTRONIC CONTROLLER/INDICATOR/MANUAL LOADING STATION

- A. The universal control station shall be configurable as a dual PID controller, bar graph indicator or as a dual manual loading station. The electronic controller, indicator or manual loading station shall be for flush mounting and shall be equipped with a 21 segment deviation bar graph indicator for process variable, set point and output. In addition, the unit shall have a display with two lines of 4-digit and one line of 3-digit alpha numeric text providing for tag and the values of process variable, set point and output in direct engineering units. In addition, calculated and characterized values and auxiliary inputs can be displayed.
- B. All interaction with the controller is via 8 keys located on the front panel. Complete configuration and custom programming shall be done via the front mounted keypad. All programming/configuration shall be done via menu driven configuration.
- C. Indicators are provided for alarms, controller status, set point status and the selected variable for digital display.

Inputs:

- (2) Universal Process Inputs - Thermocouple, RTD, mA, volts/mV
 - (1) Fixed Process Input - mA, mV, THC
 - (1) Discrete inputs (dry contacts)
- Outputs:
 - (2) 4-20mA, 500 Ω
 - (2) contact outputs (pilot duty) Outputs shall be configurable for control, display, retransmission or alarm
- D. Digital Display: Two lines of configurable alphanumeric text, 4 characters per line and one line with 3 characters per line. Display includes PV, Setpoint, % Output, Alarms, Totalizer, Loop Tag, Configuration, etc.
- E. Serial Communications: RS 485 MODBUS RTU
- F. Bar graph Indicators: 21 Segment bargraphs with individual display for PV, Setpoint and % Output.
- G. Alarms: (8) Process alarms. Alarms can be configured for high/low process, high/low output, and high/low deviation. Hysterisis and two real time alarms shall be accessible via PC.
- H. Control Modes: The PID controller shall have the following pre-configured templates:
 - a. Single loop controller with local setpoint.
 - b. Single loop controller with remote setpoint.
 - c. Auto manual station (low signal detection).
 - d. Auto manual station (digital signal selection).
 - e. Analog backup station (low signal detection).
 - f. Analog backup station (digital signal selection).
 - g. Signal indicator/manual loader station.
 - h. Dual indicator/manual loader station.
- I. Setpoint Modes: Local, remote, and four fixed setpoints, selectable via digital signals.
- J. Power Supply: 115 VAC, 60 Hz (nominal) or 24Vdc.
- K. Power Supply: 24 VDC, 60mA (loop power for two (2), two-wire transmitters).
- L. Mounting: Panel mount in standard DIN (3.78" x 3.78"). The controller electronics shall be able to be removed from housing without the need to disconnect any wiring or removal of housing.
- M. Enclosure: NEMA 4X (front face).
- N. Two forms of power failure recovery shall be available, programmable between 0 and 9999s for recovery time:

'HOT' Restart - if the power is restored within the recovery time the controller defaults to Auto mode, allowing the process to be up-and-running without delay.

'COLD' Restart - if the power is not restored within the preset recovery time, the controller defaults to Manual mode, or a predetermined control output level. This ensures that after power failure the controller does not start to control the process without operator acknowledgment.

- O. Four individual math blocks, each having up to seven operators and operands, provide +, -, x, ÷, average, maximum and minimum calculations. Square root, high select, low select, median select, relative humidity and arithmetic functions are also included as standard. Inputs can be selected or switched in and out of calculations by digital signals. This allows both simple and advanced calculations to be processed and these can be soft-wired to control functions.
- P. There shall be two delay timers, programmable in seconds, for duration and delay.
- Q. There shall be six logic equations with 15 elements per equation, with OR, AND, NOR, NAND, NOT, and EXOR operators.
- R. There shall be two custom linearizers with 15 breakpoints per linearizer.
- S. Math blocks, timers, logic equations, and customer linearizers shall be accessible and configurable via PC.
- T. The electronic controller/indicator/manual loading station shall be a Model CM50 as manufactured by ABB, or equal.

2.02 MICROPROCESSOR BASED INDICATOR/TOTALIZER

- A. The microprocessor based indicator/totalizer shall provide up to four channels of process variable indication using a 96 x 48 pixel dot matrix display. The display shall be in bar graph format, with selected inputs displayed digitally. The displays shall be sequentially organized, with the capability to scroll using pushbuttons on the face of the indicator. Each channel shall have programmable input range, engineering units, and nomenclature for each process variable displayed.
- B. Each channel shall have a totalizer with a ten digit display, also with programmable nomenclature for each value.
- C. The four inputs shall be any combination of 0-20 mA, 0-5V, 1-5V, or 4-20 mA. Each channel shall have selectable square root extraction capabilities.
- D. The unit shall be capable of retransmitting any analog input to an analog output.
- E. Alarm conditions for each channel shall be indicated by a flashing message at the top of the display. Alarm acknowledgement is by pushbutton on the face of the unit. The unit shall include an alarm summary screen which displays the status of the alarms for each channel in a summary format.
- A. The unit shall include both an RS-485, accessible from the rear of the unit, and an

RS-232 communications port, accessible from the front. All internal functions of the unit shall be accessible through either port.

- B. The unit shall include an internal power supply of 24-26 VDC, 80 mA.
- C. Power requirements shall be 21-28 VDC, 120VAC $\pm$ 10% @ 50-60 Hz, or 220/240VAC $\pm$ 10% @ 50-60 Hz.
- D. The unit shall be ABB CM15, or equal.

PART 3 - EXECUTION

Not applicable.

END OF SECTION - 13440

SECTION 13450 CENTRAL CONTROL

PART 1 - GENERAL

1.01 WORK INCLUDED

A. General

- a. The process control and instrumentation system supplier shall provide a completely installed and operational, networked system which provides human-machine interface with the PLC based process control system specified in this and other Divisions of the Specifications.
- b. Any components required for complete and functional operation of this system, as specified throughout these Documents, and as recommended by equipment manufacturers, shall be provided. This includes, but not limited to, system programming, network components, system software, hardware, etc.
- c. Any modifications required to system hardware or software, to accommodate upgrades or patches available during the course of the project shall be provided at no additional cost to the Owner.

B. Systems I/O and Special Requirements

- a. The inputs and outputs (I/O) for each PLC are defined in the Drawings and accompanied by Section 13480. The SCADA system provided shall accommodate all points and functions specified, plus capacity for future expansion as specified herein.

C. Graphics and Reports

- a. Graphic screens and reports shall be designed to logically follow the plant layout and operational sequences specified in 13480. Graphical symbols shall follow industry standard guidelines, and color representations for piping, etc, shall follow AWWA standards. Specific details of graphical representations shall be determined in the Owner review meeting specified herein.
- b. The system shall be set up by the supplier to automatically print reports for all flows, levels, outputs, inputs, and related data base points at midnight each night.

1.02 RELATED WORK

- A. Additional Division 13 Sections of this Specification contain requirements on instrumentation and control equipment and software which are considered to be covered by applicable requirements of this section (and shall be included in the bid by a single Instrumentation Supplier for this Project).
- B. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

DIVISION 1-GENERAL REQUIREMENTS
DIVISION 11-EQUIPMENT
DIVISION 16-ELECTRICAL

PART 2 - PRODUCTS

2.01 HARDWARE AND ACCESSORIES

- A. Portions of the SCADA system hardware shall be furnished under an allowance as identified in Division 1. The computer hardware allowance will provide for the following

Quantity	Description	Location
1	Server	Control Room
2	Client Workstation	Office, Lab
2	UPS	Client Workstations

2.02 SYSTEM SOFTWARE

- A. SCADA system software shall be furnished under an allowance as identified in Division 1. The computer software allowance will provide for both PLC programming software and HMI software. The PLC programming software allowance will provide for the latest version of Rockwell RS Logix 5000. HMI software shall be FactoryTalk View SE, with FactoryTalk Historian SE, XL Reporter, and Win911. Details regarding specific software requirements will be provided by the Engineer after the Contract is awarded.

PART 3 - EXECUTION

3.01 PROJECT MEETINGS

- A. The Contractor shall chair and develop an agenda for a meeting which shall address the basic criteria to be adhered to in the configuration and development of graphic displays. At this meeting, which shall be attended by plant managerial personnel, the Contractor shall distribute sample display formats for illustration purposes. As a minimum, this meeting shall address the following issues:
- All in-plant and remote site areas and conventions for identifying tag names and descriptors.
 - Designation of groups within each plant area along with tag names and descriptors.
 - The assignment of individual control loops and inputs to specific groups.
 - Organization of the systems universal display hierarchy.
 - Paging schemes to be used to enable the movement from one display to another.
 - 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.)
 - Color convention to be employed on all graphics for the annotation of various

status information, differentiation between alarms on the basis of alarm priority, background colors, static field colorization, and dynamic field colorization.

- 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. 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.). If the Contractor's library of shapes does not adequately describe plant or pipeline conditions, the Contractor shall develop additional shapes to meet the plant or pipeline requirements.
 - 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 faceplates, control stations, and custom graphic displays to implement control outputs/functions.
 - m. Definition of data input commands which enable the operator to enter numeric values into the SCADA system.
 - n. Definition of the utilization of "poke" points or fields which are dynamically sensitive to operator inputs to facilitate operator entry directly into graphic displays.
 - o. A review of graphics generation procedures:
 - 1. Subsequent to the adjournment of the graphics meeting, the Contractor shall prepare and formalize a document titled, "GRAPHICS CRITERIA", which shall contain the detailed minutes of the meeting and a definition of all graphic guidelines to be adhered to. This report shall be supplemented by graphics examples which illustrate the incorporation and application of each graphic criteria. This report shall be submitted within 30 calendar days of the meeting's adjournment.
 - p. The Contractor shall prepare a formalized submittal of the graphic layout package for review in similar fashion to a Shop Drawing, adhering to the graphics criteria.
- B. The Contractor shall chair and develop an agenda for a meeting which shall address the basic criteria to be adhered to in the configuration and development of the reports. At this meeting, which shall be attended by plant managerial personnel, the Contractor shall distribute sample report formats for illustration purposes. As a minimum, this meeting shall address the following issues:
- 1. All in-plant and remote site areas and conventions for identifying tag names and descriptors.
 - 2. Designation of groups within each plant area along with tag names and descriptors.
 - 3. The assignment of inputs to specific categories.
 - 4. Organization of the systems universal report categories.
 - 5. An itemization of the type of report available.
 - 6. Definition of terms to be used on the reports.
 - 7. Definition of all report commands that enable the operator to move within the

- report editor.
8. The utilization of cursor movement commands which enable the operator to move within a report.
 9. Definition of data input commands which enable the operator to enter numeric values into the system.
 - 10 A review of report generation procedures:
 - a. Subsequent to the adjournment of the reports meeting, the Contractor shall prepare and formalize a document titled, "REPORT CRITERIA", which shall contain the detailed minutes of the meeting and a definition of all report guidelines to be adhered to. This report shall be supplemented by report examples which illustrate the incorporation and application of each report criteria. This report shall be submitted within 30 calendar days of the meeting's adjournment.
 11. The CONTRACTOR shall prepare a formalized submittal of the report layout package for review in similar fashion to a Shop Drawing, adhering to the report criteria.
- C. The meetings specified above, and likewise the criteria, and submittal packages, may be combined. These meetings may last longer than one day. A followup meeting shall be held after submittal and review by the OWNER of the graphics and report package, to go over final corrections needed and/or changes desired.

END OF SECTION - 13450

SECTION 13480 FUNCTIONAL DESCRIPTIONS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The existing water treatment plant shall have existing human-machine interface software and existing servers and workstations in the control building replaced. The existing software shall be upgraded to Factory Talk. The existing functionality shall be maintained, with the addition of control of and monitoring of the MIOX system, and monitoring of one new filter.
- B. Programmable logic controllers shall be replaced for the Main Control Panel and the Actiflo Control Panel. Existing programming shall be migrated from the existing Allen Bradley SLC 5/05 to new Allen Bradley CompactLogix PLC's with additional programming Filter No. 5. Programming of the MIOX PLC will be performed by the equipment supplier. PLC's to be removed and new PLC's to be installed are shown on the Drawings.
- C. For the existing Main Control Panel, the PLC, power supply, I/O modules, operator interface terminal, and network switch shall be replaced in the existing enclosure and existing and new I/O connected as shown in the I/O schedule. Existing components shall be removed as detailed on the Drawings.
- D. For the Actiflo Control Panel, the PLC, power supply, I/O modules, and network switch shall be replaced in the existing enclosure and existing I/O wiring connected. The operator interface terminal shall be reconnected to the new network switch.
- E. For the existing Main Control Panel, programming for existing systems to remain, including monitoring and/or control of the following, shall be replicated in the new PLC and HMI programs:
 - Existing four filters
 - High service and backwash pumps
 - Raw water flow
 - High service flow
 - Backwash flow
 - Clearwell level
 - Raw water turbidity
 - Fluoride pumps
 - Carbon feed system
 - Raw water pumps (via telemetry)
 - Lake pumps (via telemetry)
 - Tank levels (via telemetry)
- F. Main PLC and HMI programming shall be added for Filter No. 5, with points as shown on the P&ID.

- G. Main PLC and HMI programming shall be added for points hardwired from the Miox system, included in I/O list.
- H. HMI programming shall include additional information monitored by the MIOX system.
- I. For the Actiflo Control panel, existing programming be replicated in the new PLC and HMI programs.
- J. Tank levels, raw water pump controls and monitoring, and lake pump controls and monitoring are transmitted to the plant SCADA system via cellular modem, which shall be networked with the new water treatment plant master panel. Monitoring of the remote sites shall be included in the HMI software at the water treatment plant.
- K. In addition to the functionality specified, the Contractor shall provide an additional 40 hours of programming time for any unforeseen or additional functionality not specified herein.

1.02 GENERAL

- A. The system shall provide monitoring and control of new and existing equipment as indicated on the P&ID's and as described herein. P&ID's are included only for those systems which are being modified or added. Systems which are not being modified are documented in the input/output list included in the Drawings.
- B. The input/output list includes existing I/O to be incorporated into the new plant SCADA system. I/O which is in addition to the existing system is shown in bold print. New PLC's at the water treatment plant shall include the I/O shown.
- C. If communication is lost with any PLC, the system shall continue to operate locally, using the last settings provided through the network.
- D. In the HMI software, provide monitoring and alarms for all digital inputs shown in the I/O lists and P&ID's. Provide alarms for those generated within the PLC's for call to run fail and similar existing alarms.
- E. In the HMI software, provide trending for all continuously monitored values, with operator adjustable setpoints for low and high levels as applicable.
- F. On/off and/or speed control of equipment, where applicable shall be provided via HMI software.
- G. Total and daily run time shall be recorded for all equipment.
- H. For all equipment to be controlled via the HMI software, provide an operator control "pop-up" which includes selection of manual or automatic control. If

the equipment is in operable due to a lockout condition, the lockout condition shall be displayed.

- I. All fault or fail conditions shall be displayed and recorded, with manual reset required from HMI.
- J. All measured flows shall be totalized in HMI.
- K. All equipment run times shall have daily run times recorded as well as total run time.
- L. Communication fail shall be monitored for each remote panel.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

END OF SECTION - 13480

**SECTION 13490
MEASUREMENT AND CONTROL COMMISSIONING**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The CONTRACTOR shall furnish and install all instrumentation equipment and accessory items as shown on the Contract Drawings and as specified herein.

1.02 RELATED WORK

- B. Additional Division 13 Sections of this Specification contain requirements on instrumentation and control equipment and software which are considered to be covered by applicable requirements of this section (and shall be included in the bid by a single Instrumentation Supplier for this Project).
- C. The following Divisions of these Specifications contain requirements on equipment furnished by other suppliers that must interface with the instrument system, or on methods and materials to be performed/used in the installation and/or wiring of the instrumentation system.

DIVISION 1 - GENERAL REQUIREMENTS

DIVISION 11 - EQUIPMENT

DIVISION 16 - ELECTRICAL

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

3.01 SEQUENCE OF CONSTRUCTION

- A. The project includes modifications to two existing PLC based SCADA panels to be performed under this Division. An additional PLC based control panel shall be furnished with the MIOX equipment package and networked over Ethernet I/P. The master PLC panel will also be networked with the existing cellular based distribution system telemetry over Ethernet I/P. The instrumentation system supplier shall coordinate with the MIOX system supplier to extract information to be monitored from the system.
- B. Any downtime of the plant SCADA system required for PLC replacement shall be scheduled at least 30 days in advance with the Owner.

- C. A new filter console is required for Filter No. 5, which shall be installed as required for operation of the new filter.

3.02 INSTALLATION/APPLICATION/ERECTION

- A. Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices shown on the Drawings are approximate only. Exact locations shall be as accepted by the ENGINEER during construction. Obtain in the field all information relevant to the placing of process control work, proceed as directed by the manufacturer and furnish all labor and materials necessary to complete the work in an acceptable manner.
- B. The instrumentation installation details on the Drawings indicate the designed installation for the instruments specified. Where specific installation details are not specified or shown on the Drawings, the manufacturer's recommended practice shall be followed.
- C. All work shall be executed in full accordance with codes. Should any work be performed contrary to said codes and/or regulations, the CONTRACTOR shall bear full responsibility for such violations and assume all costs arising therefrom. All equipment used in areas designated as hazardous shall be designed for the Class, Division, and Group as required on the Drawings for the locations.
- D. Unless specifically shown in the Contract Documents, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands. All instrumentation connections shall be provided with shutoff and drain valves.
- E. All piping to and from field instrumentation shall be provided with necessary unions, test tees, couplings, adaptors, and shut-off valves.
- F. Field instruments requiring power supplies shall be provided with local electrical shut-offs and fuses as required.
- G. Brackets and hangers required for mounting of equipment shall be provided. They shall be installed in a workmanlike manner and not interfere with any other equipment.
- H. The system supplier shall investigate each space in the building through which equipment must pass to reach its final location. If necessary, the system supplier shall be required to ship his material in sections sized to permit passing through restricted areas in the building. The system supplier shall also investigate, and make any field modifications to the allocated space for each cabinet, enclosure and panel to assure proper space and access (front, rear, side).
- I. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded as directed by the manufacturer of the instrumentation equipment but in no case shall more than one ground point be employed for each shield.

- J. Lifting rings shall be removed from cabinets/assemblies. Hole plugs shall be provided for the holes of the same color as the cabinet.
- K. The system supplier, acting through the CONTRACTOR, shall coordinate the installation, the placing and location of system components, their connections to the process equipment panels, cabinets and devices, subject to the ENGINEER'S acceptance. He shall be responsible to ensure that all field wiring for power and signal circuits are correctly done in accordance with best industry practice and provide for all necessary system grounding to ensure a satisfactory functioning installation. The CONTRACTOR hereunder shall schedule and coordinate his work under this Section with that of the electrical work specified under applicable Sections of Division 16.

3.03 FIELD QUALITY CONTROL

- A. After equipment and materials have been shipped to the job site, the Supplier shall furnish the services of a factory-trained service technician or engineer to assist and advise the CONTRACTOR during installation and to provide programming/calibration/ adjustment at initial startup. A minimum period of 2 calendar days on the job site is required, and expenses associated with additional days necessary shall be at no cost to the OWNER.
- B. Following installation, checkout, and final adjustment of all panels, instruments, meters, monitoring, and control devices, the CONTRACTOR shall schedule a performance test in the presence of the ENGINEER on all equipment. The CONTRACTOR shall furnish the services of the system supplier's servicemen, all special tools, calibration equipment, and labor to perform the tests.
- C. Meters shall be tested at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of scale, if possible. All status and alarm switches as well as all monitoring and control functions shall also be checked, including logging at printers and change of state on graphics. Testing shall be done from the signal source to the final element or device including all field wiring. Results of all testing shall be submitted to the ENGINEER in writing.
- D. As much as possible, points shall be checked "end-to-end". For example, valve status inputs shall be checked by stroking the valve, and a pump start output shall be checked by using it to start to start the pump. Simulated testing shall be allowed only when no practical alternative exists. Workstation displays shall be verified for correctness at the same time. An I/O checklist shall be used to record test results and a copy provided to the ENGINEER upon completion. During system testing, the CONTRACTOR shall have a representative onsite continuously who is capable of troubleshooting and modifying SCADA system configuration programming.
- E. If, during running of the tests, one or more points appear to be out by more than the system accuracy statement, or fails to perform in accordance with agreed strategies, the system supplier's servicemen shall make such adjustment or alterations as are necessary to bring equipment/programming up to specification performance. Following such adjustment, the tests shall be repeated for all specified points to ensure compliance.

3.04 FACTORY TEST

- A. Prior to the delivery and installation of the SCADA panels at the jobsite, but after the procurement, assembly, and configuration of all components, the Contractor shall conduct a factory test. This test may be witnessed by representatives of the Owner and/or Engineer. The factory test is not intended to be a complete SCADA system test, since this will be performed at the jobsite prior to Project Closeout. The factory test shall demonstrate the functionality and performance of significant specified features of the SCADA system as noted below. Input and output modules shall be installed in their assigned housings and wired to field termination points in the enclosures. The Contractor shall have a complete, up-to-date set of wiring drawings, a register list, a workstation database list, and a listing of workstation displays available for review throughout the test. The test shall include verification of a random sample of 15 to 25 percent of all I/O points, which may be randomly selected by the Owner and Engineer during the test, along with their respective workstation status and/or control displays. Some points on each display shall be checked. A complete system checklist shall be submitted which provide recorded results of the test.
- B. The Contractor shall schedule the factory test after receiving approval of the factory test procedures submittal. The Contractor shall provide the Engineer with written notice of the start and expected duration of the factory test at least 14 days prior to the start of the test.
- C. The factory test shall be conducted in accordance with the previously submitted and approved test procedures. All testing shall be completed in one continuous factory test which may extend over several continuous days if necessary. The test procedures shall include written descriptions of how individual tests shall be performed and shall incorporate testing the following features as a minimum:
 - 1. Verification that an alarm is generated upon loss of communication with any SCADA system component.
 - 2. External power to enclosures and/or workstations shall be turned off and back on in order to test the operation of the UPS units.
- D. The Contractor shall record the results of all factory testing on pre-approved test forms which the Owner's and/or Engineers' representatives shall sign. A copy of the completed test forms and a report certifying the results shall be provided to the Engineer within 10 days of completing the test.
- E. If the SCADA system does not operate as required, the Contractor shall make whatever corrections are necessary, and the failed part of the tests shall be repeated. If in the opinion of the Engineer's representative, the changes made by the Contractor to effect such a correction are sufficient in kind or scope to effect parts of system operation already tested, then the effected parts shall be retested also. If a reliable determination of the effect of changes made by the Contractor cannot be made, then the Engineer's representative may require that all operations be retested. The Contractor shall bear all of its own costs for the factory test, including any required re-testing.

3.05 TESTING

- A. Prior to placing the equipment in service, the Contractor shall conduct a field test. The field testing shall be a joint effort between the Process and Instrumentation System supplier and the Engineer. The field test shall demonstrate the functionality and performance of significant specified features of the SCADA system as noted below. The test shall include verification of all I/O points, along with their respective status and/or control displays. Points on each display shall be checked. A complete system checklist shall be available during the test for recording results of points.
- B. General: Individual instrument loop diagrams per ISA Standard S5.4 - Instrument Loop Diagrams, expanded format, shall be submitted to the Engineer for review prior to the loop tests. The Contractor shall notify the Engineer of scheduled tests a minimum of 30 days prior to the estimated completion date of installation and wiring of the system. After the Engineer's review of the submitted loop diagrams for correctness and compliance with the specifications, loop testing shall proceed. The loop check shall be witnessed by the Engineer.
- C. Interlocks: All hardware and software interlocks between the instrumentation and the motor control circuits, control circuits of variable-speed controllers and packaged equipment controls shall be checked to the maximum extent possible.
- D. Instrument and Instrument Component Validation: Each instrument shall be field tested, inspected, and adjusted to its indicated performance requirement in accordance with its Manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirement, or, in the absence of a Contract requirement, any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer.
- E. Loop and Point Validation: Controllers and electronic function modules shall be field tested and exercised to demonstrate correct operation. All control I/O points and loops shall be checked under simulated operating conditions by impressing input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements and final control elements. Actual signals shall be used wherever available. Following any necessary corrections, the points shall be retested. Accuracy tolerances for each analog network are defined as the root-mean-square (RMS) summation of individual component accuracy requirements. Individual component accuracy requirements shall be as indicated by Contract requirements or by published manufacturer accuracy specifications, whenever Contract accuracy requirements are not indicated. Each analog network shall be tested by applying simulated analog or discrete inputs to the first element of an analog network. For networks which incorporate analog elements, simulated sensor inputs corresponding to 20, 40, 60, 80 and 100% of span shall be applied, and the resulting element outputs monitored to verify compliance with the calculated RMS summation accuracy tolerance requirements. Continuously variable analog inputs shall be applied to verify the proper operation and setting of discrete devices. Provisional settings shall be made on controllers and alarms during analog loop tests. All analog loop test data shall be recorded on test forms attached at the end of this section which include

calculated RMS summation system accuracy tolerance requirements for each output.

