CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING
ENGINEERING AND CONTRUCTION DIVISION

PROJECT MANUAL
UPPER BRAYS WASTE WATER TREATMENT PLANT IMPROVEMENTS
WBS No. R-000265-0096-4

VOLUME 1 of 1

Divisions 00 through 16

September 2016

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B.R.M. RATNALA, P.E.
36055
Registration Number
08/30/2016
Date

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Document 00010

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END OF DOCUMENT

Document 00410A

BID FORM – PART A

To: **The Honorable Mayor and City Council of the City of Houston**
City Hall Annex
900 Bagby Street
Houston, Texas 77002

Project: Upper Brays Waste Water Treatment Plant Improvements
Project No.: WBS No. R-000265-0096-4
Bidder: _____
(Print or type full name of business entity, such as corporation, LLC, etc.)

1.0 OFFER

A. Total Bid Price: Having examined the Project location and all matters referred to in Bid Documents for the Project, we, the undersigned, offer to enter into a Contract to perform the Work for the Total Bid Price shown on the signature page of this Document

B. Security Deposit: Included with the Bid is a Security Deposit in the amount of 10 percent of the Total Bid Price subject to terms described in Document 00200 – Instructions to Bidders.

C. Period for Bid Acceptance: This offer is open to acceptance and is irrevocable for 90 days from Bid Date. That period may be extended by mutual written agreement of the City and Bidder.

D. Addenda: All Addenda have been received. Modifications to Bid Documents have been considered and all related costs are included in the Total Bid Price.

E. Bid Supplements: The following documents are attached:

[X] Security Deposit *(as defined in Document 00200 – Instructions to Bidders)*
[X] Document 00450 - Bidder's Statement of MWSBE Status
[X] Document 00454 - Affidavit of Non-interest
[X] Document 00455 - Ownership Information Form
[X] Document 00456 - Bidder's Certificate of Compliance with Buy American Program *(required for AIP funded project)*
[X] Document 00457 – Conflicts of Interest Questionnaire (CIQ)
[X] Document 00458 - Bidder's Certificate Regarding Foreign Trade Restriction *(required for AIP funded project)*
[ ] Document 00459 - Contractor's Statement Regarding Previous Contracts Subject to EEO *(required for AIP funded project)*
[X] Document 00460 – Pay or Play Acknowledgement Form (POP 1-A)
[X] Document 00470 – Bidder's MWSBE Participation Plan *(required unless no MWSBE participation goal is provided in Document 00800* (the "Goal")*)*.

[ ] Document 00471 – Bidder's Record of Good Faith Efforts *(required if the goal in Bidder's Participation Plan–Document 00470 is lower than the Goal).*

[ ] Document 00472 – Bidder's Goal Deviation Request *(required if the goal in Bidder's Participation Plan–Document 00470 is lower than the Goal).*

[ ] Others as listed: _____

_____

2.0 CONTRACT TIME

A. If offer is accepted, Contractor shall achieve Date of Substantial Completion within 400 days after Date of Commencement of the Work, subject to adjustments of Contract Time as provided in the Contract.

Document 00410B

BID FORM – PART B

1.0 TOTAL BID PRICE HAS BEEN CALCULATED BY BIDDER, USING THE FOLLOWING COMPONENT PRICES AND PROCESS (PRINT OR TYPE NUMERICAL AMOUNTS):

A. STIPULATED PRICE: $N/A

(Total Bid Price; minus Base Unit Prices, Extra Unit Prices, Cash Allowances and All Alternates, if any)