- F. I/O and Loop Validation Sheets: The Contractor shall prepare I/O and loop confirmation sheets for each PLC point and loop. Confirmation sheets shall form the basis for operational tests and documentation. Each confirmation sheet shall cite the following information and shall provide spaces for sign-off on individual items and on the complete test by the Instrumentation Contractor:
1. Project name
 2. Point number
 3. Tag number, description, for each element
 4. Calibrated range
 5. Point description number
 6. Adjustment check
 7. Verification of proper surge arrestor installation
 8. Space for comments
 9. Space for sign-off by Instrumentation Contractor and date
 10. Space for Engineer witness signature and date
- G. Certifications: When installation tests have been successfully completed for all individual instruments and all separate analog control networks, a certified copy of all test forms signed by the Engineer or the Engineer's representative as a witness, with test data entered, shall be submitted to the Engineer together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, inspected, and tested.

3.06 PRE-COMMISSIONING

- A. General: Pre-commissioning shall commence after acceptance of all wire test, calibration tests and loop tests, and all inspections have demonstrated that the instrumentation and control system complies with all Contract requirements. Pre-commissioning shall demonstrate proper operation of all systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.
- B. Pre-commissioning Procedures and Documentation: Pre-commissioning and test activities shall follow detailed test procedures and check lists accepted by the Engineer. Test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the Engineer, which include calculated tolerance limits for each step. Completion of system pre-commissioning and test activities shall be documented by a certified report, including all test forms with test data entered, delivered to the Engineer with a clear and unequivocal statement that all system pre-commissioning and test requirements have been satisfied.
- C. Operational Validation: Where feasible, system pre-commissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and

stable control is achieved using motor control center and local field mounted control circuits. Hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady-state operation of final control elements running under the control of field mounted automatic analog controllers or software based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any) and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.

- D. Loop Tuning: Electronic control stations incorporating proportional, integral or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed setpoint settings shall be compared to measured final control element position/speed values at 20, 40, 60, 80 and 100% of span and the results checked against indicated accuracy tolerances.
- E. Pre-commissioning Validation Sheets: Pre-commissioning shall be documented on one of two types of test forms as follows:
 - 1. For functions which can be demonstrated on a loop-by-loop basis, the form shall include:
 - a. Project name
 - b. Loop number
 - c. Loop description
 - d. Tag number, description, manufacturer, and data sheet number for each component.
 - e. Space for sign-off and date by both the Instrumentation Contractor and Engineer.
 - 2. For functions that cannot be demonstrated on a loop-by-loop basis, the test form shall be a listing of the specific tests to be conducted. With each test description the following information shall be included:
 - a. Specification page and paragraph of function demonstrated
 - b. Description of function
 - c. Space for sign-off and date by both the Instrumentation Contractor and Engineer.
- F. Pre-commissioning Certification: The Contractor shall submit an instrumentation and control system pre-commissioning completion report which shall state that all Contract requirements have been met and shall include a listing of all instrumentation and control system maintenance and repair activities conducted during the pre-commissioning testing. Acceptance of the instrumentation and control system pre-commissioning testing must be provided in writing by the Engineer before the performance testing may begin. Final acceptance of the control system shall be based upon plant completion as stated in the General Conditions.

3.04 PERFORMANCE TEST

- A. Subsequent to the full system implementation, the CONTRACTOR shall conduct a successful 30 day final acceptance test for the SCADA system furnished and installed under this Contract. In this test, the entire SCADA system must operate continuously for 24 hours per day, 7 days per week during the test period, with zero downtime resulting from system failures. If a system failure occurs, the 60 day test period will be repeated, starting over at time zero, from the time that the system failure is repaired. The CONTRACTOR shall repeat the test until it is satisfactorily completed. The SCADA system will only be acceptable to the OWNER after all equipment and software has satisfied the performance test requirements.
- B. Downtime resulting from the following shall be considered system failures:
 - a. If a component failure cannot be repaired/replaced within 2 hours.
 - b. Downtime of any component (exclusive of I/O) whose failure results in the inability of the operator to monitor and manipulate control loops from the associated workstations, using standard workstation interface procedures.
 - c. Downtime in excess of 2 hours resulting from any I/O component failure.
 - d. Downtime resulting from concurrent failure of 2 or more I/O components in a single PLC/RTU.
- C. The CONTRACTOR shall submit a final acceptance test completion report which shall state that all Contract requirements have been met and which shall include a summary of maintenance/repair efforts that were required during the test period. Final acceptance of the system by the OWNER until this has occurred.

3.05 SCADA SYSTEM DOCUMENTATION

- A. Subsequent to system configuration or configuration updates, all information which defines the hardware, control and display configuration of the SCADA system shall be stored in mass memory within the workstations. The workstations shall be provided with all the intelligence and printing/plotting capabilities to enable the automatic generation of system documentation. All documentation shall be printed/plotted in both a text and graphic format. All documentation shall be accessible in report formats. It is not acceptable to use screen prints as a documentation report method. The workstation shall provide the means to produce the following documentation:
 - a. Current control system databases (including tags, descriptors, alarm limits, engineering units, associated alarm priority, logical states, etc.), control loops and ladder logic.
 - b. Definition of the current hardware configuration, including locations and associated PLC/RTU numbers.
 - c. Definition of the current display hierarchy and all displays currently in the system.
- B. This information may be provided as a part of the Operators Reference Manual required as a part of Specification 13410, under Submittals.

3.06 ADJUSTING AND CLEANING

- A. All equipment furnished under this Section of the Specifications shall be adjusted/calibrated as defined elsewhere this Section/Division.
- B. All instruments and equipment shall be left free from shipping stickers, paint splatter, dirt, grease, etc., and shall be clean and in like new condition at final acceptance. Touch-up paint shall be furnished as needed to repair blemishes and scratches in finish paint on panels and enclosures, which shall be corrected by the CONTRACTOR.

3.07 EXTRA STOCK/SPARE PARTS

- A. The following supplies and spare parts shall be furnished:
 - a. Ten fuses for each type/size in the system.
 - b. Eight Cutler-Hammer C799L2 oxidation inhibitors; Install one in each MTU and RTU. Turn over spares to OWNER.
 - c. Spare power supply for each type furnished.
 - d. Spare UPS for each type furnished.
 - e. Spare I/O cards for each PLC type. Provide a 10% spare cards (not spare points) for each type used, or a minimum of one card per type used.
- B. Other spare parts are listed in specific instrument technical specifications in the appropriate Division 13 Specification Section herein. All spare parts shall be packaged in an acceptable manner for long term storage and adequately protected against corrosion, humidity and temperature extremes. All items shall be tagged externally with what they are; both a written description and a manufacturer brand/part number.

END OF SECTION - 13490

Division 15 – Mechanical

SECTION 15010 GENERAL MECHANICAL PROVISIONS

PART 1 - GENERAL

- A. The General Requirements of this specification and Division 1, in its entirety, shall be considered part of this section and incorporated hereby, as if fully set forth herein. Requirements of Division 1 supersede and replace any statements in Division 15 with which they are in direct conflict. Sections 15010 through 15199 (as included) contain basic mechanical materials and methods of a general nature and apply to all work specified in Division 15, except as modified in individual sections.

1.01 SYSTEM DESCRIPTION

- A. Consult Plans and Specifications
- B. Drawings:
 - 1. Drawings are schematic and show approximate locations of ducts, piping and equipment. Coordinate and field verify exact locations with other trades.
 - 2. Obtain Engineer's approval for significant deviations from drawing locations and layout.
 - 3. The Engineer reserves the right to make minor changes in the location of mechanical work or equipment prior to roughing-in without additional cost.
 - 4. Examine the Contract Documents and immediately report any error, discrepancy or omission. The Engineer will determine which interpretation shall take precedence where two or more conflicting statements occur. Otherwise, the Contractor is responsible for the more stringent (or expensive) interpretation. In general, schedules, wherever they appear, supersede specifications, and specifications supersede plans.
 - 5. Contractor shall make use of all data in all Contract Documents and shall verify this information at the building site. All Drawings of the Contract set are hereby made a part of these Specifications and shall be consulted by Contractor and his work adjusted to meet the conditions shown thereon.

1.02 QUALITY ASSURANCE

- A. Materials, equipment and installation shall meet the requirements of the following as applicable:
 - 1. American Gas Association (AGA)
 - 2. American National Standards Institute (ANSI).
 - 3. American Society for Testing and Materials (ASTM).

4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
 5. American Society of Mechanical Engineers (ASME).
 6. National Fire Protection Association (NFPA).
 7. Sheet Metal and Air-Conditioning Contractor's National Association (SMACNA).
 8. Underwriters Laboratories (UL).
- B. All equipment shall bear the label of an approved independent testing laboratory (e.g. UL), where such standards exist.
- C. All equipment shall be supplied with integral fusing as required for compliance with its listing.
- D. Performance of work shall be in strict accordance with the best common practices of the trades involved, in a thorough, substantial, neat, and workman-like manner by competent, qualified workmen. No trainees or apprentice workmen shall be allowed at the job site unless under the direct, continuous supervision of a qualified journeyman. All work on HVAC, plumbing, fire protection or electrical systems shall be supervised and performed by individuals properly licensed, where required by state law, or as otherwise indicated in these Documents.

1.03 REGULATORY REQUIREMENTS

- A. The work in this Division shall meet the requirements, as applicable, of the following Codes and regulatory bodies:
1. Kentucky Building Code.
 2. Kentucky Energy and Environment Cabinet.
 3. Kentucky Department of Housing, Building and Construction and Associated Code Officials.
 4. Life Safety Code - NFPA 101.
 5. Local Building Codes and Health Department.
 6. Local Utility Regulations.
 7. ANSI 17.1 Elevator Code as adopted by IBC and KBC.
 8. Americans with Disabilities Act (ADA) - Where referenced, product design and installation shall meet minimum requirements of the Act.
- B. Conformity with code requirements shall be maintained whether or not official inspections, fees or certificates are required due to project not falling under scope or jurisdiction of regulatory agencies.

1.04 REFERENCES

- A. With regard to this Project and these Contract Documents, the following specific definitions shall apply:
1. "Furnish": To purchase and deliver products to the project site and prepare for installation.

2. "Install": To take furnished products, assemble, erect, secure, connect and place into operation.
3. "Provide": To furnish and install.
4. "Products": Includes materials, systems, equipment and accessories, as specified.
5. "Work": The providing of products for any or all of the entire Contract.
6. "Project": The sum total of all work by all parties, to be accomplished as directed in the Contract Documents.
7. "Documents", "Contract Documents": All Plans, Specifications, addenda, bid packages and any other enclosures, agreements or instruments specifically included in the Contract.
8. "Division(s)": Means the generally accepted subdivisions of the Specifications, usually according to the CSI scheme of organizing construction documents, such as Division 15 - Mechanical, Division 16 - Electrical, etc. Also refers to all work covered within the referenced Division(s) of the Specifications.
9. "Section(s)": Means the subdivisions of the "Division" of construction specifications, such as, under Division 15, Section 15010 - General Mechanical Provisions, Section 15011 - Scope of Work, etc. Also refers to all work covered within the referenced Section(s) of the Specifications.
10. "Engineer", "Architect", "E/A", "A/E": The engineering, architectural or architectural/engineering firm with design authority for the Project.
11. "Contractor": Means the General Contractor and also the Plumbing, Fire Protection, Controls, HVAC or any other Mechanical Contractor, individually or collectively.
12. "Concealed": Embedded in or installed behind walls, within partitions, above ceilings, in trenches, in tunnels and crawl spaces. Areas above lay-in ceilings, in crawl spaces or in service tunnels and trenches, other than stand-up utility tunnels, chases or vaults, may be considered concealed with reference to appearance or finish but not concealed with respect to accessibility. Check for specific exceptions.
13. "Exposed": Not installed underground or "concealed" as defined above. Generally, systems in all mechanical spaces, including mechanical or boiler rooms, stand-up or walk-thru chases and utility tunnels or vaults shall be considered to be exposed with respect to finish or accessibility requirements.
14. "Equivalent" or "Equal": In the opinion of the Engineer, acceptably comparable in concept, form, quality, performance and compatibility with the design.
15. "Mechanical": May refer to all mechanical trades, including HVAC, plumbing, fire protection, or may refer to HVAC work as opposed to say plumbing, the difference being necessarily taken from context.
16. "Plans", "Drawings": Mean all information presented in a drawing or graphical format, which have been included in the Contract, including but not limited to plans, sections, elevations, details, diagrams, schedules, notes, legends and addenda thereto.
17. "Specifications": Means all information pertaining to performing the Work, presented in text format and in the accepted organization of Divisions and Sections and in the addenda thereto.

18. "Addendum", "Addenda": Means information published after the original distribution of Documents (but before the Bid Opening), which may contain changes to Drawings, Specifications or the bidding process. Such information carries the same weight as if originally included in the Documents.
19. "Demolish": Means to carefully and legally disconnect, separate and remove the item from the project site and dispose of it, unless specific directions are given in these Documents to move, preserve, store or transport the item to a different location, in which case, "Demolish" shall mean to disconnect and take out of service.

B. Abbreviations and Symbology:

1. Refer to the following references for any abbreviations, acronyms or symbols not defined in the Contract Documents:
 - a. ASHRAE Fundamentals Handbook, current edition, chapter on Abbreviations and Symbols.

C. Technique:

1. HVAC Metal Duct Standards - SMACNA
2. Industrial Duct Construction - SMACNA
3. Industrial Ventilation - ACGIH
4. Welding Pressure Piping - ASME

1.05 SUBMITTALS

- A. Refer to Division 1 for submittal procedures and references.
- B. Otherwise, submit 8 to 12 copies of information to the Engineer for approval. Check each Specification Section for all items to be included
- C. Submit all required items within sixty (60) days of Contract date or Notice to Proceed, whichever is later, unless otherwise specifically instructed. Approval of the Engineer must be obtained to submit later on any item.
- D. Submittals are required for all items of mechanical equipment and products provided by the Contractor which are called out in individual sections of the specifications. In general, do not submit product data on pipe, pipe fittings, sheet metal, sleeves, lubrication or packing unless specifically directed in these Contract Documents, but do submit schedules listing materials to be used.
- E. All drawings or other material submitted on sheets larger than 8 1/2" X 11" (or 11" X 17" foldout) shall be submitted as one set of paper sepia or mylar sepia reproducibles and one set of blue-line prints. Corrections and approvals will be indicated on the sepias and returned to the Contractor for copying and distribution.

- F. Submittals shall be referenced correctly to the appropriate Sections of the Specifications.
- G. Manufacturer's catalog cuts, instead of complete shop drawings, may be submitted for all standard cataloged equipment, provided that the item required to meet the project specifications is not modified in any way from the standard catalog version of said item. Cuts shall be clearly marked to indicate the version of said item, including the exact size, type, rating, capacity, accessories, etc., of the item to be furnished. Any cut sheets showing multiple items, multiple dimensions, multiple performance figures, multiple accessories and/or multiple options shall be legibly marked to indicate the exact item to be provided and its associated information. Failure to do this will result in rejection of the submittal without further review or comment. Do not use the term "furnished by others" or similar designations, as this may imply that the item is not being provided in the Contract.
- H. No faxed (Facsimile Transmitted) material will be accepted for submittals and all drawings and text shall be clear original printed material or low-generation copies with no blurred, blotched or unreadable areas. Submittals with any illegible portions or materials not suitable for permanent record will result in rejection of the submittal for cause, without further review or comment.
- I. Bind shop drawings/catalog cuts in folders with a title sheet and identification on front of the folder. Allow space for Contractor, Architect and Engineer review stamps.
- J. All submittals must bear the dated, handwritten signature of the Contractor and his stamp of approval before being considered for review.
- K. See additional requirements in individual Sections of these Specifications.

1.06 SAMPLES AND MOCK-UPS

- A. Samples of any product called for by individual sections of the specifications shall be delivered to the Engineer at the time of submittal on that item. Submittals, in those cases, will not be approved until the samples have been examined.
- B. Where called for in the specifications, the Contractor shall construct a sectional mock-up of equipment installations using actual equipment or equipment cabinets of the type to be used for purposes of checking appearance, fit of piping, ductwork, controls or structural elements. Mock-ups shall be inspected and approved by the Engineer prior to release for shipment of the material in question.

1.07 CERTIFICATES, LICENSES AND FEES

- A. The Contractor shall pay all fees, stand all required inspections, obtain all necessary licenses, and obtain all required certificates for the work at his own expense.
- B. Certificates requiring display shall be suitably framed and mounted in the mechanical room or other appropriate location. Copies of the certificate shall be included in each copy of the maintenance and operating manuals.
- C. Certificates not requiring display shall be delivered to the Engineer for transmittal to the Owner, and copies of the certificate shall be included in each copy of the maintenance and operating manuals.

1.08 PROJECT RECORD DOCUMENTS

- A. Record Drawings
 - 1. Comply with Division 1 for record document procedures and requirements.
 - 2. Maintain and protect one complete set of drawing prints on job site to record any deviations from Contract drawings.
 - 3. Neatly and correctly enter with multicolored pencils any deviations on drawings and keep drawings available for inspection.
 - a. Record locations of concealed ducts, piping and valves.
 - b. Record Addendum and Change Order items.
 - 4. Record deviations made necessary to incorporate equipment different from base equipment specified.
 - 5. Drawings shall be available at the site at all times for inspection by the Engineer during normal project working hours.
 - 6. At completion of Project and before final approval, make any final corrections to drawings, certify to the accuracy of each print by signature thereon and deliver same to Engineer for approval and drafting.
 - 7. Underground site utilities shall be located by survey. Actual inverts and elevations shall be recorded.

1.09 MAINTENANCE AND OPERATING MANUALS

- A. Submit in accordance with Division 1 specification requirements to the Engineer for review and obtain receipt for delivery.
- B. Format of the manual shall be as follows:
 - 1. First page, Each Volume: Title of Project, Owner, Address, Date of Submittal, Name and Address of Contractor, Name of Engineer.
 - 2. Second page, Each Volume: Index of manual contents.
 - 3. First section: A copy of each shop drawing and reviewed submittal with an index at the beginning of the section. Include operating and

- maintenance instructions, wiring/control diagrams, spare parts lists for each type of equipment.
4. Second section: A list of all major equipment used on the job, together with supplier's name and address and servicing agency's name and address.
 5. Third section: Copies of Contractor and manufacturer warranties.
 6. Fourth section: Test and balance reports, construction test reports, start-up reports, water treatment reports.
 7. Fifth section:
 - a. Include a list of any special keys, tools and wrenches required for operation.
 - b. Include a list of all lubrication procedures, special lubricants and equipment.
 - c. Include a list of all tagged valves with tag number, valve description, location, and function. Include a revised flow chart, obtained from the Engineer to show valve identification.
- C. No faxed (Facsimile Transmitted) material will be accepted for M & O submittals and all drawings and text shall be clear original printed material or low-generation copies with no blurred, blotched or unreadable areas.
- D. Final payments cannot be made and Project cannot be closed out until Maintenance and Operating Manuals have been approved.

1.10 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Arrange deliveries of products in accordance with construction schedules to avoid conflict with work and site conditions.
1. Deliver products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.
 2. Immediately on delivery, inspect shipments to assure compliance with the requirements of the Contract Documents and approved submittals, and that products are properly protected and undamaged.
 3. Provide equipment and personnel to handle products by methods to prevent soiling and damage to products or packaging.
- B. Store products in accordance with manufacturer's instructions with seals and labels intact and legible.
1. Store fabricated products above the ground, on blocking or skids, prevent soiling or staining. Cover products which are subject to deterioration with impervious sheet coverings. Provide adequate ventilation to avoid condensation.
 2. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specific conditions, and free from damage or deterioration.
 3. Provide substantial coverings as necessary to protect installed products from damage. Remove when no longer needed.

1.11 ENVIRONMENTAL REQUIREMENTS AND EXISTING CONDITIONS

- A. Locate existing utilities prior to beginning work. Reroute or replace existing utilities where necessary to permit installation of the work. Provide adequate means of protection during work operations. Repair existing utilities damaged during work operations to the satisfaction of the utility owner and at Contractor's expense.
- B. Should uncharted or incorrectly charted piping or other utilities be encountered during work operations, notify the Engineer immediately for procedure directions. Cooperate with utility companies in maintaining active utilities in operation.
- C. Contractor shall not remove or disturb any known or suspected existing hazardous materials in buildings, above ground or underground, except work performed in compliance with EPA requirements, as instructed in this Contract, including, but not limited to, asbestos, lead-based paints, PCB's and radioactive materials. If such materials are encountered during the course of the Work, the Engineer shall be immediately notified and the materials shall be avoided.
- D. All materials removed from the site including scraps, construction materials, excavated or demolished materials shall be disposed of in a legal manner.

1.12 WARRANTY

- A. The Contractor shall guarantee all work, both labor and products against defects and failure under normal use for the period of one year from the official date of Substantial Completion. The Contractor shall leave the entire installation in complete working order and free from any and all defects in materials, workmanship or finish. He shall repair or replace at his own expense any part that may develop defects due to faulty material or workmanship during construction and the warranty period and shall guarantee also to repair or replace with like materials any existing work of the building or equipment which is damaged during the repairing of such defective apparatus, materials or workmanship. The signing of the Contract for this Work, covered by these Documents of which they shall become a part, shall become a written guarantee on the part of the Contractor to carry out all the provisions of this Division of these Specifications.
- B. Refer to Division 1 for other specific requirements.
- C. Refer to each Section of Division 15 for additional requirements.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS, STANDARD PRODUCTS AND SUBSTITUTIONS

- A. All material and equipment shall be new and in good condition. Refer to Division 1 for additional requirements.
- B. Design is based upon a specific make and model of equipment. However, except where noted, the specifications are not intended to limit competition or the Contractor's option to use alternate products of equivalent concept, quality, and performance.
- C. Products of alternate manufacturers listed may be substituted without approval prior to the Bid, if they are regularly catalogued items and meet the criteria of equivalence in concept, quality, and performance in the opinion of the Engineer. It is recommended that the opinion of the Engineer be solicited prior to the bid if there are any questions. This opinion does not guarantee approval of the submittals at a later time. In the case where the equipment is unfamiliar to the Engineer, all vendors desiring to furnish equipment other than that specified must submit, in addition to ordinary shop drawings, a complete verification specification for the substituted equipment along with catalogs, literature, wiring diagrams, piping diagrams, and a list of similar sized installations where the proposed equipment is installed. This information may be required to be presented immediately after the Bid and lack of information or of qualifications, as judged by the Engineer, may result in a Bid not being accepted.
- D. All products which require submittals, whether design basis or otherwise accepted, must be formally approved by the Engineer before shipment to the job.
- E. The Contractor is responsible for any and all costs for changes to the mechanical work or the work of other trades necessitated by the optional substitution of approved alternate equipment. Approval of alternate equipment or modifications to the plans by the Engineer are not to be construed as relief from this responsibility. In the case of significant modification to the design, the Contractor may also be required to pay for the cost of design review and/or redesign by the Engineer.
- F. Listing: The successful bidder shall furnish to the Engineer within one hour of the Bid opening, or as indicated in bidding instructions, a list of all major items of mechanical equipment to be provided, indicating the manufacturer and the general type. List shall include all items of major equipment such as boilers, chillers, towers, pumps, tanks, air handlers, packaged equipment, controls, plumbing fixtures, or other items to which whole Sections of Specifications are devoted. Do not include piping, sheet metal, small specialty items or the like unless specifically requested. In addition, a list of all Subcontractors to be involved in the project shall be furnished to include, in addition to the prime mechanical contractor, as a minimum, the plumbing, pipe fitting, sheet metal,

controls, water treatment, thermal balancing, insulating, fire protection and asbestos removal subcontractors, as utilized in the project. Any list of required items included in the Bid Form, Instructions to Bidders or other Bid documents shall supercede these items. Changing manufacturers or subcontractors after the listing will not be acceptable, unless initiated by the Owner or the Engineer. Final acceptance of the bids is contingent upon submission and approval of these lists.

2.02 QUANTITIES AND COMPLETENESS

- A. Items may be referred to as singular or plural on drawings and specifications. Contractor is responsible for determining quantity of each item.
- B. All components required for the complete installation and legal, proper and safe operation of equipment and systems indicated in the Documents shall be provided by the Contractor. Optional accessory items shall be included only as specified.

2.03 TESTING AND CERTIFICATION

- A. Conduct tests and adjustments of equipment as specified and necessary to verify performance requirements. Submit test data to the Engineer. Pay all fees involved in required testing of equipment.
- B. Provide necessary personnel and testing instruments required to perform test(s) of installation.
- C. Refer to individual Sections for additional requirements.
- D. Submit copies of all test reports, manufacturer's certifications and inspection reports to the Engineer. Include copies of each in each copy of the Maintenance and Operating Manual (Section 15010, Paragraph 1.10).

2.04 NOISE AND VIBRATION

- A. Equipment shall be free of unusual or excessive noise and vibration in the opinion of the Engineer. No amount of rattling of loose, improperly isolated or ill-fitting parts will be acceptable. Vibration transmitted to the structure shall be reasonable and within recognized and specified limits.

2.05 HAZARDOUS MATERIALS

- A. No materials or products containing known regulated hazardous materials shall be used in the Project, including asbestos, paint containing lead or products containing PCB's in amounts greater than current standards allow.
- B. No solder containing lead shall be used on the Project.
- C. Chemical products used in the construction process or for water treatment purposes shall be used in a manner in complete compliance with all OSHA and

EPA regulations and guidelines. Formal Material Safety Data (MSD) Sheets shall be provided for each product used and shall be posted in the work area most accessible to the place of use of the product. In addition, MSD sheets shall accompany and be attached to water treatment products from the time they arrive on site through the end of Warranty.

PART 3 - EXECUTION

3.01 TEMPORARY SERVICES

- A. Refer to Division 1 for specific requirements, responsibilities and methods for temporary water service, sanitation, heat and ventilation.

3.02 COORDINATION

- A. The Contractor is responsible for sequencing of the work and coordination with all trades to prevent delays in the project. No extras will be allowed for changes made necessary by interference of work between trades.
- B. Carefully check and coordinate location and level of all pipes, ducts, etc. Run preliminary levels and check with all trades so that conflicts in all locations may be avoided. Contractor shall rough sketch sections through the corridors or other tight mechanical/electrical spaces when requested to do so, in order to show that any possible conflicts have been resolved among all the trades. Where conflicts occur, if any, the following preference schedule shall be followed:
 - 1. Recessed electrical light fixtures.
 - 2. Sanitary and storm drainage piping on critical grade.
 - 3. Ductwork.
 - 4. Large HVAC or domestic water mains.
 - 5. Sprinkler piping.
 - 6. Communications wireway
 - 7. Small HVAC piping.
 - 8. Domestic water piping.
 - 9. Electric and communications conduits.
- C. Ductwork or Heating Main: No ductwork or heating main shall have preference over plumbing lines below plumbing fixtures, or over electrical conduits above or below electric switchgear and panels. No piping conveying fluids shall be installed directly over electrical equipment.
- D. Unless otherwise indicated, coordinate all work with the arrival of materials on the site to prevent unnecessary delays between demolition or other preliminary phases of work and the installation of new materials. Periods of abandonment of work area, once work has begun shall be avoided unless necessary to allow other trades to complete their work.

- E. The storage of materials on site shall be minimized. Materials delivered to the site far in advance of construction, and/or exposed to weather, mud or construction abuse for long periods, will not be eligible to be included in pay requests, and will be accepted for use in the project at the time of construction based upon condition at that time. Generally, rusted, beat-up products, including large equipment, will not be accepted for use.

3.03 INSPECTIONS

- A. The Engineer or his representative may inspect the work at any time and for any reason, but, generally, inspections will be arranged to coordinate with phasing of the work and with regularly scheduled Project meetings. The Engineer will attempt to accommodate the Contractor where possible, but in general, it is the Contractor's responsibility to schedule the work in such a manner that inspections are not required more often than the regular meetings, except for substantial completion and final inspections.
- B. No work shall be permanently concealed (underground, behind drywall or masonry, or any other inaccessible location) without being inspected by the Engineer or his representative, unless specific permission is granted to do so by the Engineer.
- C. In general, piping and ductwork must be inspected by the Engineer or his representative before insulation is applied, unless specific permission to do otherwise is given by the Engineer.
- D. The Contractor shall supply lights, ladders, tools, equipment and assistance to the Engineer, as required, for performing inspections and verifying the operation of mechanical systems.

3.04 CONCRETE WORK

- A. Provide all concealed concrete work required for Division 15, including but not limited to pipe and duct anchors, foundations and encasement, inertia bases, and pads. Coordinate with other divisions.
- B. Equipment pads, slabs and bases exposed to view and not part of the building structure (see architectural/structural plans) shall be provided by the Contractor. Coordinate with other divisions. The Contractor shall locate, dimension and furnish sleeves and anchors as required.
- C. Concrete shall conform to Division 3 requirements.

3.05 PROTECTION

- A. Protect equipment and materials during construction from damage from water, dirt, welding and cutting, spatters, paint droppings, etc., by use of shield and drop cloths. Damaged equipment or materials shall be repaired or replaced by the Contractor. Rusting, corroded or damaged materials or equipment is not acceptable, whether installed or not.

- B. Products stored outside or in unheated spaces shall be covered with water-proof drop cloths or tarpaulins. Condensation shall be prevented by heating and ventilating. Method shall be acceptable to the Engineer. (See Section 15010, Paragraph 1.11).
- C. During construction, maintain all materials and equipment in an orderly manner.
- D. Protect floors from soiling and damages caused by tools, chips, cutting oil, pipe compound, paint and the like.
- E. The Contractor shall use OSHA-approved ladders and lifts for Division 15 work. Workmen shall not be allowed to stand or sit on the unprotected surfaces of insulation, equipment jackets, conduit, control panels or any other location not intended for traffic.

3.06 CUTTING AND PATCHING

- A. Avoid cutting of concrete, masonry and other finished work by use of sleeves and inserts.
- B. Perform cutting and patching required for installation of the work. Methods and procedures shall be acceptable to the Engineer. Obtain written permission before any cutting.
- C. Cut holes through concrete, brick, tile, etc., when necessary, by rotary core drilling or masonry saw.
- D. Damages, patches, or work in areas previously finished under the work of other Divisions shall be repaired at the expense of the Contractor and to the satisfaction of the Engineer.

3.07 CLEANING

- A. Upon completion, ductwork, piping and equipment shall be thoroughly cleaned of dirt, grease, rust and oil, primed where necessary, and left ready for painting. Vacuum clean the inside and outside of fan plenums, air handling units and equipment cabinets. Vacuum clean coils and comb out damaged fins.
- B. Clean galvanized piping and ductwork in exposed areas with diluted acetic acid.
- C. Clean copper piping in exposed areas with emery cloth and solvent.
- D. Clean gauges, thermometers, traps, strainers and fittings.
- E. Install new filters in throwaway and replaceable filter frames. Properly clean permanent filters.

- F. Upon completion of Work, the Contractor shall remove all resulting rubbish, debris, and surplus materials from the premises, together with all disused instruments and equipment and shall leave the site in a neat, clean, and acceptable condition as approved by Engineer. Contractor shall maintain Work areas of existing facilities in a reasonably clean condition on a daily basis, and shall not allow debris to create operational or safety problems for the Owner.

3.08 PAINTING AND FINISHING

- A. Painting shall meet the requirements of Section 15099, when included in the Specifications. No painting or coating shall be done on surfaces already rusting without proper surface preparation.
- B. Exterior insulation and coverings shall be cleaned and painted per Section 15099 or coated as specified and left ready for service identification. Consult Engineer for color to be used.
- C. Ferrous metal exposed to weather shall be cleaned, primed, and painted per Section 15099. Consult Engineer for color to be used.
- D. All ferrous fasteners, hardware, hangers, hanger rods exposed to weather shall be stainless steel, galvanized or cadmium plated. Plating must include threads and all other surfaces. Other fasteners shall be properly prepared and coated immediately after installation with black asphaltum.
- E. Non-ferrous metals, stainless steel and plastic materials shall not be painted unless indicated in other Sections or Divisions or in the Drawings.
- F. Factory finished equipment which has rusted or been damaged shall be replaced. Only after approval by the Engineer, may it be cleaned, primed, and entirely repainted the original color by the Contractor.
- G. Interior insulation coverings shall be cleaned, sized if necessary, painted white and left ready for service identification. Exposed insulation inside finished areas shall match colors of nearby finishes, or color selected by the Architect.
- H. Interior uninsulated ferrous piping, supports and hangers exposed to view shall be painted per Section 15099 in areas not finished under other Divisions of the Specifications. All items shall be painted white except for pipe designated to be color coded in other Sections. In finished areas, color shall be selected by Architect.
- I. Clean interior surfaces of air ducts, and convector and baseboard heating cabinets, that are visible through grilles and louvers and cover with one coat of flat black paint, to limit of sight line. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.
- J. Paint insulated and uninsulated duct and piping, cabinets, louvers, boxes, hangers, brackets, collars, and supports where exposed to view in finished areas, except when prefinished or where painted under other Divisions.

- K. Contractor is responsible for any damage to building or contents from painting process. Do not allow paint over any existing or new name or identification plates or tags. Mask off any warning or instructional stickers or tags on equipment while painting.
- L. Wall mounted plumbing fixtures shall be caulked between fixture and wall or floor with caulking compatible with finish surfaces.

3.09 ACCESS

- A. Equipment has been chosen to properly fit into the physical spaces provided and indicated, allowing ample room for access, servicing, removal and replacement of parts, etc. Adequate space shall be allowed for clearance in accordance with Code requirements. Physical dimensions and arrangements of equipment to be installed shall be subject to Engineer approval. Submit shop drawings of equipment layout for approval where it does not comply with plans.
- B. Space Requirements: In the preparation of Drawings, a reasonable effort has been made to include all equipment manufacturer's recommendations. Since space requirements and equipment arrangement vary according to manufacturer, the responsibility for initial access and proper fit rests with the Contractor. The final arrangement of equipment and service connections shall allow the unit to be serviced. This shall include space to pull motors, filters, coils, tubes, etc. Contractor shall demonstrate that proper access has been provided to inspectors.

3.10 CONSTRUCTION DIRT, DUST AND NOISE CONTROL

- A. All cutting or drilling of concrete, masonry, steel or wood shall be performed with absolute control of dirt and dust resulting from the cutting or drilling operation. Workers performing operations or in the immediate vicinity shall wear OSHA approved protective equipment.
- B. The Contractor is required to minimize construction noise levels in all locations adjacent to or in occupied areas.
- C. The Owner reserves the right to prevent use of any tools which cause detrimental vibration or noise.

3.11 TRAINING

- A. Training and instruction to the Owner shall be provided for all Division 15 equipment, systems and controls. See individual Sections for additional specific requirements. Contractor shall submit a training agenda to the Engineer for approval, prior to Substantial Completion, including a proposed schedule, all items to be covered and who is to make the presentations. If the Owner chooses to decline training, or any part thereof, the Contractor will credit the Project for the cost of any unused hours of training and instruction. Contractor

shall keep record of attendance at the training sessions and submit to the Engineer upon completion.

- B. Instruction shall be based upon material in the Maintenance & Operating Manuals, described above, which shall be approved by the Engineer, prior to the training. Any supplemental information required shall be provided by the Contractor.
- C. Training and instruction to the Owner shall be videotaped at the Contractor's expense, in DVD format, and the original and one copy shall be submitted to the Engineer for approval, prior to Project Closeout. Video is not required to be made by professional videographers, but shall show technical competence, with clear pictures and sound, and useable for future personnel training by the Owner.

3.12 LEAKS

- A. During the time period from date of Contract until termination date of the guarantee, Contractor shall be responsible for damages to the building, grounds, walks, roads, piping systems, insulation, electrical systems, refrigeration, heating, ventilating and air conditioning systems, building equipment, furniture, and other building contents caused by leaks in piping systems or equipment being installed or having been installed by him. All repair work shall be done as directed by, and in a manner satisfactory to the Engineer and at no cost to the Owner.

END OF SECTION 15010

SECTION 15061

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Pipe hangers and supports.
 - 2. Hanger rods.
 - 3. Inserts.
 - 4. Flashing.
 - 5. Formed steel channel.
- B. Related Sections include but are not necessarily limited to:
 - 1. Section 03 00 05 - Concrete.
 - 2. Section 07 84 00 - Firestopping.
 - 3. Section 07 92 00 - Joint Sealants.
 - 4. Section 09 96 00 - High Performance Industrial Coatings.
 - 5. Section 22 05 03 - Pipe and Pipe Fittings - Plumbing Systems.

1.02 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B31.1, Power Piping.
 - b. B31.5, Refrigeration Piping.
 - c. B31.9, Building Services Piping.
 - 2. ASTM International (ASTM):
 - a. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - b. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
 - c. E814, Standard Test Method for Fire Tests of Through Penetration Fire Stops.
 - d. F708, Standard Practice for Design and Installation of Rigid Pipe Hangers.
 - e. E1966, Standard Test Method for Fire-Resistive Joint Systems.
 - 3. American Welding Society (AWS):
 - a. D1.1, Structural Welding Code - Steel.
 - 4. FM Global (FM):
 - a. Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
 - 5. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
 - a. SP 58, Pipe Hangers and Supports - Materials, Design and Manufacturer.
 - b. SP 69, Pipe Hangers and Supports - Selection and Application.
 - c. SP 89, Pipe Hangers and Supports - Fabrication and Installation Practices.
 - 6. Underwriters Laboratories Inc. (UL):

- a. 263, Fire Tests of Building Construction and Materials.
 - b. 723, Tests for Surface Burning Characteristics of Building Materials.
 - c. 1479, Fire Tests of Through-Penetration Firestops.
 - d. 2079, Tests for Fire Resistance of Building Joint Systems.
 - e. Fire Resistance Directory.
- 7. Intertek Testing Services (Warnock Hersey Listed):
 - a. WH - Certification Listings.
- B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

1.03 SUBMITTALS

- A. See Division 1.
- B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.
- C. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
 - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum five years' experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.06 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.07 WARRANTY

- A. Furnish five year manufacturer warranty for pipe hangers and supports.

PART 2 - PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
 - 1. Anvil International.
 - 2. CADDY by nVent.
 - 3. Carpenter & Paterson, Inc.
 - 4. B-Line by Eaton.
 - 5. Empire Industries, Inc.
 - 6. ERICO by nVent.
 - 7. Hilti, Inc.
 - 8. NIBCO, Inc.
 - 9. PHD Manufacturing, Inc.
 - 10. TOLCO by Eaton.
- B. Plumbing Piping - Domestic Water:
 - 1. Conform to ASME B31.9, MSS SP58, MSS SP69, MSS SP89.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 IN: Malleable iron, adjustable swivel, split ring.
 - 3. Hangers for Cold Pipe Sizes 2 IN and Larger: Carbon steel, adjustable, clevis.
 - 4. Hangers for Hot Pipe Sizes 2 to 4 IN: Carbon steel, adjustable, clevis.
 - 5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 6. Wall Support for Pipe Sizes 3 IN and Smaller: Cast iron hook.
 - 7. Wall Support for Pipe Sizes 4 IN and Larger: Welded steel bracket and wrought steel clamp.
 - 8. Vertical Support: Steel riser clamp.
 - 9. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 10. Floor Support for Hot Pipe Sizes 4 IN and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 11. Copper Pipe Support: Copper-plated, Carbon-steel ring.

2.02 ACCESSORIES

- A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.
 - 1. Electro-galvanized or cadmium plated after threads are cut.

2.03 INSERTS

- A. Manufacturers:
 - 1. CADDY by nVent.
 - 2. Carpenter & Paterson, Inc.
 - 3. B-Line by Eaton.
 - 4. Hilti, Inc.
 - 5. National Pipe Hanger Corporation.
 - 6. Pipe Shields, Inc.
 - 7. Piping Technology & Products, Inc.
 - 8. Rilco Manufacturing Company, Inc.
 - 9. Simpson Strong-Tie Company, Inc.

10. TOLCO by Eaton.

- B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.04 FLASHING

- A. Metal Flashing: 26 gage thick galvanized steel.
- B. Metal Counterflashing: 22 gage thick galvanized steel.
- C. Lead Flashing:
 - 1. Waterproofing: 5 LB/SQFT sheet lead.
 - 2. Soundproofing: 1 LB/SQFT sheet lead.
- D. Flexible Flashing: 47 MIL thick sheet compatible with roofing.
- E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.05 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sealant: Acrylic.

2.06 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 - 1. Flexicraft Industries.
 - 2. GPT Industries.
 - 3. Proco Products, Inc.
- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.07 FORMED STEEL CHANNEL

- A. Manufacturers:
 - 1. Unistrut by Atkore International, Inc.
 - 2. B-Line by Eaton.
 - 3. ERICO by Pentair.
- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 IN on center.

2.08 FIRESTOPPING

- A. Firestopping Materials: Comply with requirements of Division 7.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify openings are ready to receive sleeves.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install materials to arrest liquid material leakage.
- D. Obtain permission from Engineer before using powder-actuated anchors.
- E. Obtain permission from Engineer before drilling or cutting structural members.

3.03 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 IN and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

3.04 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME 31.9, ASTM F708, MSS SP 58, MSS SP 69, MSS SP 89.
- B. Support horizontal piping as scheduled.
- C. Install hangers with minimum 1/2 IN space between finished covering and adjacent work.
- D. Place hangers within 12 IN of each horizontal elbow.
- E. Use hangers with 1-1/2 IN minimum vertical adjustment.
- F. Support horizontal cast iron pipe adjacent to each hub, with 5 FT maximum spacing between hangers.
- G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- H. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- I. Support riser piping independently of connected horizontal piping.
- J. Provide copper plated hangers and supports for copper piping.
- K. Design hangers for pipe movement without disengagement of supported pipe.

- L. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- M. Provide clearance in hangers and from structure and other equipment for installation of insulation.

3.05 INSTALLATION - FLASHING

- A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 3 IN minimum above finished roof surface with lead worked 1 IN minimum into hub, 8 IN minimum clear on sides with 24 x 24 IN sheet size. For pipes through outside walls, turn flanges back into wall and seal, metal counter-flash, and seal.
- C. Flash floor drains in floors with topping over finished areas with lead, 10 IN clear on sides with minimum 36 x 36 IN sheet size. Fasten flashing to drain clamp device.
- D. Seal floor drains watertight to adjacent materials.
- E. Adjust storm collars tight to pipe with bolts; seal around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.06 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors 1 IN above finished floor level. Seal sleeves.
- E. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with insulation and sealant. Provide metal escutcheon covers at both sides of penetration.
- F. Install stainless steel escutcheons at finished surfaces.

3.07 SCHEDULES

PIPE HANGER SPACING		
PIPE MATERIAL	MAXIMUM HANGER SPACING (FT)	HANGER ROD DIAMETER (IN)
Copper Tube, 1-1/4 IN and smaller	6	1/2
Copper Tube, 1-1/2 IN and larger	10	1/2
PVC (All Sizes)	4	3/8

END OF SECTION 15061

SECTION 15076
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Nameplates.
 - 2. Tags.
 - 3. Stencils.
 - 4. Pipe markers.
 - 5. Ceiling tacks.
 - 6. Labels.
 - 7. Lockout devices.
- B. Related Sections include but are not necessarily limited to:
 - 1. Section 09 96 00 - High Performance Industrial Coatings.

1.02 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. A13.1, Scheme for the Identification of Piping Systems.
- B. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.
- C. Maintain one copy of each document on site.

1.03 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit manufacturers catalog literature for each product required.
- C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- F. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Division 1 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
 - 2. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Nameplates, Tags and Stencils:
 - a. Brady Corporation.
 - b. Panduit.
 - c. Seton by Brady Corporation.
 - d. National Band & Tag Company.
 - e. Carlton Industries, LP.

2.02 NAMEPLATES

- A. Laminated two-layer phenolic or DR (high impact) acrylic with engraved black letters on light contrasting background color.
 - 1. Thickness: Minimum 1/16 IN.
 - 2. Color: Manufacturer standard or as specified.
- B. Alternate: Laminated three-layer plastic with engraved black letters on light contrasting background color.
 - 1. Thickness: Minimum 60 MILS.
 - 2. Color: Manufacturer standard or as specified.

2.03 TAGS

- A. Nonmetallic Tags:
 - 1. Fiberglass reinforced engraved black letters on light contrasting background color.
 - a. Tag size: Minimum 1-1/2 IN diameter.
 - b. Thickness: Minimum 100 MILS.
 - c. Color: Manufacturer standard or as specified.
- B. Metal Tags:
 - 1. Aluminum or stainless steel disc with stamped letters and finished edges.
 - a. Tag size: Minimum 1-1/2 IN diameter.
 - b. Thickness: Minimum 0.035 IN (20 Ga).
 - c. Color: Black color filled into stamped text with natural metal background.
- C. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

2.04 STENCILS

- A. With clean cut symbols and letters of following size:
 - 1. Up to 2 IN Outside Diameter of Insulation or Pipe: 1/2 IN high letters.
 - 2. 2-1/2 to 6 IN Outside Diameter of Insulation or Pipe: 1 IN high letters.
 - 3. Over 6 IN Outside Diameter of Insulation or Pipe: 1-3/4 IN high letters.
 - 4. Equipment: 1-3/4 IN high letters.
- B. Stencil Paint: As specified in Section 09 96 00, colors and lettering size conforming to ASME A13.1.

2.05 SELF ADHESIVE PIPE AND EQUIPMENT MARKERS

- A. Color and Lettering: Conform to ASME A13.1.

- B. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
 - 1. Thickness: Minimum 5 MILS.
 - 2. Letter Height:
 - a. Up to 2 IN Outside Diameter of Insulation or Pipe: 1/2 IN high letters.
 - b. 2-1/2 to 6 IN Outside Diameter of Insulation or Pipe: 1 IN high letters.
 - c. Over 6 IN Outside Diameter of Insulation or Pipe: 1-3/4 IN high letters.
 - d. Equipment: 1-3/4 IN high letters.
 - 3. Indoor/outdoor grade.
 - 4. Weather and UV resistant inks.
 - 5. Permanent adhesive.

2.06 UNDERGROUND WARNING TAPE

- A. Description: Polyethylene tape with metallic core for detection and location of piping with metal detector resistant to acids, alkalis and other soil components.
 - 1. Size: 0.004 IN thick; 6 IN wide.
 - 2. Color: As Specified.
 - 3. Service Marking: Printed text as selected by Architect/Engineer in [black] [contrasting] color and repeated at maximum 40 IN intervals.

2.07 TRACER WIRE

- A. 12 GA AWG.
- B. Solid.
- C. Waterproof type wire nuts.
- D. Brass split bolts.

2.08 LOCKOUT DEVICES

- A. Lockout Hasps:
 - 1. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 IN.
- B. Valve Lockout Devices:
 - 1. Manufacturers:
 - a. Brady Corporation.
 - b. Master Lock Company, LLC.
 - 2. Nylon device preventing access to valve operator, accepting lock shackle.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 09 96 00 for stencil painting.

3.02 INSTALLATION

- A. Apply stencil painting in accordance with Division 9.
- B. Install identifying devices after completion of coverings and painting.
- C. All identification devices to be printed by mechanical process. Hand printing is not acceptable.