B. BASE UNIT PRICE TABLE:

Item No.	Spec Ref.	Base Unit Short Title	Unit of Measure	Estimated Quantity	Unit Price (this column controls)	Total in figures
1	01502	Mobilization	LS	1		
2	01520	Filter Fabric Fence	LF	1500		
3	01570	Reinforced Fabric Fence Barrier	LF	1500		
4	01570	Inlet Protection Barrier	LF	100		
5	015752	Stabilized Construction Exit	SY	80		
6	DIV 2 thru 16	WWTP Improvements as shown on the Drawings and Specifications, but not limited to: i) Aeration Basin - Construction of miscellaneous electrical and instrumentation improvements to existing Aeration Basin equipment- All per Section 01110 paragraph 1.02.	LS	1		
7	DIV 2 thru 16	WWTP Improvements as shown on the Drawings and Specifications but not limited to: ii) Final Clarifiers- Replacement of RAS Pumps with hatches including electrical, instrumentation, control, and SCADA system and RAS telescoping valves with hatches complete	LS	1		

		functional in place. Installation of new Scum Pump Stations including structures, pumps, piping, force main, replace Clarifier Scum Beaches, add new Clarifier Walkways, install electrical, instrumentation, control, and SCADA complete functional in place. All as described in Section 01110 paragraph 1.02.				
8	DIV 2 thru 16	WWTP Improvements as shown on the Drawings and Specifications, but not limited to: iii) Chlorine Contact Basin- Replace existing Scum Pumps. Replace Chlorine Scum Pumps and System and install access hatch for each pump including electrical, instrumentation, control, and SCADA system complete functional in place. All as described in Section 01110 Paragraph 1.02.	LS	1		
9	DIV 2 thru 16	WWTP Improvements as shown on the Drawings and Specifications but not limited to: iv) Gravity Flow Thickener – Construct WAS Flow Meter Vault and replace Flow Meter, construct Gravity Thickener Modifications and replace Thickened Sludge Pumps and construct new facility. Replace thickener system includes electrical, instrumentation, control, and SCADA system complete functional in place. All as described in Section 01110 Paragraph 1.02.	LS	1		
10	DIV 2 thru 16	WWTP Improvements as shown on the Drawings and Specifications, but not limited to: v) Sludge Dewatering Facility- Remove and replace Belt	LS	1		

		Presses, Conveyors and Belt Press Foundations demolition and replacement of portions of concrete floor Slab and modify existing Floor Drain System. Construction of new concrete floor slab under and around the proposed Belt Press. Replace belt press system including electrical, instrumentation, control, and SCADA system complete functional in place. Provide and operate interim portable belt press system to be supplied, installed, operated to dewater sludge while the existing sludge dewatering facility is under construction. All as described in Section 01110 Paragraph 1.02.				
TOTAL BASE UNIT PRICES						$_____

C. EXTRA UNIT PRICE TABLE:

Item No.	Spec Ref.	Extra Unit Short Title	Unit of Measure	Estimated Quantity	Unit Price (this column controls)	Total in figures
1	01570	Reinforced Fabric Fence	LF	50		
2	02318	Extra Hand excavation	CY	50		
3	02318	Extra Machine	CY	50		
4	02338	Extra Cement stabilized sand Back fill complete in place	CY	50		
5	02921	Site grading and Hydro mulch Seeding	AC	50		
6	16122	Extra 2” PVC Coated RS Conduit	LF	50		
7	16124	Extra Copper No. 8 AWG Conductor	LF	50		
8	16402	Extra 3” PVC Sch. 80Conduit In Ductbank	LF	50		
TOTAL EXTRA UNIT PRICES						$_____

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D. CASH ALLOWANCE TABLE:

Item No.	Spec Ref.	Cash Allowance Short Title	Cash Allowance in figures (1)
1		Flood Plain Development Permit	$500.00
2		Building Permit	$15,000.00
TOTAL CASH ALLOWANCES			$15,500.00

REST OF PAGE INTENTIONALLY LEFT BLANK

F. TOTAL BID PRICE: **$**_____
(Add Totals for Items A., B., C., D., and E. above)

2.0 SIGNATURES: By signing this Document, I agree that I have received and reviewed all Addenda and considered all costs associated with the Addenda in calculating the Total Bid Price.

Bidder: _____
(Print or type full name of your proprietorship, partnership, corporation, or joint venture.*)

**By: _____
Signature Date

Name: _____
(Print or type name) Title

Address: _____
(Mailing)

_____
(Street, if different)

Telephone and Fax Number: _____
(Print or type numbers)

* If Bid is a joint venture, add additional Bid Form signature sheets for each member of the joint venture.