- D. Install nameplates with adhesive where equipment has sufficient surface area and texture.
 - 1. Attach tags with 1/8 IN flat head screws where adhesive application is not suitable.
 - 2. Attach tabs with plastic strap where screws should not or cannot penetrate substrate.
- E. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.
- F. Install tags using corrosion resistant chain. Number tags consecutively by location.
- G. Install underground plastic pipe markers 6 to 8 IN below finished grade, directly above buried pipe.
- H. Identify air tanks, and water treatment devices with stencil painting. Identify in-line pumps and other small devices with tags.
- I. Tag single items of equipment enclosed in a housing or compartment on outside of housing.
 - 1. Tag multiple items mounted inside a housing or compartment individually inside the housing.
- J. Identify control panels and major control components outside panels with plastic nameplates.
- K. Identify valves in main and branch piping with tags.
- L. Tag automatic controls, instruments, and relays. Key to control schematic.
- M. Identify piping, concealed or exposed, with stenciled painting. Use tags on piping 3/4 IN diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 FT on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- N. Tracer Wire:
 - 1. Attach to buried nonmetallic pipe at maximum of 10 FT intervals with tape or tie-wraps.
 - 2. Install continuously from structure to structure including valve boxes and buildings.
 - 3. Splice wire with split bolts or wire nuts only as needed; use continuous strands of no less than 100 FT length.

3.03 SCHEDULES

- A. Ductwork:
 - 1. Install labels on all duct in accordance with Article 3.2.
 - a. Stencils or self-adhesive labels.
 - 2. Color Coding:
 - a. Black lettering on yellow background:
 - 1) Supply Air, Outside Air or Makeup Air.
 - b. White lettering on green background:
 - 1) Return Air, Exhaust Air and Relief Air.
- B. Above Grade Piping:
 - 1. Install labels on all piping in accordance with Article 3.2.

- a. Stencils or self-adhesive labels.
- 2. Color Coding: Per ASME A13.1.
 - a. Black lettering on yellow background:
 - 1) Hazardous, flammable or high temperature fluids:
 - a) Domestic Hot Water.
 - b) Domestic Hot Water Return.
 - b. White lettering on red background:
 - 1) Fire quenching fluids:
 - a) Fire Protection Water.
 - c. White lettering on green background:
 - 1) Low temperature water:
 - a) Domestic Cold Water.
 - b) Tepid Water.
 - c) Nonpotable Water.
 - d. White lettering on blue background:
 - 1) Compressed Air.
- C. Below Grade Piping
 - 1. Use underground warning tape in accordance with Article 3.2.
 - a. Lettering: Minimum: 1-1/4 IN.
 - b. Wording:
 - 1) First line: "CAUTION CAUTION CAUTION"
 - 2) Second line: "BURIED (Pipe Descriptor) LINE BELOW"
 - c. Pipe Descriptors and color coding:
 - 1) Natural Gas: Black lettering on yellow background.
 - 2) Sewer or Waste: Black Lettering on Green Background.
 - 3) Water (potable): Black lettering on blue background.
 - 4) Water (nonpotable): Black lettering on Green background.
- D. Valves:
 - 1. Install on all automatic valves used in temperature controls:
 - a. Label per Control Drawings.
 - 2. Install on all manual valves:
 - a. Number and schedule all valves utilized on project. Number tags per Drawings.
 - 3. Utilize nonmetallic or metal tags.
 - a. Use stainless steel metal tags only for corrosive areas.
- E. Equipment:
 - 1. Provide nameplate or stencil as warranted per Article 3.2.
 - 2. Label with equipment tag as shown on the Drawings.
 - a. Black lettering on white background.
 - 3. Provide OSHA warning sign for equipment that starts automatically.
 - 4. Label all equipment control panels located remote from unit.
 - 5. Label all thermostats with self-adhesive markers with tag of equipment served.

END OF SECTION 15076

SECTION 15085 PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic cold-water piping.
 - 2. Domestic hot-water piping.
 - 3. Domestic recirculating hot-water piping.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
- B. Qualification Data: For qualified Installer.
- C. Field quality-control reports.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

- C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.06 COORDINATION

- A. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- B. Coordinate installation and testing of heat tracing.

1.07 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA, Inc.; Aerocel.

- b. Armacell LLC; AP Armaflex.
- c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

2.02 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA, Inc.; Aero seal.
 - b. Armacell LLC; Armaflex 520 Adhesive.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
 - d. K-Flex USA; R-373 Contact Adhesive.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Corning Corporation; 739, Dow Silicone.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Polyco VP Adhesive.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

2.03 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.04 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: White.
 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- C. Metal Jacket:
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
 - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
 - c. RPR Products, Inc.; Insul-Mate.
 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper] 3-mil- thick, heat-bonded polyethylene and kraft paper 2.5-mil- thick polysurlyn.

- d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper 2.5-mil- thick polysurlyn.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
- a. Sheet and roll stock ready for shop or field sizing.
 - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper 3-mil- thick, heat-bonded polyethylene and kraft paper 2.5-mil- thick polysurlyn.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper 2.5-mil- thick polysurlyn.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- D. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Pittsburgh Corning Corporation; Pittwrap.
 - b. Polyguard Products, Inc.; Insulrap No Torch 125.

2.05 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 - 2. Width: 3 inches.
 - 3. Thickness: 11.5 mils.
 - 4. Adhesion: 90 ounces force/inch in width.
 - 5. Elongation: 2 percent.
 - 6. Tensile Strength: 40 lbf/inch in width.
 - 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
 - 2. Width: 2 inches.
 - 3. Thickness: 6 mils.
 - 4. Adhesion: 64 ounces force/inch in width.
 - 5. Elongation: 500 percent.
 - 6. Tensile Strength: 18 lbf/inch in width.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Cleanouts.

3.04 PENETRATIONS

- A. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Division 07 Section for firestopping and fire-resistive joint sealers.
- D. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.05 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation barrier. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.07 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.08 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

3.09 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their

installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, two locations of threaded strainers, three locations of threaded valves, for each pipe service defined in the "Piping Insulation Schedule, General" Article.

- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.010 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.011 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 - 1. NPS 1 and Smaller: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1/2 inch thick.
 - 2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
- B. Domestic Hot and Recirculated Hot Water:
 - 1. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.

3.012 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. None.

D. Piping, Exposed:

1. PVC: 20 mils thick.

3.013 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 1. None.
- D. Piping, Exposed:
 1. Stainless Steel, Type 316, Smooth 2B Finish with Z-Shaped Locking Seam: 0.020 inch (0.51 mm) thick.

END OF SECTION 15085

SECTION 15088 HVAC REFRIGERANT PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
 - 1. Refrigerant suction and hot-gas piping, indoors and outdoors.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 3. Detail removable insulation at piping specialties.
 - 4. Detail application of field-applied jackets.
 - 5. Detail application at linkages of control devices.
- C. Qualification Data: For qualified Installer.
- D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- E. Field quality-control reports.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.06 COORDINATION

- A. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.07 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

- E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
 - d. Approved equal.

2.02 ADHESIVES

- A. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA, Inc.; Aero seal.
 - b. Armacell LLC; Armaflex 520 Adhesive.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
 - d. K-Flex USA; R-373 Contact Adhesive.
 - e. Approved equal.
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

- B. PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
 - d. Mon-Eco Industries, Inc.; 22-25.
 - e. Approved equal.
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

- C. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 739, Dow Silicone.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Polyco VP Adhesive.
 - e. Approved equal.
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

2.03 SEALANTS

- A. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Approved equal.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
 5. Color: White.
 6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 7. Use sealants that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

2.04 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm (0.013 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread

index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

- a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
 - 2) Approved equal.
4. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm (0.007 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
 - 2) Approved equal.
5. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
 - 2) Approved equal.
6. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perms) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.05 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 - e. Approved equal.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

- C. Self-Adhesive Outdoor Jacket: 60-mil- (1.5-mm-) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Polyguard Products, Inc.; Alumaguard 60.
 - b. Approved equal.
- D. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); Saran 560 Vapor Retarder Film.
 - b. Approved equal.
- E. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
 - b. Approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.

3.04 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
 4. Seal jacket to wall flashing with flashing sealant.

- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.

3.05 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.07 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.
- C. Where PVDC jackets are indicated, install as follows:
1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
 2. Wrap factory-presize jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presize jacket with an approximate overlap at butt joint of 2 inches (50 mm) over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
 3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.

4. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.08 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- B. Do not field paint aluminum or stainless-steel jackets.

3.09 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Inspect pipe, fittings, strainers, and valves, randomly selected by project manager by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of threaded valves, and three locations of flanged valves for each pipe service.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.010 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Drainage piping located in crawl spaces.
 2. Underground piping.
 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.011 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 3/4 inch (19 mm) thick.

- B. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch (25 mm) thick.

- C. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch (25 mm) thick.

3.012 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inches (50 mm) thick.
- B. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 2 inches (50 mm) thick.

3.013 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. None.
- D. Piping, Exposed:
 - 1. PVC: 30 mils (0.8 mm) thick.

END OF SECTION 15088

SECTION 15140
PIPE AND PIPE FITTINGS - PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plumbing Piping.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. B32, Standard Specification for Solder Metal.
 - b. B88, Standard Specification for Seamless Copper Water Tube.
 - 2. American National Standards Institute (ANSI/ASTM):
 - a. B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
 - b. B16.22, Wrought Copper and Bronze Solder - Joint Pressure Fittings.
 - c. B16.23, Cast Copper Alloy Solder Joint Drainage Fittings (DWV).
 - d. B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
 - 3. Chlorine Institute, Inc. (CI):
 - a. Pamphlet 6, Piping Systems for Dry Chlorine.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Copies of manufacturer's written directions regarding material handling, delivery, storage and installation.
 - c. Separate schedule sheet for each piping system scheduled in this Specification Section showing compliance of all system components.
 - 1) Attach technical product data on gaskets, pipe, fittings, and other components.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Division 1 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
- C. Informational Submittals:
 - 1. Qualifications of lab performing disinfection analysis on water systems.
 - 2. Test reports:
 - a. Copies of pressure test results on all piping systems.
 - b. Reports defining results of dielectric testing and corrective action taken.
 - c. Disinfection test report.
 - d. Notification of time and date of piping pressure tests.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Couplings:

- a. Dresser.
 - b. Smith-Blair.
- 2. Mechanical Couplings:
 - a. Victaulic.
 - b. Tyler.
- 3. Expansion Fittings:
 - a. Flexicraft.
 - b. Mason.
 - c. Metraflex.
- B. Piping Systems:
 - 1. Piping systems are scheduled by service in PART 3 of this specification.
- C. Pipe and Tube:
 - 1. Copper:
 - a. Type K, L, or M tube per ASTM B88.
 - b. Utilize only annealed (soft) type tubing where flared joints are used and drawn temper (hard) type tubing where soldered or brazed joints are used.
 - c. Fittings, per System Type:
 - 1) Cast copper or bronze (pressure): Per ASTM B16.18.
 - 2) Wrought copper or bronze (pressure, solder): ASTM B16.22.
 - 3) Cast copper or bronze (DWV): Per ASTM B16.23.
 - 4) Wrought copper or bronze (pressure, flared): Per ASTM B16.26.
 - d. Joints:
 - 1) Flared.
 - 2) Soldered or Brazed:
 - a) Above ground below 180 DEGF: ASTM B32 solder with a tin/antimony ratio of 95/5 and non-corrosive flux.
 - b) Above ground 180 DEGF and above: use brazing alloy with melting temperature above 1000 DEGF and suitable flux.
 - c) Buried: Silver solder per AWS A5.8M/A5.8.
 - d) Provide unions and valves and equipment.
 - e. Unions: Class 150, bronze.

2.2 MANUFACTURED UNITS

- A. Unions:
 - 1. Copper pipe:
 - a. Copper ground joint unions for pipe sizes 2 IN and smaller.
 - b. Brass flanged unions for pipe sizes larger than 2 IN.

2.3 ACCESSORIES

- A. Heating Water Application:
 - 1. Provide pump connectors with stainless steel construction, rubber filled bellows and flanged end connections.
- B. Bellows-type Expansion Fitting:
 - 1. Single sphere style stainless steel construction.
 - 2. Pressure rating: 125 PSIG.
 - 3. Temperature Rating: 250 DEGF.
 - 4. Maximum Compression: 1-3/4 IN.
 - 5. Maximum Extension: 1/4 IN.
 - 6. Joint: As specified for individual piping system.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends.
- B. Remove burrs.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment with flanges and unions.
- E. Deep open ends of pipe free from scale and dirt.
- F. Protect open ends with temporary plugs or caps.

3.2 EXTERIOR BURIED PIPING INSTALLATION

- A. Unless otherwise shown on the Drawings, provide a minimum of 3 FT and maximum of 8 FT earth cover over exterior buried piping systems and appurtenances conveying water, fluids, or solutions subject to freezing.
- B. Enter and exit through structure walls, floors, and ceilings by using penetrations and seals specified in Specification Section 01 73 20 and as shown on Drawings.
- C. When entering or leaving structures with buried mechanical joint piping, install joint within 2 FT of point where pipe enters or leaves structure.
 - 1. Install second joint not more than 6 FT or less than 4 FT from first joint.
- D. Install expansion devices as necessary to allow expansion and contraction movement.
- E. Laying Pipe in Trench:
 - 1. Excavate and backfill trench in accordance with Specification Section 31 23 33.
 - 2. Clean each pipe length thoroughly and inspect for compliance to specifications.
 - 3. Grade trench bottom and excavate for pipe bell and lay pipe on trench bottom.
 - 4. Install gasket or joint material according to manufacturer's directions after joints have been thoroughly cleaned and examined.
 - 5. Except for first two joints, before making final connections of joints, install two full sections of pipe with earth tamped along side of pipe or final with bedding material placed.
 - 6. Lay pipe in only suitable weather with good trench conditions.
 - a. Never lay pipe in water except where approved by Engineer.
 - 7. Seal open end of line with watertight plug if pipe laying stopped.
 - 8. Remove water in trench before removal of plug.
- F. Lining Up Push-On Joint Piping:
 - 1. Lay piping on route lines shown on Drawings.
 - 2. Deflect from straight alignments or grades by vertical or horizontal curves or offsets.
 - 3. Observe maximum deflection values stated in manufacturer's written literature.
 - 4. Provide special bends when specified or where required alignment exceeds allowable deflections stipulated.
 - 5. Install shorter lengths of pipe in such length and number that angular deflection of any joint, as represented by specified maximum deflection, is not exceeded.

- G. Anchorage and Blocking:
 - 1. Provide reaction blocking, anchors, joint harnesses, or other acceptable means for preventing movement of piping caused by forces in or on buried piping tees, wye branches, plugs, or bends.
 - 2. Place concrete blocking so that it extends from fitting into solid undisturbed earth wall.
 - a. Concrete blocks shall not cover pipe joints.
 - 3. Provide bearing area of concrete in accordance with drawing detail.
- H. Install underground hazard warning tape per Specification Section 10 14 00.
- I. Install insulating components where dissimilar metals are joined together.

3.3 INTERIOR AND EXPOSED EXTERIOR PIPING INSTALLATION

- A. Install piping in vertical and horizontal alignment as shown on Drawings.
- B. Alignment of piping smaller than 4 IN may not be shown; however, install according to Drawing intent and with clearance and allowance for:
 - 1. Expansion and contraction.
 - 2. Operation and access to equipment, doors, windows, hoists, moving equipment.
 - 3. Headroom and walking space for working areas and aisles.
 - 4. System drainage and air removal.
 - 5. Enter and exit through structure walls, floor and ceilings using penetrations and seals specified in Division 1 and as shown on the Drawings.
- C. Install vertical piping runs plumb and horizontal piping runs parallel with structure walls.
- D. Pipe Support:
 - 1. Use methods of piping support as shown on Drawings.
 - 2. Where pipes run parallel and at same elevation or grade, they may be grouped and supported from common trapeze-type hanger, provided hanger rods are increased in size as specified for total supported weight.
 - a. The pipe in the group requiring the least maximum distance between supports shall set the distance between trapeze hangers.
 - 3. Size pipe supports with consideration to specific gravity of liquid being piped.
- E. Locate and size sleeves and castings required for piping system.
 - 1. Arrange for chases, recesses, inserts or anchors at proper elevation and location.
- F. Use reducing fittings throughout piping systems.
 - 1. Bushings will not be allowed unless specifically approved.
- G. Equipment Drainage:
 - 1. Provide drip pans and piping at equipment where condensation may occur.
 - 2. Avoid piping over electrical components such as motor control centers, panelboards, etc.
 - a. If piping must be so routed, utilize 16 GA, 316 stainless steel drip pan under piping and over full length of electrical equipment.
 - b. Hard pipe drainage to nearest floor drain.
- H. Miscellaneous Piping:
 - 1. If system is not otherwise specified, provide stainless steel tubing.
 - 2. Size to handle application with 3/4 IN being minimum size provided.

- I. Unions:
 - 1. Install in position which will permit valve or equipment to be removed without dismantling adjacent piping.
 - 2. Mechanical type couplings may serve as unions.
 - 3. Additional flange unions are not required at flanged connections.
- J. Install expansion devices as necessary to allow expansion/contraction movement.
- K. Provide full face gaskets on all systems.
- L. Anchorage and Blocking:
 - 1. Block, anchor, or harness exposed piping subjected to forces in which joints are installed to prevent separation of joints and transmission of stress into equipment or structural components not designed to resist those stresses.
- M. Equipment Pipe Connections:
 - 1. Make piping connections to plumbing and HVAC equipment, including but not limited to installation of fittings, strainers, pressure reducing valves, flow control valves and relief valves provided with or as integral part of equipment.
 - 2. Furnish and install sinks, fittings, strainers, pressure reducing valves, flow control valves, pressure relief valves, and shock absorbers which are not specified to be provided with or as integral part of equipment.
 - 3. For each water supply piping connection to equipment, furnish and install union and gate or angle valve.
 - a. Provide wheel handle stop valve at each laboratory sink water supply.
 - b. Minimum size: 1/2 IN.
 - 4. Furnish and install "P" trap for each waste piping connection to equipment if waste is connected directly to building sewer system.
 - a. Size trap as required by IPC.
 - 5. Stub piping for equipment, sinks, lavatories, supply and drain fittings, key stops, "P" traps, miscellaneous traps and miscellaneous brass through wall or floor and cap and protect until such time when later installation is performed.
- N. Provide insulating components where dissimilar metals are joined together.

3.4 CONNECTIONS WITH EXISTING PIPING

- A. Where connection between new work and existing work is made, use suitable and proper fittings to suit conditions encountered.
- B. Perform connections with existing piping at time and under conditions which will least interfere with service to customers affected by such operation.
- C. Undertake connections in fashion which will disturb system as little as possible.
- D. Provide suitable equipment and facilities to dewater, drain, and dispose of liquid removed without damage to adjacent property.
- E. Where connections to existing systems necessitate employment of past installation methods not currently part of trade practice, utilize necessary special piping components.
- F. Where connection involves potable water systems, provide disinfection methods as prescribed in this Specification Section.

- G. Once tie-in to each existing system is initiated, continue work continuously until tie-in is made and tested.

3.5 ACCESS PROVISIONS

- A. Provide access doors or panels in walls, floors, and ceilings to permit access to valves, piping and piping appurtenances requiring service.
- B. Size of access panels to allow inspection and removal of items served, minimum 10 x 14 IN size.
- C. Fabricate door and frame of minimum 14 GA, stretcher leveled stock, cadmium plated or galvanized after fabrication and fitted with screw driver lock of cam type.
- D. Provide with key locks, keyed alike, in public use areas.
- E. Furnish panels with prime coat of paint.
- F. Style and type as required for material in which door installed.
- G. Where door is installed in fire-rated construction, provide door bearing UL label required for condition.

3.6 CATHODIC PROTECTION

- A. Isolate, dielectrically, all piping from all other metals including reinforcing bars in concrete slabs, other pipe lines, and miscellaneous metal.
- B. Make all connections from wire or cable by Thermit Cad welding accomplished by operators experienced in this process.
- C. Install all cables with a loop and overhead knot around each pipe and slack equal to at least 50% of the straight line length.
- D. After cad welding, coat all exposed metallic surfaces with hot applied tape.

3.7 INSTALLATION - PIPE SYSTEM SPECIFIC

- A. Potable Water Piping Installation:
 - 1. Install drain tees with capped nipples of IPS brass 3 IN long at low points.
 - a. If low point occurs in concealed piping, provide approved flush access panel.
 - b. These drains are not shown on Drawings.
 - 2. Slope water lines down to drain points not less than 1 IN in 60 FT.
 - 3. Install all threaded piping with clean-cut tapered threads and with ends thoroughly reamed after cutting to remove burrs.
 - a. Pipe joint cement permitted only on external threads.
 - 4. For screwed nipples for connections to flush valves, lavatory supplies, and other equipment with threaded connections use iron, copper, or brass pipe.
 - 5. Install ball, butterfly and plug valves where indicated or required to adequately service all parts of system and equipment.
 - a. Install valves on each branch serving restroom.
 - b. Install valves on inlet and outlet connections of heat exchangers and on other equipment connected to water lines.
 - 6. Install unions between valves and connections to each piece of equipment, and install sufficient number of unions throughout piping system to facilitate installation and servicing.

- a. On copper pipe lines, install wrought, solder-joint, copper to copper unions for lines 2 IN and smaller and, for lines 2-1/2 IN and over install brass flange unions.
7. Construct and equip plumbing fixtures and equipment with anti-siphon devices as to entirely eliminate any danger of siphoning waste material into potable water supply system.
8. Where exposed pipes 6 IN in size and smaller pass through floors, finished walls, or finished ceilings, fit with nickel or chrome-plated plates large enough to completely close hole around pipes.
 - a. Secure plates to pipe by set screw in approved manner.
9. Size supply branches to individual fixtures as scheduled or indicated on Drawings.
10. Install piping so as to be free to expand with proper loops, anchors and joints without injury to system or structure.
11. Provide branches to wall hydrants or hose bibbs in exterior locations with interior shutoff and drain valves.
12. Provide approved type vacuum breaker and backflow preventer installations indicated or as required by Code.
13. Install concealed in finished structures such as administration and office facilities and at locations shown on Drawings.

3.8 JOINING

- A. Install products in accordance with manufacturer's instructions.
- B. Joining Method - Couplings:
 1. Compression sleeve:
 - a. Install coupling to allow space of not less than 1/4 IN but not more than 1 IN.
 - b. Provide harnessed joint.
 - 1) Use joint harness arrangements detailed in AWWA M11.
 - c. Design harness assembly with adequate number of tie rods for test pressures indicated in Section 40 05 00 and allow for expansion of pipe.
 - d. Provide ends to be joined or fitted with compression sleeve couplings of the plain end type.
 - e. Grind smooth welds the length of one coupling on either side of joint to be fitted with any coupling.
 - f. Assure that outside diameter and out-of-round tolerances are within limits required by coupling manufacturer.
 2. Mechanical coupling:
 - a. Arrange piping so that pipe ends are in full contact.
 - b. Groove and shoulder ends of piping in accordance with manufacturer's recommendations.
 - c. Provide coupling and grooving technique assuring a connection which passes pressure testing requirements.
- C. Joining Method - Threaded and Coupled (T/C):
 1. Provide T/C end conditions that meet ASME B1.2 requirements.
 2. Furnish pipe with factory-made T/C ends.
 3. Field cut additional threads full and clean with sharp dies.
 4. Leave not more than three pipe threads exposed at each branch connection.
 5. Ream ends of pipe after threading and before assembly to remove burrs.
 6. Use Teflon thread tape on male thread in mating joints.

3.9 FIELD QUALITY CONTROL

A. Pipe Testing - General:

1. Test piping systems as follows:
 - a. Test exposed, non-insulated piping systems upon completion of system.
 - b. Test exposed, insulated piping systems upon completion of system but prior to application of insulation.
 - c. Test concealed interior piping systems prior to concealment and, if system is insulated, prior to application of insulation.
 - d. Test buried piping (insulated and non-insulated) prior to backfilling and, if insulated, prior to application of insulation.
2. Isolate equipment which may be damaged by the specified pressure test conditions.
3. Perform pressure test using calibrated pressure gages and calibrated volumetric measuring equipment to determine leakage rates.
 - a. Select each gage so that the specified test pressure falls within the upper half of the gage's range.
 - b. Notify the Engineer 24 HRS prior to each test.
4. Completely assemble and test new piping systems prior to connection to existing pipe systems.
5. Acknowledge satisfactory performance of tests and inspections in writing to Engineer prior to final acceptance.
6. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.

B. Pressure Testing:

1. Testing medium:
 - a. Water systems: Water.
2. Testing pressure:
 - a. See below for gravity systems.
 - b. For pumped systems, test at no less than 125% of pump head plus the system fill pressure.
 - c. For pressurized systems, test at 150 PSIG.
3. Allowable leakage rates:
 - a. All exposed piping systems, all pressure piping systems and all buried, insulated piping systems which are hydrostatically pressure tested shall have zero leakage at the specified test pressure throughout the duration of the test.

4. Hydrostatic pressure testing methodology:
 - a. General:
 - 1) All joints, including welds, are to be left exposed for examination during the test.
 - 2) Provide additional temporary supports for piping systems designed for vapor or gas to support the weight of the test water.
 - 3) Provide temporary restraints for expansion joints for additional pressure load under test.
 - 4) Isolate equipment in piping system with rated pressure lower than pipe test pressure.
 - 5) Do not paint or insulate exposed piping until successful performance of pressure test.
 - C. Dielectric Testing Methods and Criteria:
 1. Provide electrical check between metallic non-ferrous pipe or appurtenances and ferrous elements of construction to assure discontinuity has been maintained.
 2. Wherever electrical contact is demonstrated by such test, locate the point or points of continuity and correct the condition.

3.10 CLEANING, DISINFECTION AND PURGING

- A. Cleaning:
 1. Clean interior of piping systems thoroughly before installing.
 2. Maintain pipe in clean condition during installation.
 3. Before jointing piping, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint.
 4. Immediately prior to pressure testing, clean and remove grease, metal cuttings, dirt, or other foreign materials which may have entered the system.
 5. At completion of work and prior to Final Acceptance, thoroughly clean work installed under these Specifications.
 - a. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated by operation of system, from testing, or from other causes.
 - b. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner.
 6. Clean chlorine piping in accordance with CI Pamphlet 6.
- B. Disinfection of Potable Water Systems:
 1. After favorable performance of pressure test and prior to Final Acceptance, thoroughly flush entire potable water piping system including supply, source and any appurtenant devices and perform disinfection as prescribed.
 2. Perform work, including preventative measures during construction, in full compliance with AWWA C651.
 3. Perform disinfection using sodium hypochlorite complying with AWWA B300-10.
 4. Flush each segment of system to provide flushing velocity of not less than 2.5 FT per second.
 5. Drain flushing water to sanitary sewer.
 - a. Do not drain flushing water to receiving stream.
 6. Use continuous feed method of application.
 - a. Tag system during disinfection procedure to prevent use.

7. After required contact period, flush system to remove traces of heavily chlorinated water.
8. After final flushing and before placing water in service, obtain an independent laboratory approved by the Owner to collect samples and test for bacteriological quality.
 - a. Repeat entire disinfection procedures until satisfactory results are obtained.
9. Secure and deliver to Owner, satisfactory bacteriological reports on samples taken from system.
 - a. Ensure sampling and testing procedures are in full compliance to AWWA C651, local water purveyor and applicable requirements of State of Kentucky.

3.11 SCHEDULES

- A. Potable Water:
 1. Above ground, 3 inch diameter and less:
 - a. Pipe: Type L Copper.
 - b. Fittings: Wrought Copper or bronze.
 - c. Joints: Brazed or Soldered.
 2. Buried, 3 inch diameter and less:
 - a. Pipe: Type K Copper.
 - b. Fittings: Cast or Wrought Copper.
 - c. Joints: Flared.
- B. System 4 - Condensate and Equipment Drains:
 1. Above Ground (gravity drainage):
 - a. Pipe: DWV grade PVC.
 - b. Fittings: DWV PVC.
 - c. Joints: Solvent Weld.
 2. Above ground (pumped):
 - a. Pipe: Schedule 40 PVC or CPVC (for systems above 100 DEGF).
 - b. Fittings: Schedule 40 PVC or CPVC to match pipe.
 - c. Joints: Solvent weld.

END OF SECTION 15140

SECTION 15183 REFRIGERANT PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.03 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
 - 2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
 - 3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

1.04 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
 - 1. Thermostatic expansion valves.
 - 2. Solenoid valves.
 - 3. Hot-gas bypass valves.
 - 4. Filter dryers.
 - 5. Strainers.
 - 6. Pressure-regulating valves.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.06 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.07 COORDINATION

- A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.01 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L or ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.
- F. Flexible Connectors:
 - 1. Body: Stainless steel or tin-bronze bellows with woven, flexible, stainless steel or tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: NPS 2 inches and smaller with threaded ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
 - 4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
 - 5. Maximum Operating Temperature: 250 deg F (121 deg C).

2.02 VALVES AND SPECIALTIES

- A. Diaphragm Packless Valves:
 - 1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
 - 2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
 - 3. Operator: Rising stem and hand wheel.
 - 4. Seat: Nylon.
 - 5. End Connections: Socket, union, or flanged.
 - 6. Working Pressure Rating: 500 psig (3450 kPa).
 - 7. Maximum Operating Temperature: 275 deg F (135 deg C).

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig (3450 kPa).
8. Maximum Operating Temperature: 275 deg F (135 deg C).

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig (3.4 kPa).
8. Working Pressure Rating: 500 psig (3450 kPa).
9. Maximum Operating Temperature: 275 deg F (135 deg C).

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig (3450 kPa).

E. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F (4.4 deg C).
6. Superheat: Nonadjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 700 psig (4820 kPa).

F. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig (3450 kPa).
6. Maximum Operating Temperature: 275 deg F (135 deg C).

G. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 240 deg F (116 deg C).

H. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig (14 kPa).
8. Working Pressure Rating: 500 psig (3450 kPa).
9. Maximum Operating Temperature: 240 deg F (116 deg C).

2.03 REFRIGERANTS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Atofina Chemicals, Inc.
 2. DuPont Company; Fluorochemicals Div.
 3. Honeywell, Inc.; Genetron Refrigerants.
 4. INEOS Fluor Americas LLC.
- C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Suction Lines NPS 1-1/2 (DN 40) and smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

- B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR or L , annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.02 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless or packed-angle valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless or packed-angle valves on inlet and outlet side of filter dryers.
- E. Install a full-sized, three-valve bypass around filter dryers.
- F. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- G. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- H. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
 - 1. Solenoid valves.
 - 2. Thermostatic expansion valves.
 - 3. Hot-gas bypass valves.
 - 4. Compressor.
- I. Install filter dryers in liquid line between compressor and thermostatic expansion valve.
- J. Install receivers sized to accommodate pump-down charge.
- K. Install flexible connectors at compressors.

3.03 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.
- L. Install refrigerant piping in protective conduit where installed belowground.
- M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- N. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.

- O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- Q. Identify refrigerant piping and valves.
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs.
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.04 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
- F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.05 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1/2 (DN 15): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
 - 2. NPS 5/8 (DN 18): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
 - 3. NPS 1 (DN 25): Maximum span, 72 inches (1800 mm); minimum rod size, 1/4 inch (6.4 mm).
 - 4. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
 - 5. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
 - 6. NPS 2 (DN 50): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
 - 7. NPS 2-1/2 (DN 65): Maximum span, 108 inches (2700 mm); minimum rod size, 3/8 inch (9.5 mm).
- D. Support multifloor vertical runs at least at each floor.

3.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

- a. Fill system with nitrogen to the required test pressure.
- b. System shall maintain test pressure at the manifold gage throughout duration of test.
- c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
- d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.07 SYSTEM CHARGING

- A. Charge system using the following procedures:
 1. Install core in filter dryers after leak test but before evacuation.
 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
 4. Charge system with a new filter-dryer core in charging line.

3.08 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat as applicable
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 1. Open shutoff valves in condenser water circuit.
 2. Verify that compressor oil level is correct.
 3. Open compressor suction and discharge valves.
 4. Open refrigerant valves except bypass valves that are used for other purposes.
 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 15183

SECTION 15412
EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Combination emergency eyewash shower units.
 - 2. Water-tempering equipment - Thermostatic mixing valve.

1.03 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.
- D. Tepid: Moderately warm.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.
- D. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities for plumbing fixtures for people with disabilities."

1.06 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushing-Fluid Solution: Separate lot and equal to at least 200 percent of amount of solution installed for each self-contained unit.

PART 2 - PRODUCTS

2.01 COMBINATION UNITS

- A. Standard, Plumbed Emergency Shower with Eye/Face Wash Combination Units:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or approved equal product by one of the following:
 - a. Acorn Safety; a division of Acorn Engineering Company.
 - b. Bradley Corporation.
 - c. Encon Safety Products.
 - d. Guardian Equipment Co.
 - e. Haws Corporation.
 - f. Sellstrom Manufacturing Company.
 - g. Speakman Company.
 - h. WaterSaver Faucet Co.
 - 3. Piping:
 - a. Material: Stainless steel or PVC.

- b. Unit Supply: NPS 1-1/4 (DN 32) minimum
 - c. Unit Drain: Outlet at back or side near bottom.
- 4. Shower:
 - a. Capacity: Not less than 20 gpm (76 L/min.) for at least 15 minutes.
 - b. Supply Piping: NPS 1 (DN 25) with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Pull rod.
 - d. Shower Head: 8-inch- (200-mm-) minimum diameter, stainless steel or plastic.
 - e. Mounting: Pedestal.
- 5. Eye/Face Wash Unit:
 - a. Capacity: Not less than 3 gpm (11.4 L/min.) for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 (DN 15) with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Spray-Head Assembly: Two or four receptor-mounted spray heads.
 - e. Receptor: stainless-steel or plastic bowl.
 - f. Mounting: Attached shower pedestal.
 - g. Drench-Hose Option: May be provided instead of eye/face wash unit.
 - 1) Capacity: Not less than 3 gpm (11.4 L/min.) for at least 15 minutes.
 - 2) Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
 - 3) Mounting: Bracket on shower pedestal.

2.02 WATER-TEMPERING EQUIPMENT

A. Hot- and Cold-Water, Water-Tempering Equipment:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Acorn Safety; a division of Acorn Engineering Company.
 - b. Armstrong International, Inc.
 - c. Bradley Corporation.
 - d. Encon Safety Products.
 - e. Guardian Equipment Co.
 - f. Haws Corporation.
 - g. Lawler Manufacturing Co., Inc.
 - h. Leonard Valve Company.
 - i. Powers; a division of Watts Water Technologies, Inc.
 - j. Speakman Company.
- 2. Description: Factory-fabricated equipment with thermostatic mixing valve.

- a. Thermostatic Mixing Valve: Designed to provide 85 deg F (29 deg C) temperature tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F (3 deg C) throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
- b. Supply Connections: For hot and cold water.

2.03 SOURCE QUALITY CONTROL

- A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in for water piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 EMERGENCY PLUMBING FIXTURE INSTALLATION

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.
- D. Install shutoff valves in water-supply piping to fixtures. Use ball, gate, or globe valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in specification Section 22 05 23 General-Duty Valves for Plumbing Piping.
 - 1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
 - 2. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
- E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals.
- F. Install thermometers in supply and outlet piping connections to water-tempering equipment.

- G. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations.
- H. Fill self-contained fixtures with flushing fluid.

3.03 CONNECTIONS

- A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Division 22 Section "Domestic Water Piping."
- B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Division 22 Section "Domestic Water Piping."
- C. Connect cold water and electrical power to electric heating water-tempering equipment. Comply with requirements for cold-water piping specified in Division 22 Section "Domestic Water Piping."
- D. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.04 IDENTIFICATION

- A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.05 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.

- D. Prepare test and inspection reports.

3.06 ADJUSTING

- A. Adjust or replace fixture flow regulators for proper flow.
- B. Adjust equipment temperature settings.

END OF SECTION 15412

SECTION 15441 PLUMBING PUMPS

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Plumbing Pumps, as indicated, in accordance with provisions of Contract Documents.
- B. Systems Included:
 - 1. Circulating pumps.
- C. Completely coordinate with work of other trades.

1.02 QUALITY ASSURANCE

- A. Standards:
 - 1. UL 778: Motor Operated Water Pumps.

1.03 SUBMITTALS

- A. Product Data:
 - 1. Circulating pumps.
 - a. Include pump curves with point of operation indicated.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data.
 - 2. Owner instruction reports.

1.04 WARRANTY

- A. Eighteen (18) months from start-up.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Circulating pumps:
 - 1. Base:
 - a. Bell & Gossett, ITT.
 - 2. Optional:
 - a. Armstrong Pumps.
 - b. Grundfos.
 - c. Thrush.
 - d. Aurora.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.02 MATERIALS

- A. Pumps - General:
 - 1. Motors: Section 23 05 00.
 - 2. Motor data: As scheduled.
 - 3. Pump capacities: As scheduled.
 - 4. Provide disconnects.
 - 5. Provide starters for 3-phase motors.

2.03 CIRCULATING PUMPS

- A. Circulating Pumps:
 - 1. In-line centrifugal.
 - 2. Pump casing and impeller: Bronze, designed for domestic water circulating.
 - 3. Fractional-horsepower pumps: Seal-less.

PART 3 - EXECUTION

- A. Install as indicated and in accordance with manufacturer's instructions and recommendations.
- B. Furnish piping, isolation valves, check valves, and fittings per manufacturer recommendation.
- C. Provide manual isolation valves at following locations:
 - 1. On inlet and outlet of each circulating pump.
 - 2. As indicated and as required to adequately service parts of systems and equipment.
- D. Provide check valve at outlet of each pump.

END OF SECTION 15441

SECTION 15738
DUCTLESS SPLIT SYSTEM AIR CONDITIONERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Field quality-control reports. Include in the Owner's Manual a copy of the test and inspection report by the service representative at factory startup.
- E. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.
- F. Warranty: Sample of warranty.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2010.

1.05 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.06 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. For Compressor: Five years from date of Substantial Completion.
 - b. For Parts: Five years from date of Substantial Completion.
 - c. For Labor: One year from date of Substantial Completion.

1.07 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set for each fan coil unit.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.
2. Daikin Applied.
3. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
4. SANYO North America Corporation; SANYO Fisher Company.
5. Trane; a business of American Standard companies.
6. Approved equal.

2.02 INDOOR UNITS 5 TONS (18 kW) OR LESS

A. Cassette Type, Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
4. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
5. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
6. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - b. Electronically Commutated Motor (ECM)
 - c. ECM, multispeed with internal thermal protection and permanent lubrication.
 - d. Wiring Terminations: Connect motor to chassis wiring with plug connection.
7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
8. Filters: Permanent, cleanable.
9. Condensate Drain Pans:
 - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - 2) Depth: A minimum of 1 inch (25 mm) deep.
 - b. Single-wall, galvanized or stainless-steel sheet insulated with foam insulation and moisture-tight seal.

- c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end or both ends of pan.

- 1) Minimum Connection Size: NPS 1 (DN 25) .

- d. Pan-Top Surface Coating: Asphaltic waterproofing compound.

B. Wall-Mounted, Evaporator-Fan Components:

- 1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
- 2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
- 3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
- 4. Fan: Direct drive, centrifugal.
- 5. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements.
 - b. ECM, multispeed with internal thermal protection and permanent lubrication.
 - c. Enclosure Type: Totally enclosed, fan cooled.
 - d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
 - e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
 - f. Mount unit-mounted disconnect switches on exterior of unit.
 - g. Electronically Commutated Motor (ECM).
- 6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- 7. Condensate Drain Pans:
 - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - 2) Depth: A minimum of 1 inch (25 mm) deep.
 - b. Single-wall, galvanized or stainless-steel sheet insulated with foam insulation and moisture-tight seal.
 - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end or both ends of pan.
 - 1) Minimum Connection Size: NPS 1 (DN 25).

- d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
- 8. Air Filtration Section:
 - a. General Requirements for Air Filtration Section:
 - 1) Comply with NFPA 90A.
 - 2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
 - 3) Filters: Permanent, cleanable
 - 4) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors so filters are removable from one side.

2.03 OUTDOOR UNITS (5 TONS (18 kW) OR LESS)

- A. Air-Cooled, Compressor-Condenser Components:
 - 1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
 - 2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant Charge: R-410A.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.
 - 3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
 - 4. Fan: Aluminum-propeller type, directly connected to motor.
 - 5. Motor: Permanently lubricated, with integral thermal-overload protection.
 - 6. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).
 - 7. Mounting Base: Polyethylene.
 - 8. Housekeeping Pad: Concrete pad four (4) inches thick, six (6) inches greater than unit footprint on all sides.

2.04 ACCESSORIES

- A. Control Package: Factory wired, including contactor, high and low pressure cutouts, internal-winding thermostat for compressor, control circuit transformer, and noncycling reset relay, multi-unit lead/lag controls.
- B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

- C. Thermostat: Hard-wired to remotely control compressor and evaporator fan, with the following features:
 - 1. Compressor time delay.
 - 2. 24-hour time control of system stop and start.
 - 3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
 - 4. Fan-speed selection including auto setting.
- D. Control Panel: Remote mounted panel with lead/lag control alternating run time for each unit.
- E. Automatic-reset timer to prevent rapid cycling of compressor.
- F. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- G. Drain Hose: For condensate.
- H. Additional Monitoring:
 - 1. Monitor constant and variable motor loads.
 - 2. Monitor variable-frequency-drive operation.
 - 3. Monitor economizer cycle.
 - 4. Monitor cooling load.
 - 5. Monitor air distribution static pressure and ventilation air volumes.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install ground-mounted, compressor-condenser components on 4-inch (100-mm) thick, reinforced concrete base that is 6 inches (150 mm) larger, on each side, than unit. Anchor unit to concrete pad with corrosion resistant concrete compatible fasteners. Coordinate anchor installation with concrete base.
- D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.02 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.04 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 15738

SECTION 15838 HVAC POWER VENTILATORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Centrifugal roof ventilators.
 - 2. Propeller fans.

1.03 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on sea level.
- B. Operating Limits: Classify according to AMCA 99.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Field quality-control reports.

- D. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

1.06 COORDINATION

- A. Coordinate size and location of structural-steel support members.

PART 2 - PRODUCTS

2.01 CENTRIFUGAL VENTILATORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Acme Engineering & Manufacturing Corporation.
 - 2. Aerovent; a division of Twin City Fan Companies, Ltd.
 - 3. Greenheck Fan Corporation.
 - 4. Hartzell Fan Incorporated.
 - 5. JencoFan.
 - 6. Loren Cook Company.
 - 7. PennBarry.
 - 8. W.W. Grainger, Inc.; Dayton Products.
- B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
 - 1. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- D. Accessories:
 - 1. Motor Starter: With current overloads - klixon type.
 - 2. Hand-Off-Auto switch with thermostat.
 - 3. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

4. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
5. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in base; factory set to close when fan stops.

E. Capacities and Characteristics: See schedule on drawings.

2.02 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
- B. Enclosure Type: Totally enclosed, fan cooled.

2.03 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Secure wall-mounted fans to walls with cadmium-plated hardware.
- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.02 CONNECTIONS

- A. Install ducts adjacent to power ventilators to allow service and maintenance.
- B. Ground equipment according to Division 16.
- C. Connect wiring according to Division 16.

3.03 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Verify lubrication for bearings and other moving parts.
 - 5. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Prepare test and inspection reports.

3.04 ADJUSTING

- A. Lubricate bearings.

END OF SECTION 15838

Division 16 – Electrical

SECTION 16050
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 CONTRACTOR'S UNDERSTANDING

- A. Contractors bidding work under this Contract shall read and understand Division Zero and Division 1 - General Requirements. If any discrepancies are discovered between the Basic Electrical Materials and Methods and General Requirements, the above mentioned documents shall overrule this section. The Basic Electrical Materials and Methods are intended as a supplement to the above mentioned documents.
- B. The Contractor shall bid as outlined in the above mentioned Specifications and shall be governed by any alternates or unit prices called for in the form of the proposal.
- C. Each Contractor bidding on the work included in these Specifications shall view the building site and carefully examine the contract Drawings and Specifications, so that he/she may fully understand what is to be done, and to document existing conditions.

1.02 SCOPE OF WORK

- A. Work included in this section of the Specifications shall include the furnishings of all labor, material, tools, approvals, excavation, backfill, and other equipment necessary to install the electrical system as shown on the Contract Drawings and as specified herein.
- B. It also includes installation and connection of all electrical utilization equipment included in this contract but furnished by other contractors or suppliers.
- C. It is the general intent that all motors shall be furnished with the particular object of equipment it drives.
- D. The Contractor shall furnish and install all conduit, wire disconnect switches and miscellaneous material to make all electrical connections to all items of utilization equipment to wiring devices except as otherwise specified.
- E. Equipment connections shall be made with flexible or rigid conduit as required controllers for motors, disconnect switches, and all control protective and signal devices for motor circuits, except where such apparatus is furnished mounted and connected integrally with the motor driven equipment, shall be installed, connected and left in operating condition. The number and size of conductors between motors and control or protective apparatus shall be as required to obtain the operation described in these Specifications, and /or by the Contractor Documents, and/or as shown in manufacturer furnished, Engineer reviewed Shop Drawings.

- F. All devices and items of electrical equipment, including those shown on the Contract Drawings but not specifically mentioned in the Specifications or those mentioned in the Specifications but not shown on the Contract Drawings, are to be furnished under this section of the specifications. Any such device or item of equipment, if not defined in quality, shall be equal to similar Equipment and/or devices specified herein.
- G. All devices and items of equipment mentioned in this section of the Specifications whether electrical or not whether furnished under this or other Division of the Specifications shall be installed under this Division of the Specifications, unless specifically indicated otherwise.
- H. Where wiring diagrams are not shown on the Contract Drawings, they are to be provided by the supplier of the equipment served and such diagrams shall be adhered to except as herein modified.
- I. The following is a list of items that may not be defined clearly on the Contract Drawings or in other parts of these Specifications. The list is meant to be an aid to the Contractor and is not necessarily a complete list of work to be performed under this Contract: Connect all motors and accessories furnished by equipment suppliers.
 - 1. Furnish, install, and connect all motor controls.
 - 2. Furnish, install, and connect power and signal lines to all instrumentation equipment, and accessories.
 - 3. Furnish, install, and connect all electrical conduit, duct and cables.
 - 4. Furnish, install, and connect all power distribution equipment.
 - 5. Abandon and remove all existing wiring and materials not to be reused, as shown on the Contract Drawings.
- J. All raceways and wiring shall be firestopped where required by code and/or indicated in the Contract Drawings.

1.03 SHOP DRAWINGS, DESCRIPTIVE LITERATURE, INSTALLATION, OPERATION AND MAINTENANCE INFORMATION

- A. Shop Drawings including descriptive literature and/or installation, operation and maintenance instructions shall be submitted in accordance with Division 1.
- B. Shop Drawings shall be submitted on the following materials specified in Division.
 - 1. Conduit.
 - 2. Boxes - all types and sizes.
 - 3. Wiring devices.
 - 4. Device plates.
 - 5. Metal framing system (Strut type channel).
 - 6. Conduit fittings, expansion joints, support hardware.
 - 7. Motor control equipment.
 - 8. Power distribution equipment.
 - 9. Adjustable speed equipment and accessories.
 - 10. Miscellaneous spare parts and hardware.
 - 11. Wire.

- 12. Wire markers, signs and labels.
- 13. Motors.

- K. The Engineers reserves the right to make modifications to motor control and power distribution equipment ratings after Shop Drawings review, if the Shop Drawings are submitted prematurely (prematurely meaning submitted before all utilization equipment has been reviewed and accepted). Cost of modifications shall be the Contractor's responsibility.

1.04 SYMBOLS AND ABBREVIATIONS

- A. The symbols and abbreviations general follow stand electrical and architectural practice, however, exceptions to this shall be as shown on the Contract Drawings.

1.05 COORDINATION WITH OTHER TRADES

- A. The Contractor shall coordinate the electrical work with that of other trades to ensure proper final location of all electrical and/or connections. The Contractor shall verify door swings to see that light switches are located properly.