** Bidder certifies that the only person or parties interested in this offer as principals are those named above. Bidder has not directly or indirectly entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding.

Note: This document constitutes a government record, as defined by § 37.01 of the Texas Penal Code. Submission of a false government record is punishable as provided in § 37.10 of the Texas Penal Code.

Footnotes for Tables B through E:
(1) Fixed Unit Price determined prior to Bid. Cannot be adjusted by the Bidder.
(2) Minimum Bid Price determined prior to Bid. Can be increased by the Bidder by crossing out the Minimum and noting revised price on the line above.
(3) Maximum Bid Price determined prior to Bid. Can be decreased but not increased by Bidder by crossing out the Maximum and noting revised price on the line above. A Bid that increases the Maximum Bid Price may be found non-conforming and non-responsive.
(4) Fixed Range Bid Price determined prior to Bid. Unit Price can be adjusted by Bidder to any amount within the range defined by crossing out prices noted and noting revised price on the line above.

Section 01110

SUMMARY OF WORK

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Summary of the Work including cash allowances, work sequence, Contractor use of Premises, special conditions for substantial completion warranty and City occupancy.

1.02 WORK COVERED BY CONTRACT DOCUMENTS

Work of the Contract is for construction of the Upper Brays Wastewater Treatment Plant Improvements including the following but not limited to:

A. Furnish/Install:

1.Areation Basin:
Construction of Miscellaneous Electrical and Instrumentation Improvements to existing Aeration Basin equipment.

2. Final Clarifiers:
Construct (2) Scum Pump Stations. One station to serve Clarifiers 1 & 4 and the other to serve Clarifiers 2 & 3. Stations to be partially buried concrete construction with submersible pumps with transducer level controls. A force main from each station to be constructed and ran through the yard to existing piping that will deliver clarifier scum to existing Static screens at the Aeration Basins. No demolition required. Replace existing scum beaches at each clarifier. Clarifiers will have to be dewatered for demolition of existing scum beaches. Existing wall penetrations for scum beaches to be sealed and abandoned. New S.S. scum beaches to be vendor supplied and installed, (one) for each clarifier. Scum beaches to be equipped with flush valves and wash down spray booms to positively move scum to drain piping. Existing skimmer arms will need to be modified to actuate proposed flush valves. Drain piping from scum beaches to gravity flow scum to proposed scum pump stations. All drain piping to be equipped with 6” clean outs per COH specifications. Additionally, access walkways to be installed at each scum beach to allow personnel to access scum beach and wash down spray boom for servicing.

(4) RAS telescoping valves to be modified. Existing manual operators on the valves to be removed and replaced with electric motor operated

actuators. Additionally, an aluminum access hatch is to be installed at each telescoping valves to allow access to the valve for cleaning purposes.

Replacement of RAS pumps including electrical, instrumentation, control, and SCADA system complete functional in place. Installation of new scum pump stations including structures, pumps, piping, electrical, instrumentation, control, and SCADA complete functional in place.

3. Cl2 Contact Basin Scum Pumps:

Replace existing scum pumps. Remove existing (3) line shaft pumps and discharge piping. Existing 6” header to remain and be reused. Replace pumps with (3) submersible pumps equipped with S.S. guide rail systems for pump removal. Existing grating frame over pumps to be modified for installation of (3) aluminum access hatches at each new pump.

4. Gravity Thickener:

Existing Gravity Thickener bridge to be extended so that bridge spans the entire structure. Existing 4” sludge piping running along bridge beam is to be removed and taken out of service. Existing sludge supply to this pipe to be capped off above ground at the west bridge entrance. A new NPW surface spray system is to be installed in its place supported alongside the bridge beam to allow servicing. The surface spray system coverage is to include the stilling well surface and extend to the launder weir baffle. A new NPW hose bib & rack is to installed at the center of the bridge. The existing launder weirs are to be removed and replaced with new S.S. launder weirs. The gravity thickener water level will need to be lowered for this repair.