1.06 CODES

- A. The minimum standard for all work shall be the latest revision of the Kentucky Building code (KBC), Uniform Building Code (UBC) and the National Electrical Code (NEC). Whenever and wherever state and/or local laws or ordinances and/or regulations and/or the Engineer's design require a higher standard than the current NEC or KBC, then these laws and/or regulations and/or the design shall be followed.

- B. Following is a list of other applicable Standards or Codes:

1. Uniform Building Code	UBC
2. Kentucky Building Code	KBC
3. National Electrical Code	NEC
4. Factory Mutual System	FM
5. National Fire Protection Association	NFPA
6. National Electrical Manufacturers Association	NEMA
7. Occupational Safety and Health Administration	OSHA
8. Insulated Cable Engineers Association, Inc.	ICEA
9. Illuminating Engineering Society of North America	IES
10. Instrument Society of America	ISA
11. Institute of Electrical and Electronic Engineers, Inc.	IEEE
12. Certified Ballast Manufacturers Association	CMB
13. American National Standards Institution, Inc.	ANSI
14. Anti-Friction Bearing Manufacturers Association, Inc.	AFBMA
15. Joint Industry Council	JIC
16. American Society of Heating, Refrigerating And Air Conditioning Engineers, Inc.	ASHRAE
17. Federal Communications Commission	FCC
18. American Society for Testing and Materials	ASTM
19. American Wood Preservers Association	AWPA
20. Rural Electrification Association	REA

1.07 INSPECTIONS AND PERMITS

- A. Inspection of the electrical system on all construction projects is required. If the local government has appointed a state licensed inspector, the Contractor shall be required to use that person to perform the inspections. If a locally mandated inspector does not exist, the Contractor shall select and hire a state licensed inspector, who has jurisdiction before any work is concealed. The Contractor shall notify the electrical inspector in writing, immediately upon notice to proceed, and a copy of the notice shall be submitted to the Engineers.
- B. At the time of completion of the project, there shall be furnished to the Owner a certificate of compliance, from the agency having jurisdiction pursuant to all electrical work performed. The Engineer shall also receive a Photostatic copy.
- C. All costs incurred by the Contractor to execute the above mentioned requirements shall be paid by the Contractor at no extra cost to Owner.
- D. All permits necessary for the complete electrical system shall be obtained by the Contractor from the authorities governing such work. For further information, see Division 1.

1.08 STORAGE

- A. All work, equipment and materials shall be protected against dirt, water, or other injury during the period of construction.
- B. Sensitive electrical equipment such as controls, delivered to job site, shall be protected against injury or corrosion due to atmospheric conditions or physical damage by other means. Protection is interpreted to mean that equipment shall be stored under roof, in a structure properly heated in cold weather and ventilated in hot weather. Provision shall be made to control the humidity in the storage area to 50 percent relative. The stored equipment shall be inspected periodically, and if it is found that the protection is inadequate, further protective measures shall be employed. Electrical equipment other than boxes and conduit shall not be installed until the structure is under roof with doors and windows installed.

1.09 MATERIALS

- A. All materials used shall be new and at least meet the minimum standards as established by the NEC and/or National Electrical Manufacturers Association (NEMA). All materials shall be UL listed for the application, where a listing exists. Additional requirements are found in Division 1. All equipment shall meet applicable FCC requirements and restrictions.
- C. The material and equipment described herein has been specified according to a particular trade name or make to set quality standards. However, each Contractor has the right to substitute other material and equipment in lieu of that specified, other than those specifically mentioned at matching or for standardization, providing such material and equipment meets all of the requirements of those specified and is accepted, in writing by the Engineer.
- D. The reuse of salvaged electrical equipment and/or wiring will not be permitted

unless specified herein or indicated on the Contract Drawings.

- E. All salvaged or abandoned electrical materials shall become the property of the Contractor and shall be removed from the job site upon completion of the project, unless otherwise noted on the Contract Drawings or specified herein.

1.10 ERRORS, CORRECTIONS, AND/OR OMISSIONS

- A. Should a piece of utilization equipment be supplied of a different size or horsepower than shown on the Contract Drawings, the Contractor shall be responsible for installing the proper size wiring, conduit, starters, circuit breakers, etc., for proper operation of that unit and the complete electrical system at no extra cost to the Owner.
- B. It is the intent of these Specifications to provide for an electrical system installation complete in every respect, to operate in the manner and under conditions as shown in these Specifications and on the Contract Drawings. The Contractor shall notify the Engineer, in writing, of any omission or error at least 10 days prior to opening of bids. In the event of the Contractor's failure to give such notice, he/she may be required to correct work and/or furnish items omitted without additional cost. Further requirements on this subject may be found in the General Requirements, Division 1.
- C. Necessary changes or revisions in electrical work to meet any code shall be made by the Contractor without additional charge.

1.11 GUARANTEES AND WARRANTIES

- A. The Contractor shall guarantee all work including equipment, materials, and workmanship. This guarantee shall be against all defects of any of the above and shall run for a period of 1 year from the date of acceptance of the work, concurrent with the one year guarantee period designated for the general construction contract under which electrical work is performed. Date of acceptance shall be considered to be the date on which all "punch list" items are completed ("punch list" is defined to be the written listing of work that is incomplete or deficient that must be finished or replaced/repared before the Contractor receives final payment).
- B. Repair and maintenance for the guarantee period is the responsibility of the Contractor and shall include all repairs and maintenance other than that which is considered as routine.

1.12 TESTING

- A. After the wiring system is complete, and at such time as the Engineer may direct, the Contractor shall conduct an operating test for acceptance. The equipment shall be demonstrated to operate in accordance with the requirements of these Specifications and the Contract Drawings. The test shall be performed in the presence of the Engineer or his authorized representative. The Contractor shall furnish all instruments and personnel required for the tests, as well as the necessary electrical power.

- B. Before energizing the system, the Contractor shall check all connections and set all relays and instruments for proper operation.
- C. Tests may be performed by the Engineer to determine integrity of insulation on wiring circuits selected by the Engineer at random.

1.13 CLEANUP

- A. Cleanup shall be completed as soon as possible after the electrical installation is complete. All outlets, switches, motor control centers, disconnect switches and other electrical equipment shall be free of shipping tags, stickers, etc. All painted equipment shall be left free of scratches or other blemishes, such as splattered or blistered paint, etc. Surplus material, rubbish and equipment resulting from the work shall be removed from the job site by the Contractor upon completion of the work.
- B. During construction, cover all Owner equipment and furnishings subject to mechanical damage or contamination in any way.

1.14 CUTTING AND PATCHING

- A. Cutting and patching shall be held to an absolute minimum and such work shall be done only under the direction of the Engineer or Owner. The Contractor shall be responsible for and shall pay for all openings that may be required in the floors or walls, and he shall be responsible for putting said surfaces back in their original condition. Every attempt shall be made to avoid cutting reinforcing steel bars when an opening is required in a reinforced concrete wall or floor slab.

1.15 EXCAVATION AND BACKFILL

- A. Excavation for conduits shall be of sufficient width to allow for proper jointing and alignment of the type conduit used. Conduit shall be bedded on original ground. Where conduit is in solid rock, a 6 inch earth cushion must be provided. Conduit shall be laid in straight lines between pull boxes and/or structures unless otherwise notes on the Contract Drawings. The cost of solid rock excavation shall be included in the lump sum bid with no extra pay allowed (unclassified).
- B. Backfill shall be hand placed, loose granular earth for a height of 6 inches above the top of the largest conduit. This material shall be free of rocks over 2 inches in diameter. Above this, large rocks may be included but must be mixed with sufficient earth to fill all voids.

1.16 SLEEVES, CHASES AND OPENING

- A. It is the Contractor's responsibility to leave openings to allow installation of the complete, operational electrical system. Openings required but not left shall be cut as outlined under cutting and patching. The Contractor shall coordinate all holes and other openings with necessary diameters for proper fire stopping.

1.17 OVERCURRENT PROTECTION

- A. Circuit breakers shall be the size and type as written herein and shown on the

Contract Drawings. Any additional overcurrent protection required to maintain an equipment listing by an authority having jurisdiction shall be installed by the Contractor at no extra cost to the Owner.

- B. The Contractor shall submit to the Engineer actual nameplate data from motors shipped to the site, stating motor identification as well as characteristics. Overload relay thermal unit selection tables shall accompany the motor data. The Engineer will select thermal unit sizes from this data for use by the Contractor in ordering proper thermal units.

1.18 AS BUILT DRAWINGS

- A. The Contractor shall maintain 1 set of the Contract Drawings on the job in good condition for examination at all times. The Contractor's qualified representative shall enter upon these drawings, from day to day, the actual "as-built" record of construction and/or alteration progress. Entries and notes shall be made in a neat and legible manner and these drawings delivered to the Engineer after completion of the construction, for use in preparation of Record Drawings.

1.19 MAINTAINING CONTINUOUS ELECTRICAL SYSTEM AND SERVICE

- A. Existing service(s) continuity shall be maintained at all times. In no way shall the installation and/or alteration of the electrical work interfere with or stop the normal operation of the existing facilities, except where prior arrangements have been made
- B. When additions and taps to existing service(s) require electrical outages of duration in excess of a few minutes, arrangements shall be made in advance for such outages. All outages shall be held to an acceptable minimum with none exceeding 2 hours continuous duration. If necessary, cuts shall be performed on premium time. If performed at night, requiring a general outage, the Contractor shall furnish an auxiliary source of light and power as required. Under no circumstances shall an electrical outage of any duration be initiated until the Owner and Engineer have concurred, and as far as possible in advance.

1.20 GROUNDING AND BONDING

- A. All metallic conduit, cabinets, and equipment shall be grounded in accordance with the latest issue of the National Electrical Code. All supporting framework and other metal or metal clad equipment or materials which are in contact with electrical conduit, cable and/or enclosures shall be properly grounded to meet the code requirements.

1.21 RELATED SPECIFICATION DIVISIONS

The following divisions contain Specifications on utilization equipment, equipment accessories, and procedures related to execution of the electrical work, and are included here for the Contractor's information. Bids shall still be based on complete Contract Documents.

Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract
Division 1 - General Requirements
Division 2 - Site work

Division 3 - Concrete
Division 11 - Equipment
Division 15 - Mechanical

1.22 CONTRACTOR LICENSING

- A. The Contractor performing the electrical work on this project shall be locally licensed, if required by local law or ordinance. If the Contractor has passed the State test, it may not be necessary to meet local testing requirements. It shall be the Contractor's responsibility to investigate these requirements and comply with same.

1.23 ANCHORING/MOUNTING

- A. Electrical conduits and/or equipment shall be rigidly supported. Anchors used shall be metallic expansion type, or if appropriate to prevent spalling concrete, epoxy set type. Plastic or explosive type anchors are prohibited.
- B. Since this project is in Seismic Zone, the Contractor shall be sure that all supports are consistent with the KBC requirements in this regard.

1.24 ELECTRICAL COMPONENT MOUNTING HEIGHTS

- A. Unless otherwise indicated, mounting height for components shall be as defined herein. In cases of conflicts with architectural or structural aspects, the components may be relocated. If an indicated height conflicts with a code requirement, the code shall govern.
- B. Mounting heights are given from finished floor elevation to the centerline of the component, unless otherwise noted.

Component	Height	Comments
1. Push-button or control stations	4'-0"	
2. Top of panel boards or control panels	6'-6"	Maximum (except for handicapped areas)
3. Top of local motor controller	6'-0"	Maximum
4. Top of local disconnect switch	6'-0"	Maximum

In situations where there appears to be a conflict with Americans with Disabilities Act (ADA) legislation, utilize the ADA requirements herein.

1.25 RECEIPTS

- A. Some sections of the Specifications call for equipment, materials, accessories, etc. to be provided and "turned over to the Owner" or like requirements. The Contractor shall obtain a receipt for each item turned over, signed by the Owner or his representative. A copy of this receipt shall be transmitted to the Engineer.
- B. When a question arises concerning whether items have been turned over to the Owner, and there is no signed receipt, it may be assumed that the items were not provided.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

Not Applicable.

END OF SECTION-16050

SECTION 16070 SUPPORTING DEVICES

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. All electric equipment shall be rigidly mounted, and installed using supporting devices as indicated on the Contract Drawings, as required by the work, and described herein.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. "Cooper B-Line," "Unistrut," or equal.

2.02 MATERIALS

- A. All mounting brackets and strut used outside shall be aluminum. Fasteners used to mount equipment outside shall be stainless steel.
- B. All mounting brackets and strut used inside in dry locations shall be galvanized or aluminum, if galvanized is used, then the cut ends shall be cold galvanized and painted. Fasteners used inside to mount equipment into concrete shall also be stainless steel. Ungalvanized strut is prohibited.
- C. In all interior wet locations mounting strut shall be aluminum or stainless steel, with stainless steel mounting hardware.
- D. Mounting brackets strut, and support hardware in chemical feed areas shall be non-metallic, fiberglass resin.

PART 3 - EXECUTION

3.01 ANCHORING CABINETRY

- A. All free standing equipment shall be anchored to its foundation using expansion bolts of the size and number recommended by the equipment manufacturer.

3.02 SEISMIC CONSIDERATIONS

- A. Where required, seismic restraints shall be provided for electrical equipment.

END OF SECTION-16070

SECTION 16075 ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 EQUIPMENT LABELING

- A. All feeder units in panel boards, disconnects, instruments, etc. shall be marked to indicate the motor, outlet, circuit they control, or variable monitored. Marking is to be done with engraved laminated nameplates and shall bear the designation shown on the Contract Drawings where this information is given. Nameplates shall be fastened to equipment with stainless steel screws, minimum of one each side. In no way shall the installation of mounting screws void the NEMA enclosure rating of the equipment in which they are installed. If there are more than one identical unit, they shall be given consecutive numbers or other descriptions as designated by the Engineer. Nameplate background color shall be white, with black engraved letters, unless otherwise noted.
- B. Branch circuits in lighting panels shall be typed on a card suitable for the card frame furnished with the panel. The card shall bear the panel designation listed on the Contract Drawings where this information is given, as well as indicate what each circuit controls.
- C. All electrical equipment shall be marked for arc flash hazard in accordance with NEC Article 110.16.
- D. See Section 16710, Communication Systems, for additional labeling requirements.

PART 2 - PRODUCTS

Not applicable

PART 3 - EXECUTION

Not applicable

END OF SECTION-16075

SECTION 16120 CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Wire and cable shall conform to the latest requirements of the NEC and shall meet all ASTM/UL specifications. Wire and cable shall be new; shall have size, grade of insulation, voltage rating and manufacturer's name permanently marked on the outer covering at regular intervals. Complete descriptive literature shall be submitted to the Engineer for review and acceptance prior to installation.

1.02 DELIVERY, STORAGE AND HANDLING

- A. Wire and cable shall be suitably protected from weather and damage during storage and handling and shall be in first class condition when installed.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Building Wire (types "THWN" and "THW"-cu.) - "American," "Carol," or equal.
- B. Instrumentation Cables (Shielded) 600V mx. - "American," "Belden," "Okonite," or equal.

2.02 MATERIALS

- A. General
 - a. In general, all conductors shall be 98 percent conductive, annealed copper unless otherwise noted on the Contract Drawings.
 - b. Conductors shall be type THW or THWN insulation. Conductor size shall be AWG (American Wire Gauge) Standard. Minimum conductor size shall be AWG number 12 except branch circuits in excess of 75 feet from panel to first outlet not smaller than no. 10 AWG. Minimum voltage rating shall be 600 volts. Conductors for small power may be solid (i.e. lighting, receptacles), but conductors for control work shall be stranded.
 - c. Conductors with high temperature rated insulations and special construction shall be used where required in connecting to light fixtures or appliances that have special requirements.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

- A. General

- a. Conductors shall be continuous from outlet to outlet and no splices shall be made except accessible in junction or outlet boxes. Wire connectors of insulating material or solderless pressure connectors, properly taped, shall be used for all splices in wiring, wherever possible.
- b. Conductors shall be color coded in accordance with the following schedule:

	480/277V 3 Phase	208/240V 3 Phase
Phase A	Brown	Black
Phase B	Orange	Red
Phase C	Yellow	Blue
Neutral (Grounded)	White or Light Gray	White or Light Gray
Grounding	Green	Green

- c. Conductors shall be pulled into raceways in strict accordance with manufacturer's recommendations.
- d. Ample slack conductors shall be allowed at each terminal point, and pull or junction box, to permit installation with ease and without crowding.
- e. All conductors terminating at terminal blocks shall be identified with numbers and/or letters identical to circuit or control identification.
- f. No conductors shall be drawn into conduits until all work which may cause wire or cable damage is completed. Wire pulling shall be accomplished utilizing machinery and accessories intended for the purpose.
- g. All connections and splices shall be made in accordance with conductor manufacturer's recommendations, and as written herein.
- h. In general, feeder sizes shown are based on no more than three current carrying conductors in a conduit. Multiple small branch circuit feeders may be combined in a common conduit, provided conductors are derated in accordance with NEC article 310-15.
- i. Unless otherwise specifically indicated, neutrals may not be shared.

B. Feeders

- a. All feeders are of the secondary type, below 600 volts, unless otherwise noted. The Contractor shall furnish and install all feeders from the distribution center(s) to each of the other structures/sub panels as shown on the Contract Drawings.
- b. Wire shall be factory color coded for each phase and neutral, with green used for the ground conductor. As far as practical, all feeders shall be continuous from origin to panel termination without running splices in intermediate pull boxes.

C. Instrument Cable

- a. General

1. All signal lines shall be constructed of individually twisted pairs (6 to 10 twists per foot), including thermocouple extension leads. Cables shall be made of twisted pairs, with all lays and pairs twisted in the same direction for maximum flexibility.
 2. Wire size shall be #16 AWG minimum for exterior runs and lengths over 5,000 feet. Wire size may be #18 AWG for interior under 5,000 feet in length.
 3. Stranded tinned copper conductor shall be used for all wiring other than thermocouple extension leads.
 4. Insulation resistance at 68 degrees Fahrenheit between conductors and between conductors and ground should be at least 500 megohms per 1,000 feet.
 5. Multi-pair cable should be jacketed with poly-vinyl-chloride, polyethylene or Teflon at least 0.045" thick. Voltage rating shall be 600 volts.
- b. Signal Wiring
1. Low level analog (less than 500 millivolt d-c). Use twisted pairs which may be cabled with other pairs carrying similar voltage levels. Foil wraps or equivalent shielding is required for each cable with the shield insulated from ground.
 2. High level analog (greater than 500 millivolts d-c). Use twisted pairs which may be cabled with other pairs carrying similar voltage levels and current levels less than 100 ma. Shielding is required.
 3. Analog outputs (normally 0-4 d-c or 4-20 ma). Same as b.
 4. Contact inputs - use twisted pairs and run in separate conduit.
 5. Contact outputs - same as d.
 6. Pulse inputs - same as 4.
- c. Signal and Shield Grounding
1. All shields must be grounded at one point only as close as possible to the signal source.
 2. Thermocouples may be grounded or ungrounded.
 3. Analog signals, if grounded, should be grounded as near the signal source as possible.
 4. Resistance bulbs should not be grounded.
- d. Signal and Wiring Separation
1. High level analog signals may share the same conduit or run with contact or pulse signals.
 2. Thermocouple and low level signals should be run in a separate conduit.
 3. A minimum separation of 12 inches between analog signal leads and a-c power leads should be maintained. For a-c power leads carrying 100 amps or greater, a 24 inch separation should be maintained. Parallel runs should be limited to less than 500 feet. Perpendicular runs may be as close as 6 inches.

3.02 TESTING

- A. Testing Agency: The Contractor shall engage a qualified testing agency to perform tests and inspections and prepare tests reports.

- B. Perform tests and inspections and prepare test reports.
- C. Test and Inspections
 - a. After installing conductors and cables and before electrical circuitry has been energized, test all new feeders and control wiring for compliance with requirements.
 - b. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - c. Infrared Scanning: After substantial completion, but not more than 60 days after final acceptance, perform an infrared scan of each splice in cables and conductors #3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
- D. Test Reports: Prepare a written report record the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- E. Remove and replace wiring and/or splices that do not meet the NETA criteria for the given circuit type and retest as specified above.

END OF SECTION-16120

SECTION 16130 RACEWAYS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This section of the Technical Specifications includes all raceways for accommodation of electrical conductors, communications conductors, sleeves for underground electrical installations, conduit stubs for future installations, fittings therefore and accessories.
- B. All raceways shall be marked with the manufacturer's name or trademark as well as type of raceway and size. This marking shall appear at least once every 10 feet and shall be of sufficient durability to withstand the environment involved. All raceways shall be furnished and installed as outlined under Part 3 of this Specification.
- C. All raceways and fittings shall be painted to match existing or surrounding surfaces except in mechanical spaces.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Tubular Raceways
 - a. Steel, Galvanized, Rigid, Heavy-Wall, Threaded - "Wheatland Tube Co.," "Thomas and Betts," "Allied Tube & Conduit Corp.," or equal.
 - b. Aluminum, Rigid, Heavy-Wall, Threaded - "Wheatland Tube Co.," "Thomas and Betts," "Allied Tube & Conduit Corp.," or equal.
 - c. Plastic (PVC); Type 80 (or Schedule 80) (Heavy -Wall) - "Allied Tube & Conduit Corp.," "Carlson," or equal.
 - d. Flexible Metal Conduit - "Thomas and Betts," "Allied Tube & Conduit Corp.," or equal.
 - e. Liquidtight Flexible Metal Conduit - "Thomas and Betts," "Allied Tube & Conduit Corp.," "Carlson," or equal.
 - f. PVC Coated Rigid Steel - "Robroy", or equal.
 - g. Fiberglass Reinforced Epoxy - "FRE Composites," or equal.
- B. Raceway Fittings
 - a. Conduit fittings - "Crouse-Hinds," "Appleton," "OZ Gedney," or equal.
 - b. Non-metallic conduit fittings - "Carlson," or equal.
 - c. PVC coated rigid steel fittings shall be provided by the conduit manufacturer.
 - d. Flexible conduit fittings - "Raco," "T & B," "OZ Gedney," or equal.

2.02 MATERIALS

A. Aluminum Conduit

- a. Aluminum conduit shall be extruded from alloy 6063 and shall be the rigid type, non-toxic, corrosion resistant, and non-staining. It shall be manufactured per UL standards as well as listed/labeled by same.
- b. Fittings, boxes, and accessories used in conjunction with aluminum conduit shall be die cast, copper free type. They shall be resistant to both chemical and galvanic corrosion. All covers shall have neoprene gaskets.
- c. Aluminum conduit proposed for concrete slab or underground applications shall be UL listed for the purpose and factory pre-coated.

B. Rigid Steel Conduit

- a. Rigid steel conduit and fittings shall be of mild steel piping, galvanized inside and out, and shall conform to UL standards. The conduit and fittings shall be listed and labeled by UL as well. It shall have an accurate circular cross section, a uniform wall thickness, and a continuously welded seam. The interior and exterior surfaces shall be thoroughly and evenly coated with zinc using the hot-dip galvanizing process, so that metal-to-metal contact and galvanic protection against corrosion are provided. A clear coating of zinc chromate shall also be applied. Galvanizing shall be applied to the conduit threads as well. Each piece of conduit shall be straight, free from blisters and other defects, cut square, and taper reamed. It shall be delivered with plastic protectors on the threads.

C. Polyvinylchloride (PVC) Conduit

- a. PVC conduit and fittings shall be Schedule 80 heavy wall, as indicated in these Specifications manufactured to conform to UL standards. It shall be listed and labeled by UL. It shall have at least the same temperature rating as the conductor insulation. Expansion joints shall be used as recommended by the manufacturer in published literature. PVC systems shall be 90 degrees Celsius minimum UL rated, have a tensile strength of 7,000 psi @ 73.4 degrees Fahrenheit, flexural strength of 11,000 psi and compressive strength of 8,000 psi.

D. Flexible Conduit

- a. Flexible metallic conduit in dry, non-hazardous locations shall be constructed from flexibly or spirally wound electro-galvanized steel. Connections shall be by means of galvanized malleable iron squeeze type fittings.
- b. Liquidtight flexible metallic conduit shall be constructed from continuously interlocked aluminum core. It shall have a sunlight and oil resistant thermoplastic PVC jacket. It shall be IP 66/67 rated, and rated for temperatures -4 degrees F to 176 degrees F. Fittings shall be 304 stainless steel with gland nut, sealing ring, and high tensile grounding cone and body, and shall have an insulated throat. Stainless steel lock nut shall be provided for connection to boxes. Fittings shall be listed for Class I, Division 2 and Class II, Division 1 and 2 hazardous locations.

E. PVC Coated Rigid Conduit

- a. PVC coated rigid conduit shall be hot dip galvanized prior to PVC coating. All threads shall be galvanized. The exterior galvanized surface shall be coated with a primer prior to PVC coating to insure adhesion. The bond on conduit and fittings shall be greater than the tensile strength of the plastic coating. The PVC coating on the exterior of the conduits shall be applied by a plastisol dip method to a nominal thickness of 40 mils, minimum. The interior of the conduit and fittings, and threads shall be painted with a urethane coating. The coating shall allow flexibility for field bending without cracking. PVC sleeves shall be formed at each female opening, with the inside diameter of the sleeve matching the outside of the conduit.

F. Fiberglass Reinforced Epoxy Conduit

- a. Conduit and fittings shall consist of continuous E-glass roving encapsulated in an internally steam cured, corrosion resistant epoxy resin bases system manufactured for use for use at temperatures from 40°F to +230°F. All conduit and fittings will be pigmented with UV inhibiting carbon black dispersed homogeneously throughout the epoxy resin based system. Conduit shall not contain chlorine, halogen gases or other toxic materials in excess of trace levels and always less than safe OSHA limits. The conduit shall be filament wound with a computer controlled filament winder on a polished steel mandrel and cured internally with steam at temperatures in excess of 300°F. The conduit must be 100% cured. The exterior surface finish shall be smooth and normal with good filament winding practice and shall be limited in magnitude such that the O.D. will be in allowable limits. The roughness shall be no greater than 2,000 micro-inches. The inside surface shall have a roughness less than 125 micro-inches with an average value of 63 micro-inches.
- b. Conduit and fittings shall be free from all defects and commercially practicable in color, opacity, density and other physical properties. All fittings, adapters, and bends shall be constructed of the same filament wound materials as the conduit and will be in accordance with UL Requirements. All fittings with an integral bell must contain a tri-seal gasket unless adhesive bonding is used.
- c. The epoxy resin based system shall be design to meet UL 1684-96 for flame retardance. Conduit shall have tensile strength of $\geq 9,000$ psi in accordance with ASTM-D-2105. Thermal characteristics shall be in conformance with ASTM-C-335, ASTM-D696, and ASTM-C-335. Flammability shall be in accordance with UL 1684-96. Conduit and fittings shall bear nationally accepted testing laboratory approval per Harmonized C.S.A. C22.2 No. 211.3-96 file no. LR28032 and UL 1684-96 file no. E53373N for above ground conduit and 44G7 for fittings.
- d. Each length of conduit shall be supplied with an integral bell and spigot with an integral urethane tri-seal gasket held in place with a retainer ring for sealing. No threads or adhesives shall be required to assemble the joints for above ground installation. Minimum pull out force for the tri-seal joint is 400lbs. Should joint be used with adhesive, it shall be supplied by the manufacturer of the conduit and shall meet UL 1684-96 (5.9 Joint separation) such as be subjected to an axial pull of 6670N (1500 lbf) applied for 1 minute.

G. Conduit Fittings

a. Rigid Steel Conduit Fittings

1. Standard threaded couplings, locknuts, bushings, and elbows made only of steel or malleable iron are acceptable. Integral retractable type IMC couplings are acceptable also.
2. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
3. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
4. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted or use to complete a conduit run where conduit is installed in concrete. Use set screws of case hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
5. Sealing fittings: Threaded copper free aluminum. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, installed fittings in flush steel boxes with blank coverplates having the same finishes as that of other electrical plates in the room.
6. Fittings for PVC coated rigid conduit shall be manufactured by the maker of the conduit.

b. Rigid Aluminum Conduit Fittings

1. Standard threaded couplings, locknuts, bushings, and elbows: Malleable iron, steel or aluminum alloy materials. Zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.4 percent copper are prohibited.
2. Locknuts and bushings: As specified for rigid steel and IMC conduit.
3. Set screw fittings: Not permitted for use with aluminum conduit.

c. Expansion and Deflection Couplings

1. Accommodate 1.9 cm (0.75 inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
2. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL, and the NEC code tables for ground conductors.
3. Watertight, seismically qualified, corrosion-resistant, threaded for and compatible with rigid metal conduit.
4. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material and stainless steel jacket clamps.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Exterior underground metallic conduits shall be degreased, pretreated, and coated with 2 coats of Carboline 888 epoxy, or equal.

3.02 INSTALLATION

A. Conduit

- a. All conduit shall be installed in a first class workmanship manner. It shall be installed in horizontal and vertical runs in such a manner as to ensure against trouble from the collection of trapped condensation and shall be arranged so as to be devoid of traps wherever possible. Special care shall be used in assuring that exposed conduit runs are parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. No open wiring is allowed.
- b. Fittings or symmetrical bends shall be required wherever right angle turns are made in exposed work. Bends and offsets shall be avoided wherever possible, but where necessary, they shall be made with an approved conduit bending machine. All conduit joints shall be cut square, reamed smooth and drawn up tight, using couplings intended for the purpose.
- c. Conduits shall be securely fastened to all sheet metal outlets, junction and pull boxes with double galvanized locknuts and insulating-grounding bushings as required by the NEC. Runs of exposed conduit shall be supported in accordance with the NEC using cast aluminum or malleable iron one hole pipe straps with spacers to provide an air space behind the conduit. All conduit in walls and slabs shall be securely braced, capped, and fastened to the forms to prevent dislodgement during vibration and pouring of concrete.
- d. During construction, all conduit work shall be protected to prevent lodgement of dirt, plaster or trash in conduits, fittings or boxes. Conduits which have been plugged shall be entirely freed of accumulations or be replaced. All conduits in floors or below grade shall be swabbed free of debris and moisture before wires are pulled. Crushed or deformed conduit shall not be permitted.
- e. The final section of conduit connecting each motor or piece of utilization equipment subject to vibration shall be of the flexible type. Type "UA" shall be used in all process areas and in outdoor or wet locations. Flexible conduit to space heaters shall be long enough to allow swivel action.
- f. All underground conduits entering a building or enclosure shall be sealed against water/condensate entering around the conductors. Sealant shall be Polywater FST duct sealant.
- g. Conduit expansion fittings shall be provided in exposed vertical conduit runs between underground transition and termination into an exterior enclosure or LB fitting. Expansion fittings shall also be provided in all exposed exterior conduit lengths of more than 50ft.
- h. Conduits to electrical enclosures installed below grade shall be sealed using Polywater FST duct sealant.
- i. All conduit to be added to an existing structure shall be exposed in unfinished and process areas. Where new devices are shown in existing walls in finished spaces, every attempt shall be made to conceal the conduit, by fishing flexible conduit through walls from ceiling cavities.
- j. Conduits entering from underground into buildings shall be watertight through the wall, both inside and outside.
- k. PVC conduit installed underground for low voltage application shall be schedule 80 without encasement. Where PVC conduit is installed, transition shall be made to GRS conduit at bends where wire pulling could cut conduit.
- l. Aluminum conduit shall not be used underground, in chlorine, or placed in

concrete slabs.

- m. All metal raceway systems shall be grounding conductive, solidly bonded throughout and grounded in accordance with NEC requirements and/or as noted on the Contract Drawings. In addition, all raceway systems shall be provided with separate grounding conductors.
- n. **Minimum conduit size shall be ¾ inch.** The following table shows the minimum burial depth required for all exterior conduit or cable:

Schedule 80 PVC 30”

- o. Maximum conduit burial depth shall be 60” unless otherwise indicated or agreed on a case-by-case basis.
- p. Wire pulling shall be facilitated by the use of a UL approved pulling compound in pulls over 30 feet in length or where there are 2 or more 90 degree bends. Only polypropylene, nylon, or manila pulling ropes will be permitted. **Standard industry recognized wire pulling equipment shall be used.**
- q. All conduits entering and leaving instrument enclosures shall be sealed around the wires with silicone caulk.
- r. Areas of use for each type of conduit:

Space Description	Schedule 80 PVC	GRS	Aluminum	PVC Coated GRS	FRE
Interior Finished Spaces (Concealed Only)		X	X		
Interior Finished Spaces - Exposed (Where Specifically Indicated Only)		X	X		
Electrical Rooms		X	X	X	
Process Rooms (Except as Noted Otherwise)			X	X	
Chemical Feed Rooms	X				
Filter Galleries					X
Exterior Exposed			X	X	
Exterior Underground Direct Bury	X	X			

- s. Underground raceways (conduit) shall be concrete encased where they pass over or under obstructions, such as: sidewalks; roadways; piping; etc.
- t. All conduit shall have an insulated ground wire pulled to all equipment and receptacles.
- u. All raceway runs are shown diagrammatically to outline the general routing of the raceway. The installation shall be made to avoid interference with pipes, ducts, structural members or other equipment. Should structural or other interference prevent the installation of the raceways, or setting of boxes,

cabinets, or the electrical equipment, as indicated in the Drawings, deviations must be approved by the Owner, and after approval, shall be made without additional charges and shown on the Record Drawings.

- v. Fire Stop: Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between raceways and openings with the fire stop material.
- w. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
- x. No conduit shall be run exposed across roofs without first obtaining permission from the Engineer.
- y. Conduit may be run inside concrete slabs as long as the slab is at least 6-inches thick and conduit will have at least 2-inches of cover on both sides.
- z. Flexible conduit used in mechanical rooms shall be liquid tight.
- aa. Runs of flexible conduit above accessible ceilings shall be limited to 10 ft. Runs of exposed flexible conduit shall be limited to 5 ft. All runs of flexible conduit shall be supported in accordance with NEC requirements.
- bb. Communications conduits shall utilize minimum 15 inch radius for all bends. LB's may not be used for communications conduits. Communications ductbanks shall have marker tape installed in trench directly above, at 12 inch below grade.

END OF SECTION-16130

SECTION 16131 BOXES

PART 1 - GENERAL

1.01 SCOPE OF WORK

Outlet and junction boxes shall be furnished and installed where indicated on the Contract Drawings, and/or as required by the work in accordance with the NEC.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Boxes - "Wiegmann," "Appleton," "Raco," "Crouse-Hinds," "Hoffman," "Robroy Industries," "Cloud Concrete Products," "Spring City," "Carlson," or equal.

2.02 GENERAL

- A. All junction and/or pull boxes for dry (non-corrosive) areas shall be of code gauge sheet metal construction, of the inside dimensions as required by code, with covers.
- B. Junction and/or pull boxes for wet or damp locations shall be cast metal, rust and corrosion resistant (NEMA 4X), with at least 5-1/2 full threads for each (bossed) conduit opening, and shall be suitable for flush or surface mounting as required with drilled external, cast mounting extensions (bossed to provide at least 1/8" between back of box and mounting surface for drainage). Box covers shall be hinged or cap screw retained as required, of the same material as the box and provided with stainless steel (rustproof) hardware.
- C. Junction boxes for out-of-doors use, not mounted in concrete may be sheet metal (NEMA 4X), waterproof, rustproof, rain and sleetproof, with hinged covers and latches and provided means of locking by means of keyed locks, tamper-resistant screws or padlocking as required and with clamping cap-screws top and bottom door edges to provide firm contact with gasketing. All gaskets shall be molded (unbroken) neoprene or butyl rubber.
- D. NEMA 4X junction and/or pull boxes shall be stainless steel, or non-metallic as called for on the Contract Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION, APPLICATION, AND ERECTION

- A. General
 - 1. Outlets shall be installed in the locations shown on the Contract Drawings. When necessary, the Contractor shall relocate outlets so that when fixtures or other

fittings are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment.

2. All supports for outlet boxes shall be furnished and installed by the electrical trades.
- B. Exposed Work
1. Outlet or junction boxes for use with exposed steel conduit shall be cast steel. In dry areas sheet steel with rounded corners, made for the purpose.
 2. Outlet or junction boxes for use with exposed aluminum conduit shall be copper free, cast aluminum type.
 3. Outlet or junction boxes for use with exposed PVC conduit shall be PVC.
- C. Pull Boxes
1. Interior pull boxes in dry areas shall be of code gauge steel of not less than the minimum required by the NEC and shall be provided with hinged covers. In wet areas, they shall be rated watertight, of stainless steel. In corrosive areas, they shall be watertight non-metallic PVC or fiberglass. Hardware shall be stainless steel.
- D. Openings in Electrical Boxes
1. All openings in electrical equipment, enclosures, cabinets, outlet and junction boxes shall be by means of welded bosses, standard knockouts, or shall be sawed, drilled, or punched with tools specially made for the purpose. The use of a cutting torch is prohibited. Unused openings shall be plugged per the NEC.

END OF SECTION - 16131

SECTION 16140 WIRING DEVICES

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Wiring devices shall be installed where indicated on the Contract Drawings.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. "Hubbell," "Bryant," "Eagle," "Wiremold," "P&S," "Leviton," "Daniel Woodhead," or equal.

2.02 EQUIPMENT

- A. General
 - 1. Specialty cord and plug devices shall be equipped with the proper cord and plug for receptacles.
- B. Receptacles
 - 1. Twin-convenience - weatherproof outlet (interior) - "Hubbell" cat. no. HBL-5362 ("I" for ivory) with HBL-5221 or equal cover.
 - 2. Ground fault interrupting receptacles shall be required where shown on the Contract Drawings, and shall be indicated by the abbreviation "GFI" beside the circuit symbol on the Contract Drawings. They shall be rated 20 amps (125 volts) and shall be of the duplex, feed through type, capable of protecting all downstream receptacles on the same circuit. They shall be UL listed and interrupt the current between 4-6 milliamps of ground fault leakage. Appropriate plates shall be furnished and installed. The 20 ampere rating shall apply not only to device internals but to the faceplate as well. GFI receptacles shall be "Hubbell" cat. no. GFR8300HIL, or equal.
- C. Wall Switches (Tumbler Type)
 - 1. Single pole (interior) - "Hubbell" cat. no. HBL-1221 ("I" for ivory), or equal.
 - 2. Single pole (weatherproof) - "Hubbell" cat. no. HBL-1221 ("I" for ivory), or equal, and HBL-1795 or equal plate.
- D. Plates and Covers
 - 1. Furnish and install plates of the appropriate type and size for all wiring and control devices, signal outlets.
 - 2. All plates on flush and surface mounted boxes shall be of 302 stainless steel (nonmagnetic) with rounded or beveled edges, except where weatherproof covers are indicated. All device plate screws shall be nylon or stainless steel with countersunk heads. Plates shall be installed vertically and with an

alignment tolerance of 1/16 inch. Device plates shall be of the one-piece type, of suitable shape for the devices to be covered. Plates shall have a smooth finish with no crevices to collect dirt. Oversize plates are not acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Wall Switches

1. Wall switches shall be mounted at a height as indicated in Section 16050, unless otherwise noted on the Contract Drawings.

B. Receptacles

1. Outlets shall be located as shown on the Contract Drawings. Where located in special interior finishes, they shall be properly centered. Boxes shall be of the type noted and accepted for the specific installation.
2. Furnish and install receptacle circuits where called for on the Contract Drawings and/or by these Specifications. Circuits shall be installed in conduit from panel to receptacle, with flush mounted boxes except as noted on the Contract Drawings.
3. Receptacles and lighting circuits shall not be combined on the same overcurrent device. For runs over 75 feet or for 30 amp receptacles, minimum wire size shall be AWG No. 10.
4. Receptacles for specific devices (i.e., air conditioner), shall be rated at the correct voltage and amperage for that unit.
5. The minimum free length of conductor at each box for the connection of a fixture, switch or receptacle shall be 8 inches. All connections shall be made mechanically and electrically secure.
6. Receptacles shall be duplex type, rated at 20 amps, 125 volts, ivory colored, unless otherwise noted. Mounting height shall be as specified for low outlets in Section 16050, unless otherwise indicated. All receptacles shall be of the grounding type.
7. Receptacles at medium or high mountings shall be mounted so that the grounding slot is below the neutral and hot. All other receptacles shall be mounted with the grounding slot above the neutral and hot.
8. Exterior weatherproof receptacles shall be weatherproof while in use. This requirement shall apply on all outdoor units, indoor weatherproof receptacles for specific equipment (i.e., metering pump) and on others as indicated on the Drawings. To meet this requirement, appropriate metal safety outlet covers as manufactured by Taymac Corporation, Intermatic, or equal shall be utilized in these areas. Non-metallic cover shall be used in and around chemical areas/rooms.

END OF SECTION-16140

SECTION 16150
WIRE CONNECTIONS AND CONNECTING DEVICES

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Wire connection and connecting devices shall be as herein specified.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Connectors, Lugs, etc. - "T & B", "Anderson", "Burndy", or equal.
- B. Termination and splice connectors - "3M Scotchlok", "Anderson", "T & B", "Burndy", or equal.

2.02 MATERIALS

- A. Wire Splicing and Terminations (600 Volts and Below)
 - 1. Electrical Terminal and Splice Connectors (#22 - #4 AWG)
 - a. Terminals and splice connectors from #22 - #4 AWG shall be compression types with barrels to provide maximum conductor contact and tensile strength. Performance, construction, and materials shall be in conformance with UL standards for wire connectors and rated for 600 volts and 105 degrees Celsius.
 - b. Connectors shall be manufactured from high conductivity copper and entirely tin plated. Terminal barrels shall be serrated on the inside surface and have a chamfered conductor entry. Terminals shall have funnel entry construction to prevent strand fold-back. All barrels shall be brazed seam or seamless construction.
 - c. Spade type terminals shall be sized for the appropriate stud and shall be locking type that snap firmly onto studs with a close fit for maximum retention. Spade type terminals shall be insulated with an insulation suitable for maintaining a high dielectric strength when crimped and be made from nylon, PVC, or equal.
 - 2. Electrical Lugs and Connectors (#6 AWG - 1000 Kcmil)
 - a. Lugs and splice connectors from #6 AWG - 1000 Kcmil shall be compression types with barrels to provide maximum conductor contact and tensile strength. They shall be manufactured from high conductivity copper and entirely tin plated. They shall be crimped with standard industry tooling. The lugs and connectors must have a current carrying capacity equal to the conductors for which they are rated and must also meet all UL requirements. All lugs above 4/0 AWG shall be 2 hole lugs with NEMA spacing. The lugs shall be rated for operation through 35 KV. The lugs

- shall be of closed end construction to exclude moisture migration into the cable conductor.
3. Twist-on Wire Connectors (#22 AWG - #10 AWG)
 - a. All twist-on wire connectors must have a corrosion resistant spring that is free to expand within a steel jacket. The steel jacket must be insulated with a flexible vinyl jacket capable of withstanding 105 degrees Celsius ambient temperatures and of sufficient length to cover wires that are inadvertently overstripped.
 - b. Each connector size must be listed by UL for the intended purpose and color coded to assure that the proper size is used on the wire combinations to be spliced. The connectors must be compatible with all common rubber and thermoplastic wire insulations.
 4. Solderless/re-usable lugs shall be used only when furnished with equipment such as control panels, furnished by others, where specification of compression type lugs is beyond the Contractor's control. In the event their use is necessary, the Contractor shall be responsible for assuring that they are manufactured to NEMA standards, with proper number and spacing of holes and set screws.

PART 3 - EXECUTION

3.01 INSTALLATION, APPLICATION, & ERECTION

A. Insulation of Splices and Connections

1. Connections/splices with a smooth even contour shall be insulated with a conformable 7 mil thick vinyl plastic insulating tape which can be applied under all weather conditions and is designed to perform in a continuous temperature environment up to 105 degrees Celsius. The tape shall have excellent resistance to abrasion, moisture, alkalies, acids, corrosion, and varying weather conditions (including sunlight). The tape shall be equal to Scotch 33+ and shall be applied in conformance with manufacturer's recommendations. In addition, it shall be applied in successive half-lapped layers with sufficient tension to reduce its width to 5/8 of its original width. The last inch of the wrap shall not be stretched.
2. Connections/splices with irregular shapes or sharp edges protruding shall be first wrapped with 30 mil rubber tape to smooth the contour of the joint before being insulated with 33+ insulating tape specified in the previous paragraph. The rubber tape shall be high voltage (69 KV) corona-resistant based on self-fusing ethylene propylene rubber and be capable of operation at 130 degrees Celsius under emergency conditions. The tape must be capable of being applied in either the stretched or unstretched condition without any loss in either physical or electrical properties. The tape must not split, crack, slip, or flag when exposed to various environments. The tape must be compatible with all synthetic cable insulations. The tape must have a dissipation factor of less than 5 percent at 130 degrees Celsius, be non-vulcanizing, and have a shelf life of at least 5 years. The rubber tape shall be applied in successive, half-lapped wound layers and shall be highly elongated to eliminate voids. Other

manufacturer's recommendations on installation shall be adhered to. The rubber tape shall be equal to Scotch 23 or 130C electrical splicing tape.

3. Splices made in wet or damp locations shall be made submersible and watertight with special kits made for the application and compatible with type of cables employed.

B. Connection Make-up

1. Connections of lugs to bus bars, etc., shall be made up with corrosion resistant steel bolts having non-magnetic properties with matching nuts, and shall utilize a Belleville spring washer (stainless steel) to maintain connection integrity. Connections shall be torqued to the proper limits. Prior to bolting up the connection, electrical joint compound shall be brushed on the contact faces of the electrical joint.
2. All motor lead connections shall be made up to match the type of lead furnished on the motor. If the lead is not lugged, then twist-on wire connectors may be used. To prevent possible vibration problems, twist-on connectors shall be taped after installation.
3. At the time of final inspection, the Engineer may request the Contractor to disassemble 3 randomly selected motor lead connections in the Engineer's presence, to assure conformance with these Specifications.
4. The Contractor shall include all necessary tools, materials, and labor in his bid for disassembly of the connections and for remaking them with new insulating materials after inspection.

END OF SECTION-16150

SECTION 16440 MOTOR CONTROL

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Contractor shall furnish and install motor control equipment as specified herein and as shown on the Drawings.

1.02 SUBMITTALS

- A. Motor control equipment shall be new and the equipment of one manufacturer. Each component is specified by a particular trade name; however, this does not relieve the Contractor of the responsibility of submitting descriptive literature and Shop Drawings for review of all components. Motor control shall be the same brand as power distribution equipment.
- B. Shop drawings, including dimension & layout drawings, and descriptive literature shall be submitted to the Engineer for review. Service manuals shall be submitted on all equipment and shall be bound in 3-ring looseleaf binders. The manuals shall also include information on accessories, etc., built in the control center.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Control Equipment - "Eaton", "Square D", "Siemens", "Allen Bradley", or equal.

2.02 MISCELLANEOUS MOTOR CONTROL DEVICES (480, 240, OR 120 VOLT)

- A. Safety Switches
 - a. Safety switches shall be of the heavy duty industrial, quick make, quick-break type. Ratings shall correspond to that of the equipment in which circuit it is used, fuses sized as shown on the Contract Drawings. All safety switches at motor locations are of the nonfused type unless otherwise noted.
 - b. Safety switches shall have a mechanical door interlock to prevent the door from being opened with the switch in the on position and facilities for locking it in the closed or open position. Enclosures for outside installation shall be NEMA 4X, unless otherwise designated on the Contract Drawings.
 - c. Safety switches shall be UL listed and shall conform to NEMA Standards. NEMA 4X enclosed safety switches shall be stainless steel, or fiberglass where called for.
- B. Manual Motor Starting Switches
 - a. Manual motor starting switches for the control of fractional horsepower motors shall be single pole, and shall be provided with a thermal heater of the correct size for the load controlled. Each starting switch shall be mounted where

shown on the Contract Drawings.