Existing (2) Thickened Sludge pumps and discharge piping to be removed and taken out of service. The existing pump slab to remain in place but curbs and exposed rebar are to be removed. Removal of existing pumps is to be delayed until new pumps are ready to be placed in service. A new pump slab with shelter roof is to be constructed south of the existing slab. The proposed slab is to have a containment curb and sloped floor to a grated drain sump. The proposed sump drain is to gravity flow to existing plant drain piping at the Gravity Thickener north end. A transition concrete walkway is to be constructed between the existing and proposed slabs after underground piping is place. (2) New self-priming sludge pumps are to be installed with new discharge piping to tie into existing above and below ground piping. New pipe supports and hose bib & rack to be included.

(One) WAS Meter Vault to be constructed. The meter is to measure WAS flow from Final Clarifiers to Gravity Thickener. The vault is to be buried concrete construction with an “open top”. Aluminum handrail protection is to be installed above ground on the top of the vault wall. A S.S. ladder is to be installed in the vault to allow access. The vault is to be equipped with a 12” Mag meter, 12” motor control valve and (two) 12” isolation gate valves & boxes. The meter run piping is to be constructed to have an air gathering high point where the air will be removed by an air release valve existing plant drain piping at the Gravity Thickener north end. A transition concrete walkway is to be constructed between the existing and proposed slabs after underground piping is place. (2) New self-priming sludge pumps are to be installed with new discharge piping to tie into existing above and below ground piping. New pipe supports and hose bib & rack to be included.

(One) WAS Meter Vault to be constructed. The meter is to measure WAS flow from Final Clarifiers to Gravity Thickener. The vault is to be buried concrete construction with an “open top”. Aluminum handrail protection is to be installed above ground on the top of the vault wall. A S.S. ladder is to be installed in the vault to allow access. The vault is to be equipped with a 12” Mag meter, 12” motor control valve and (two) 12” isolation gate valves & boxes. The meter run piping is to be constructed to have an air gathering high point where the air will be removed by an air release valve system to insure accurate meter reading. Additionally, the vault is to have a sloped floor to a grated drain sump. The drain sump piping is to gravity flow to an existing plant drain manhole.

Construct WAS Flow Meter Vault and replace Flow Meter, construct Gravity Thickener Modifications and Replace Thickened Sludge Pumps and construct new facility: -

Replacement of thickener system and pumps including electrical, instrumentation, control, and SCADA system complete functional in place.

5. Sludge Dewatering Facility:

An interim portable belt press system is to be supplied and installed to dewater sludge while the existing sludge dewatering facility is under construction. The portable unit will have sludge feed, wash down and polymer pump systems included. Electrical, sludge supply, wash down water drain and process water piping tie ins will have to be made. The portable belt press will have a conveyor system to transfer dewatered sludge for hauling. It will need to be confirmed if the conveyor can load the trailer trucks that are being using presently or if roll off boxes will be required.

Demolition will include the removal of the existing: (2) conveyors, (2) macerators, (2) sludge feed pumps, (2) belt presses, (3) polymer pump skids, (one) polymer tank and all associated piping for the listed equipment. Additionally, a portion of the building foundation is to be saw cut and removed in order to construct new structural concrete and drain trenches for the installation of the proposed equipment.

The existing drain trenches and proposed drain trenches to be covered with new heavy duty grates.

Proposed equipment to be installed includes: (2) macerators, (2) VFD self-priming sludge feed pumps, (2) belt presses, (2) polymer pumps systems and (one) wash down water booster pump system.

Proposed conveyors to be installed to discharge in the existing distribution conveyor system. Supports will be supplied by the conveyor supplier. New S.S. collection hoppers for each conveyor discharge will also be supplied to fit existing distribution conveyor system.

Proposed (2) VFD self-priming pumps will be equipped with motor control valve to allow additional flow control when needed.

Proposed (2) belt presses to be supplied with full length access platform. New 6” sludge feed piping with flow meter, mixer and injector to be constructed for each belt press.

Proposed (2) polymer pumps to be supplied water by S.S. piping from existing potable water source in the existing polymer storage room. Piping to be constructed to supply wash down water back up.

(One) polymer tank stand is to be fabricated to hold (2) pallet polymer tanks.

Proposed (3) wash down water booster pumps to be installed in existing polymer storage room on concrete slabs. Primary water supply to pumps is to be NPW water from existing NPW piping in the building with a potable water back up connection. NPW water is to be flowed through a manual strainer equipped with a low flow alarm to indicated that cleaning is required. Back up potable water connection is to be protected by proposed back flow preventers. All piping for wash down water system is to be S.S.

Proposed (3) 1 ½ wash down reels to be installed. (2) reels to be installed in the belt press area and (one) in the sludge distribution area to provide high volume/pressure wash water.

Remove and replace Belt Presses, Conveyors and Belt Press Foundations and modify existing Floor Drain System: Replacement of beltpress system and equipment including electrical, instrumentation, control, and SCADA system complete functional in place

B. Prepare Demolition/decommissioning of existing equipment, structures and facilities discussed in A. above and as shown on the drawings.

1.03 CASH ALLOWANCES

A. Include the following specific Cash Allowances in Contract Price under provision of General Conditions Paragraph 3.11:

1. City of Houston Building Permit for Upper Brays Wastewater Treatment Plant Improvements.
2. Fees for coordinating with CenterPoint Energy for power service to Upper Brays Wastewater Treatment Plant Improvements.

1.04 ALTERNATES

A. Not applicable

1.05 CITY-FURNISHED PRODUCTS

A. Not applicable

1.06 WORK SEQUENCE

A. Contractor shall coordinate construction schedule and operations detailed Construction sequencing Plan, in accordance with Section 01325 – Construction Schedule, which describes the method of construction associated with activities. Contractor shall submit Construction Sequencing Plan per Section 01330 – Submittal Procedures and Coordination of Work Plan per to Section 01312 – Coordination and Meetings.

B. Construction Sequencing Plan shall be staged so that the service/flow through the existing WWTP is not disrupted during construction in a way that could result in adverse hydraulic or process performance. In general, construction should proceed in order outlines above to provide continuous, uninterrupted flow.

C. All requests for electrical shutdowns(s) necessary to make any required transfers and/or reconnections shall be submitted in writing to the Plant Supervisor at least 5 working days in advance of the proposed shutdown date. Approval for shutdown(s) may be dependent upon influent flow conditions (wet-weather vs dry-

weather) and the operating status of near-by facilities to supplement lost influent pumping capacity. The maximum shut down period shall be no more than four (4) consecutive hours. Central control/monitoring of the pump station operation and local control of the plant shall be restricted to the same scheduling constraints regarding outages.

D. Work Area Sequence-

Final Clarifiers
During construction, (2) clarifiers will be left operational and (2) will be taken out of service for repairs. After repairs are completed on the first (2) clarifiers, they will be put back into service and work will commence on the remaining (2) clarifiers.

1. Construct (2) Clarifier Scum Pump Stations. They will need to be operational before work can be started on the clarifiers. The force mains from these stations need to be completed so that scum can be transferred to the existing Static Screens as the clarifiers are modified and brought back on line. This construction does not interrupt of any plant processes.

2. Set up portable RAS/WAS sludge pumps at Clarifiers 1 & 2 RAS wet well. Run temporary piping above ground from portable pumps to transfer RAS to the Aeration Basin inlet channel and WAS to Thickened Sludge pumps inlet header. No existing RAS pumps or piping to be used at this time. Clarifiers 1 & 2, Gravity Thickener and Thickened Sludge pumps to remain operational for this phase of work. 30” RAS underground piping to be pumped out in order to construct (2) RAS meter vaults. Completion of the RAS meter vaults to be priority. Removal of existing scum beaches and RAS pumps and piping to commence followed by installation of new scum beaches, clarifier scum piping wall penetrations, walkways, telescoping valves and RAS pumps for Clarifiers 3 & 4. After work is completed, Clarifiers 3 & 4 to be put back on line. Portable RAS/WAS pumps system can be deactivated. RAS/WAS transfer will be done by new RAS pumps at Clarifiers 3 & 4.