C. Combination Starters

- a. All combination starters shall utilize a unit disconnect as specified in the previous article. Magnetic starters shall be furnished in all combination starter units. All starters shall utilize NEMA rated contactors. IEC contactors are not acceptable. Minimum starter size shall be NEMA 1. Starters shall be provided with a three-pole, external manual reset, overload relay for ambient compensated bimetallic thermal overload units.
- b. Control circuit transformers shall include two primary protection fuses and one secondary fuse (in the non-ground secondary conductor). The transformer shall be sized to accommodate the contractor(s) and all connected control circuit loads. The transformer rating shall be fully visible from the front when the unit door is opened.
- c. When a unit control circuit transformer is not provided, the disconnect shall include an electrical interlock for disconnection of externally powered control circuits.
- d. Auxiliary control circuit interlocks shall be provided where indicated. Auxiliary interlocks shall be field convertible to normally open or normally closed operation.
- e. NEMA/EEMAC Size 1-4 starters shall be mounted directly adjacent to the wireway so that power wiring (motor leads) shall connect directly to the starter terminals without the use of interposing terminals. Larger starters shall be arranged so that the power wiring may exit through the bottom of the starter cubical without entering the vertical wireway.
- f. All starters shall be of the voltage rating, type, and sized for the motor size shown in these Specifications and/or on the Contract Drawings. Should a piece of electrically driven equipment be furnished with a larger motor than shown on the Contract Drawings, the proper size combination starter shall be provided for the equipment supplied, at no extra cost to the Owner.
- g. Terminal Blocks
 1. All starter units shall be provided with unit control terminal blocks.
 2. Terminal blocks shall be the pull-apart type 600 volt and rated at 25 amps. All current carrying parts shall be tin plated. Terminals shall be accessible from inside the unit when the unit door is opened. Terminal blocks shall be DIN rail mounted with the stationary portion of the block secured to the unit bottom plate. The stationary portion shall be used for factory connections, and shall remain attached to the unit when removed. The terminals used for field connections shall face forward so they can be wired without removing the unit or any of its components.
- h. Nameplates - Shall be engraved phenolic nameplates for unit compartment. Shall be gray background with white letters, measuring a minimum of 1.5 in H x 6.25 in W total outside dimensions.
- i. Pilot Device Panel - Each combination starter unit shall be provided with a hinged/removable control station plate, which can accommodate up to five 22 mm pilot devices or three 30 mm pilot devices.
- j. Circuit Breakers
 1. Circuit breakers shall be molded case type. Trip elements of multi-pole breakers shall be effectively insulated from one another. Multi-pole breakers shall be designed so that an overload on any one pole shall open

- all poles simultaneously.
2. The breaker operating mechanism shall be the quick-make, quick-break type and shall be entirely trip free to prevent the contacts being held in a closed position against a short circuit.
 3. Breakers not used with motor starters shall be of the thermal magnetic type with a thermal bimetallic element for time delayed overload protection and a magnetic element for short circuit protection.
 4. The breaker shall be trip indicating with the trip position midway between the "On" and "Off" positions.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

- A. Individually Mounted Motor Control Devices (480, 240, or 120 Volt)
 - a. Each motor disconnect shall be located as near as possible to its respective motor.
 - b. Remote control station at or near motor shall be mounted near its respective motor, adjacent to the motor disconnect.

END OF SECTION - 16440

SECTION 16446 VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 REFERENCES

- A. The drive shall be designed to meet the following specifications:
 - a. NFPA 70 - US National Electrical Code
 - b. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems
 - c. NEMA 250 - Enclosures for Electrical Equipment
 - d. UL 508 - Industrial Control Equipment
 - e. UL 508C - Power Conversion Equipment
 - f. CAN/CSA-C22 No.14-M91 - Canadian Standards Association
 - g. IEC 146 - International Electrical Code
 - h. IEC 61000 - Electromagnetic Compatibility

1.02 REGULATORY REQUIREMENTS

- A. The drive shall conform to the following requirements:
 - a. NFPA 70
 - b. IEC 146
 - c. EN Standard/CE marked for EMC directives

<u>Emissions</u>	<u>Immunity</u>
EN 50081-1	EN 50082-1
EN 50081-2	EN 50082-2
EN 55011 Class A	IEC 801-1,2,3,4,6,8
EN 55011 Class B	(per EN 50082-1,2
 - d. EN Standard/CE marked for Low Voltage directives
 - e. EN 60204-1
 - f. PREN 50178
 - g. IEC 801
 - h. C-UL marking to provide an approved listing for both United States and Canadian users.

1.03 QUALIFICATIONS

- A. Manufacturer: The drive manufacturer shall have been in the drive business continuously for a minimum of 15 years and specialize in the design and manufacturing of PWM Adjustable Frequency Drives.
- B. Support: The drive manufacturer shall maintain factory trained and authorized service facilities for their drives within 100 miles of the project and have a demonstrated record of service for at least the previous three years. Full-time support personnel shall be employed by the drive manufacturer.
- C. Certification: All drives must be assembled at locations that are certified to the

ISO-9001 Series of Quality Standards. This insures all quality and corrective action procedures are documented and implemented with a goal of Total Customer Satisfaction.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Square D, Allen Bradley, ABB, Eaton, or equal.

2.02 GENERAL DESCRIPTION

- A. The AC Drive shall convert the input AC mains power to an adjustable frequency and voltage as defined below and indicated on the drawings or motor control schedules.
 - a. For AC Drives rated up to 150 horsepower, the AC Drive manufacturer shall use a 6-Pulse bridge rectifier design with minimum 3% line reactors and separately enclosed passive filter for effective harmonic mitigation. The diode rectifiers shall convert fixed voltage and frequency, AC line power to fixed DC voltage. The power section shall be insensitive to phase rotation of the AC line. The passive filter shall be as specified below.
 - b. Passive Harmonic Filter:
 - 1. The filter shall filter and suppress all characteristic low frequency harmonics (5th, 7th, 11th, 13th, etc.) generated from three phase diode rectifier loads, such as variable frequency drives (VFD).
 - 2. The filter shall consist of inductive element(s) in series with the load and an inductivecapacitive network in shunt with the load. The shunt circuit shall be tuned to 4.7 times the fundamental frequency.
 - 3. The Total Demand Distortion (TDD) of the current at the input terminals of the filter, in combination with the variable frequency drive, shall not exceed 5%THID at full rated load and given the filter is correctly applied.
 - 4. The Total Harmonic Voltage Distortion (THVD) at the input terminals of the filter in combination with the variable frequency drive shall not exceed the limits defined in Table 10-2 of IEEE-519 (1992). The filter supplier shall not be responsible for preexisting voltage distortion caused by other harmonic sources.
 - 5. The full load efficiency of the filter shall not be less than 97% for filters larger than 5 HP or less than 98.5% for filters larger than 25 HP.
 - 6. The filter may produce a capacitive reactive power (KVAR) less than or equal to 40% of its HP rating over the full load range.
 - 7. Voltage Regulation: The voltage regulation at the VFD terminals and attributable to the filter shall not exceed 5%. Filters with greater than 10% voltage drop, and/or filters that have capacitors in series with the VFD, are not acceptable.
 - 8. The filter shall suppress characteristic harmonics without the requirement to phase shift against other harmonic sources or without the need for individual tuning.
 - 9. The filter shall have a contactor option to control the insertion of the shunt capacitor in the circuit and control the capacitive VARS on the power

system. The contactor shall be controlled by an external 120V dry contact. 120V power shall be provided internal to the filter.

10. The contactors shall be UL Listed and designed for 3-phase applications and rated for 600 volts.
 11. Enclosure: The filter shall be offered in a stand-alone UL Type 1 enclosure or UL Type 3R enclosure.
 12. High-Endurance Capacitor Cells:
 - i. Only standard, non-custom capacitors shall be used for availability.
 - ii. High-endurance capacitor cells shall have a voltage rating capable of handling continuously the nominal system voltage plus 10% of the over voltage tolerance. These capacitor cells shall also operate under the worst case voltage gain due to the leading nature of the capacitive current. Dielectric material shall be low-loss (less than 0.25 watts per kVAR). High-endurance capacitor cells themselves shall be rated to operate at a temperature of 65°C on the capacitor case.
 - iii. High-endurance capacitor cells shall be contained in hermetically sealed metal cans.
 - iv. High-endurance capacitor cells shall have a UL mandated, pressure-sensitive interrupter which, in case of a hazardous internal pressure increase, will disconnect all three phases simultaneously. And shall be recognized or listed under UL810.
 - v. Individual high-endurance capacitor cells, or groups of cells, shall be provided with a 3-phase, discharge resistor network. The resistors shall be sized to reduce residual voltage to less than 50V within one minute of de-energization (NEC article 460-6).
 - vi. The RMS current in each capacitor cell at full load shall not exceed 150% of the current at no load to limit the stress on the capacitors.
- B. The output power section shall change fixed DC voltage to adjustable frequency AC voltage. This section shall use insulated gate bipolar transistors (IGBT) or intelligent power modules (IPM) as required by the current rating of the motor.
- C. Where indicated, or where feeder lengths exceed 100 feet, motor protecting output filters shall be provided. The filters shall combine inductance, capacitance, and resistance to form a low pass filter. The filter shall lower the dv/dt levels to prevent exciting the natural resonant frequency of the output circuit.

2.03 CONSTRUCTION

- A. The AC drive shall be mounted in the floor-mounted enclosure Type 12. Dimensions shall not exceed the available space accounting for any additional required space for the air ventilation, etc. as shown on Drawings.
- B. A mechanical interlock shall prevent an operator from opening the AC Drive door when the disconnect is in the on position. Another mechanical interlock shall prevent an operator from placing the disconnect in the on position while the AC Drive door is open. It shall be possible for authorized personnel to defeat these interlocks.
- C. Provisions shall be made for accepting a padlock to lock the enclosure door.

2.04 APPLICATION DATA

- A. The AC Drive shall be sized to operate a Variable Torque or Constant Torque load, as indicated.
- B. The speed range shall be from a minimum speed of 0.1 Hertz to a maximum speed of 60 Hertz.

2.05 ENVIRONMENTAL RATINGS

- A. The AC Drive shall meet IEC 60664-1 and NEMA ICS-1 Annex A standards.
- B. The AC Drive shall be designed to operate in an ambient temperature from +14 to 104 degrees F.
- C. The storage temperature range shall be -13 to +149 degrees F.
- D. The maximum relative humidity shall be 95 percent at 40 degrees C non-condensing or dripping water conforming to IEC 60068-2-3.
- E. The AC Drive shall conform to IEC 600721-3-3-3M3 amplitude for Operational Vibration Specifications.

2.06 RATINGS

- A. The AC Drive shall be designed to operate from the rated input voltage plus or minus 10 percent.
- B. The AC Drive shall operate from an input voltage frequency range of 57 to 63 Hertz.
- C. The displacement power factor shall not be less than 0.95 lagging under any speed or load condition.
- D. The efficiency of the AC Drive at 100 percent speed and load shall not be less than 96 percent.
- E. The constant or variable torque rated AC Drive overcurrent capacity shall be 150 percent or 110 percent respectively for one minute.
- F. The output carrier frequency of the AC Drive shall be randomly modulated depending on Drive rating for low noise operation. No AC Drive with an operable carrier frequency above 10 kHz shall be allowed.
- G. The output frequency shall be from 0.1 to 500 Hertz.
- H. The AC Drive will be able to develop rated motor torque at 0.5 Hertz (60 Hertz base) in a sensorless flux vector (SVC) mode using a standard induction motor without an encoder feedback signal.

2.07 PROTECTION

- A. Upon power-up shall automatically test for valid operation of memory, option module, loss of analog reference input, loss of communication, dynamic brake failure, DC to DC power supply, control power and the pre-charge circuit.
- B. UL 508C listed for use on distribution systems with 100,000A available fault current. The AC Drive shall have a coordinated short circuit rating designed to UL 508C and listed on the nameplate.
- C. Protection against short circuits, between output phases and ground; and the logic and analog outputs.
- D. Minimum AC undervoltage power loss ride-through of 200 milliseconds. The AC Drive shall have the user-defined option of frequency fold-back to allow motor torque production to continue to increase the duration of the powerloss ride-through.
- E. Selectable ride through function that will allow the logic to maintain control for a minimum of one second without faulting.
- F. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function will provide programmable restart attempts. The programmable time delay before restart attempts shall be unlimited.
- G. Deceleration mode programmable for normal and fault conditions. The stop modes shall include free-wheel stop, fast stop and DC injection braking.
- H. Upon loss of the analog process follower reference signal, shall fault and/or operate at a userdefined speed set between software programmed low-speed and high-speed settings.
- I. Solid state I2t protection that is UL listed and meets UL 508C as a Class 10 overload protection and meets IEC 60947. The minimum adjustment range shall be from 20 to 150 percent of the nominal output current rating of the AC Drive.
- J. Thermal switch with a user selectable pre-alarm that will provide a minimum of 60 seconds delay before overtemperature fault.
- K. Use bonded fin heatsink construction for maximum heat transfer.
- L. Fold-back function that will automatically anticipate a controller overload condition and fold back the frequency to avoid a fault condition.
- M. The output frequency shall be software enabled to fold back when the motor is overloaded.
- N. There shall be three skip frequency ranges with hysteresis adjustment that can each be programmed independently, back to back or overlapping.

2.08 ADJUSTMENTS AND CONFIGURATIONS

- A. The AC Drive shall self-configure to the main operating supply voltage and frequency. No operator adjustments will be required.

- B. Upon power-up, automatically send a signal to the connected motor. The stator resistance data will be measured at rated current. The AC Drive will automatically optimize the operating characteristics according to the stored data.
- C. A choice of four types of acceleration and deceleration ramps will be available in the AC Drive software; linear, S curve, U curve, and custom.
- D. The acceleration and deceleration ramp times shall be adjustable from 0.01 to 9,000 seconds.
- E. The volts per frequency ratios shall be user selectable to meet variable torque loads, normal and high-torque machine applications.
- F. The memory shall retain and record run status and fault type of the past eight faults.
- G. Slip compensation shall be adjustable from 0 to 150%.
- H. The software shall have an "Energy Saving" function that will reduce the voltage to the motor when selected for variable torque loads. A constant volts/Hertz ratio will be maintained during acceleration. The output voltage will then automatically adjust to meet the torque requirement of the load.
- I. The AC Drive shall offer programmable DC injection braking that will brake the AC motor by injecting DC current and creating a stationary magnetic pole in the stator. The level of current will be adjustable between 10 and 110 percent of rated current and available from 0.1 to 30 seconds continuously. For continuous operation after 30 seconds, the current shall be automatically reduced to 50 percent of the nameplate current of the motor.
- J. Sequencing logic will coordinate the engage and release thresholds and time delays for the sequencing of the AC Drive output, mechanical actuation and DC injection braking in order to accomplish smooth starting and stopping of a mechanical process.

2.09 GRAPHIC TERMINAL DISPLAY INTERFACE

- A. The graphic display terminal will provide 8 lines of 240 by 160 pixels in plain English to control, adjust and configure the AC Drive. All electrical values, bar charts, configuration parameters, I/O assignments, application and activity function access, faults, local control, adjustment storage, self-test and diagnostics. There shall be a standard selection of six additional languages built-in to the operating software as standard.
- B. The AC Drive model number, torque type, software revision number, horsepower, output current, motor frequency and motor voltage shall all be listed on the drive identification display as viewed on the graphic display terminal.
- C. As a minimum the selectable outputs shall consist of speed reference, output frequency, output current, motor torque, output power, output voltage, line voltage, DC voltage, motor thermal state, drive thermal state, elapsed time, motor speed, machine speed reference and machine speed.

- D. The graphic display terminal will consist of programmable function keys. The functions will allow both operating commands and programming options to be preset by the operator. A hardware selector switch will allow the graphic display terminal to be locked out from unauthorized personnel.
- E. The graphic display terminal will offer a simply smart to advanced user menu consisting of parameter setting, I/O map, fault history, and drive configuration. A software lock will limit access to the main menu.
- F. The navigation wheel will provide the ability to scroll through menus and screens, select or activate functions or increase the value of a selected parameter.
- G. An escape key will allow a parameter to return the existing value if adjustment is not required and the value is displayed. The escape function will also return to a previous menu display.
- H. A RUN key and a STOP key will command a normal starting and stopping as programmed when the AC Drive is in keypad control mode. The STOP key must be active in all control modes.
- I. A user interface shall be available that is a WINDOWS® based personal computer, serial communication link or detachable graphic terminal display
- J. The keypad and all door mounted controls shall be furnished as required to meet the enclosure rating.

2.10 CONTROL

- A. External pilot devices shall be able to be connected to a terminal strip for starting/stopping the AC Drive, speed control and displaying operating status. All control inputs and outputs shall be software assignable.
- B. 2-wire or 3-wire control strategy shall be defined within the software. 2-wire control allows automatic restart of the AC Drive without operator intervention after a fault or loss of power. 3-wire control requires operator intervention to restart the AC Drive after a fault or loss of power.
- C. The control power for the digital inputs and outputs 120VAC.
- D. The internal power supply incorporates an automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs will be current limited and not be damaged if shorted or excess current is pulled.
- E. All logic connections shall be furnished on pull apart terminal strips.
- F. There shall be (2) two software assignable analog inputs with interference filtering. The analog inputs will be software selectable and consisting of user defined configurations: x-y mA or x-y V.
- G. There shall be five software assignable logic inputs that will be selected and assigned in the software. The selection of assignments shall consist of forward,

reverse, jog, plus/minus speed (2 inputs required), setpoint memory, preset speeds (up to 8 inputs), auto/manual control, controlled stop, terminal or keypad control, output contactor (2 inputs required), motor switching, and fault reset.

- H. There shall be two software assignable analog outputs with interference filtering. The analog outputs can be selected and assigned in the software. The analog output assignments shall be proportional to the following motor characteristics: frequency, current, power torque, voltage and thermal state. The output signal will be user defined configurations: x-y mA or x-y V.
- I. Two voltage-free Form C relay output contacts shall be provided. One of the contacts shall indicate AC Drive faults status. The other contact shall be user assignable.
- J. There shall be a hardware input/output extension module that also provides interlocking and sequencing capabilities. The module shall be fully isolated and housed in a finger-safe enclosure with pull apart terminal strips. The module shall add four logic inputs, two analog inputs, two relay outputs, and one analog output. All of the I/O shall be user assignable in the software as previously defined.
- K. The combination enclosure shall have as a minimum, the following 22mm door-mounted operators:
 - a. Power on pilot light (red)
 - b. Drive run pilot light (green)
 - c. Drive fault pilot light (yellow)
 - d. Hand-Off-Auto (or Local-Off-Remote) selector switch
 - e. Manual speed potentiometer

Other devices shall be provided as shown on the control circuits or specifically called for on the Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Anchor all cabinetry firmly to the foundation.
- B. Comply with manufacturer's recommendations, except as modified herein.
- C. Drives shall be adjusted such that maximum speed is motor nameplate RPM, and minimum speed is just high enough to provide motor driven equipment cooling.
- D. Verify that the location is ready to receive work and the dimensions are as indicated. Contractor shall field measure available space.
- E. Do not install AC Drive equipment until the building environment can be maintained within the service required by the manufacturer.
- F. Before and during the installation, the AC Drive equipment shall be protected from site contaminants and critters.

3.02 START-UP, TRAINING, AND TESTING

- A. The drive manufacturer shall provide factory authorized, trained service personnel for start-up and testing. Upon successful completion of installation and testing, training shall be provided in accordance with 16050.
- B. Start-up of the variable frequency drives shall be coordinated with the start-up of the driven equipment, and other related equipment which may pertain to drive settings. The VFD field service representative shall be available during the entire start-up procedure to adjust VFD settings as required for the entire system operation.
- C. VFD settings shall be modified as required from the factory settings for the actual motor nameplate data, and any other settings as required for proper operation (i.e., ramp time during start-up, etc.)

3.03 TOOLS AND SPARE PARTS

- A. Any special tools required for normal operation and maintenance shall be provided by the equipment manufacturer.
- B. Furnish the following spare parts:
 - a. Ten fuses for each type used.
 - b. Ten lamps for each type used.
 - c. One spare circuit board for each VFD model provided, as required for VFD operation.

END OF SECTION - 16446

SECTION 16710 COMMUNICATION SYSTEMS

PART 1-GENERAL

1.01. SUMMARY

- A. Work Included: This specification contains the requirements for communications cable as opposed to electrical power wire and cable.
- B. Related Sections and Divisions: Applicable provisions of Division 1 shall govern work in this section.

1.02. QUALITY ASSURANCE

- A. Standards: Comply with standards specified in this section as listed in Division 1.
- B. Qualifications of Installers: Use skilled workers who are thoroughly trained and experienced in the necessary crafts, and who are completely familiar with the specified requirements and the methods needed for proper performance of the work.

1.03. PRODUCT HANDLING

- A. Communications cable shall be furnished in lengths as necessary.
- B. Reels, coils, or package rolls of communications cable shall be identified with the project name and other tagging identification as called for.

1.04. SUBMITTALS

- A. Submit shop drawings and product data in accordance with provisions of Section 01-Submittals.

PART 2-PRODUCTS

2.01. GENERAL

- A. All materials of construction for cable and wire shall be compatible and noncontaminating.
- B. Unless otherwise noted in these specifications, the requirements herein listed shall be strictly adhered to.

2.02. INDUSTRIAL ETHERNET CABLE

- A. For communication with plant SCADA systems and equipment in supervisory control centers, control panels, etc., and areas with 480-volt power, provide

600 V-rated, 4-pair unshielded twisted-pair cabling meeting EIA/TIA Category 6A requirements. Transmission characteristics of the cables shall meet full Category 6A performance criteria as defined by the referenced TIA/EIA documents and this specification. Jacket color shall be coordinated during Shop Drawing review.

- B. Industrial Ethernet cable shall be minimum 24 AWG with PVC jacket and foil. The cable outer jacket shall be industrial-grade PVC with a nominal overall cable diameter of 0.32 inches. Cable shall be nonplenum rated, UL listed, 600 V UL AWM rated, and be as manufactured by, Belden 10GX33, or equal.
- C. Patch cables shall be provided premanufactured by the cable manufacturer or connector manufacturer in sufficient length to connect associated equipment to any port on the patch panel or switch. Field-attached plugs shall be insulation displacement type and be by the same manufacturer as the cable or connector.
- D. Connectors shall be RJ45, Category 6A, Leviton 6AUJK series, or equal. Color shall be coordinated during Shop Drawing review.

PART 3-EXECUTION

3.01. INSTALLATION REQUIREMENTS AND TESTING

- A. Industrial Ethernet specified in this section shall be installed in conduit, and may not be run free-air or in nonmetallic tubing such as innerduct.
- B. Since magnetic interference is produced by currents flowing through conductors and electrical equipment, any communications run near electric motors, transformers, induction heaters, circuit breakers, motor starters, or AC power and control cables may need additional magnetic shielding.

3.02. TELECOMMUNICATIONS CABLING FIELD TESTING

- A. Perform telecommunications cabling inspection, verification, and performance tests in accordance with TIA/EIA-568.
- B. Inspection
 - a. Visually inspect cabling jacket materials for UL or third party certification markings. Visually inspect UTP and OFO jacket materials for UL or other certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for tip and ring pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568. Visually confirm Category 6A (10 GBPS) marking of outlets, wallplates, jacks, and patch panels.
- C. Verification Tests
 - a. UTP copper cabling shall be tested for DC loop resistance, shorts, opens, intermittent faults, near-end cross talk, proper pinning and termination and polarity between conductors, and between conductors

and shield, if cable has overall shield. Test operation of shorting bars in connection blocks. Test cables after terminated but not cross connected. Perform 250 MHz near-end cross talk (NEXT), far-end cross talk (FEXT) return loss, propagation delay, delay skew requirements, and attenuation tests for Category 6A (10 GBPS) 100 ohm 4-pair systems installations.

- b. Perform OFC testing using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures. Perform tests in accordance with EIA/TIA-526-14, Method B for horizontal, multimode OFC and EIA/TIA-526-7, Method B for backbone, single mode OFC. Perform in factory acceptance tests and factory reel tests at jobsite prior to installation.

D. Performance Tests

- a. Category 6A (10 GBPS) Links. Perform UTP link tests in accordance with ANSI/TIA-568-B.2-1. Tests shall include wire map, length, attenuation, NEXT, FEXT, return loss, and propagation delay.

E. Final Verification Tests

- a. Perform verification tests for UTP and OFC systems after the complete telecommunications cabling and workstation jacks are installed. Connect to the network interface device at the demarcation point. Verify communication to outlet.

END OF SECTION 16710