3. With Clarifiers 3 & 4 operational, Clarifiers 1 & 2 to be taken out of service and dewatered. Removal of existing scum beaches and RAS pumps and piping to commence followed by installation of new scum beaches, clarifier scum piping wall penetrations, walkways, telescoping valves and RAS pumps for Clarifiers 1 & 2. After work is completed, Clarifiers 1 & 2 to be put back on line.

Cl2 Contact Basin Scum Pumps:

The (3) replacement scum pumps can be installed one at a time. Leave (2) existing pumps operational and complete work to get (one) new pump installed and operational. Follow this procedure until all pumps are installed. This construction does not interrupt plant processes.

Gravity Thickener:

WAS flow to the Gravity Thickener to be turned off using existing yard piping valves. WAS underground piping and Gravity Thickener to be dewatered. WAS meter vault to be constructed at this time as well as improvements completed to the Gravity Thickener bridge, surface spray system and launder weirs.

The Proposed Thickened Sludge pumps to be constructed and made operational before the existing pumps are taken out of service. When new pumps are operational, existing pumps can be taken out of service and removed.

Sludge Dewatering Facility:

1. An interim portable belt press system is to be supplied and installed to dewater sludge while the existing sludge dewatering facility is under construction. The portable unit will have sludge feed, wash down and polymer pump systems included. Electrical, sludge supply, wash down water drain and process water piping tie ins will have to be made. The portable belt press will have a conveyor system to transfer dewatered sludge for hauling. It will need to be confirmed if the conveyor can load the trailer trucks that are being using presently or if roll off boxes will be required. After portable belt press is operational, construction can commence.

2. Demolition will include the removal of the existing: (2) conveyors, (2) macerators, (2) sludge feed pumps, (2) belt presses, (3) polymer pump skids, (one) polymer tank and all associated piping for the listed

equipment. Additionally, a portion of the building foundation is to be saw cut and removed in order to construct new structural concrete and drain trenches for the installation of the proposed equipment.

3. The existing drain trenches and proposed drain trenches to be covered with new heavy duty grates.
4. After foundation work is completed, proposed (2) macerators, (2) sludge feed pumps, sludge feed piping and wash down water lines are to be constructed.
5. With piping systems in place, the proposed (2) belt presses, (2) conveyors, (2) polymer pump systems, access platform and wash down hose reels are to be installed.
6. The wash down water system to be installed in the converted polymer storage room. NPW supply to this system is to be run from existing 8” NPW manifold in the building as well as a back-up potable water supply.
7. The proposed polymer tank stand to be installed for pallet polymer tanks.

After above equipment is operational, portable belt press can be deactivated and removed.

1.07 CONTRACTOR USE OF PREMISES

A. Comply with procedures for access to the site and Contractor's use of rights- of-way as specified in Section 01145 - Use of Premises.

B. Construction Operations: Limited to the City's rights-of-way provided by the City and areas shown or described in the Contract documents.

C. Utility Outages and Shutdown: Provide a minimum of 48 hours notice to the City and private utility companies (when utility applicable), excluding weekends and holidays, in advance of required shutdown. Coordinate all work as required. Contractor shall submit a Shutdown Plan to the Project Manager for approval within 30 days of NTP.

1.08 STREET CUT ORDINANCES

A. Not applicable

1.09 EXISTING EQUIPMENT DESIGNATED FOR DEMOLITION/REMOVAL

A. The City shall have the first right of refusal to retain or salvage all items shown to be demolished and/or removed. Prior to initiating demolition, the Contractor and City representative from Wastewater Operations shall make a joint inspection of each site to identify all equipment to be retained by the City for salvage or reuse. All other items shown to be demolished and/or removed which are not retained by the City shall become the property of the Contractor. The Contractor shall remove these items from the City property and dispose of these items in accordance with all federal, state, and local regulations.

B. The Contractor will be responsible for disconnection/reconnection of electrical and mechanical equipment, as required under this contract, under the direct supervision of the City. The City will not be responsible for the disconnection/reconnection of any electrical and mechanical equipment.

C. The Contractor shall follow the City's Lockout/Tagout Procedure, Accident Prevention Plan (Section 14- Control of Hazardous Energy) (Lockout/Tagout) Program of the disconnection/reconnection of all equipment.

D. Items for tree and plant removal and labor to perform this work to be paid as shown in Document 00410 – Bid Form, Parts B. Live trees removed must be disposed in accordance with City of Houston Code of Ordinances.

1.10 WARRANTY

A. Comply with warranty requirements in accordance with Document 00700 – General Conditions.

1.11 ADDITIONAL CONDITIONS FOR SUBSTANTIAL COMPLETION

A. In addition to requirements outlined in Document 00700 – General Conditions, for Contractor to be substantially complete with the Work and call for inspection by Project Manager to confirm, the following conditions must be met or completed:

1. All testing shall be completed and accepted by the Project Manager.
2. All control and instrumentation equipment shall be installed, accepted by manufacturer's representative and

approved for operation by the City Project Manager.

3. Draft O&M Manuals shall be delivered to the Project Mgr.
4. Training shall be conducted, utilizing draft O&M manuals.
5. All safety-related systems and equipment shall be installed, accepted by manufactures representative and approved for use by City of Houston.

B. No additional condition described herein may be included in Contractor's punch list.

1.12 FINAL ACCEPTANCE

A. Final acceptance shall require completion of all punch list items. The completion shall be approved by the Project Manager.

B. Final acceptance shall require delivery, to Wastewater Operations Branch, the final O&M Manuals, Spare Parts, as-built drawings, and completion of all operator and maintenance training, including furnishing a training video.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N - Not Used

END OF SECTION

Section 02085

VALVE BOXES, METER BOXES, AND METER VAULTS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Valve boxes for water service.

B. Meter boxes for water service.

C. Meter vaults for water service.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for valve boxes under this Section. Include payment in unit price for Section 02511 - Water Lines.

2. No separate payment will be made for meter boxes under this Section. Include payment in unit price for Section 02512 - Water Tap and Service Line Installation.

3. Payment for each size of meter vaults is on unit price basis per vault. Payment will be made for each vault installed, regardless of depth.

4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. ASTM A 48 - Standard Specification for Gray Iron Castings.

B. ASTM D 256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.

C. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.

D. ASTM D 648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.

E. ASTM D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

F. ASTM D 2240 - Standard Test Method for Rubber Property-Durometer Hardness.

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit manufacturers' product data for following items for approval:

1. Each type of valve box and lid.

2. Each type of meter box and cover.

3. Each type of meter vault frame and cover.

C. Submit design calculations and shop drawings for precast vault elements, sealed by an Engineer registered in State of Texas.

D. Submit shop drawings for cast-in-place meter vaults for approval if proposed construction varies from City of Houston Detail Drawings.

E. Submit manufacturer's certification that plastic meter boxes meet requirements of Paragraph 2.05, Plastic Meter Boxes.

PART 2 P R O D U C T S

2.01 VALVE BOXES

A. Provide approved Type A, cast-iron/ductile-iron, slide-type, valve boxes. Design of valve box shall minimize stresses on valve imposed by loads on box lid.

B. Cast letter "W" into lid, 1/2 inch in height and raised 3/32 inch, for valves serving potable water lines.

C. Unless otherwise specified, uncoated cast iron.

D. Riser Pipe.

1. Provide 6-inch PVC, DR 18, riser pipes in accordance with Section 02506 - Polyvinyl Chloride Pipe or

2. 6-inch ductile-iron, thickness Class 51 riser pipes in accordance with Section 02501 – Ductile Iron Pipe and Fittings.

3. Provide single section of pipe.

E. Concrete for valve box placement:

1. For locations in new concrete pavement, provide strength and mix design of new pavement.

2. For other locations, provide concrete for sidewalks conforming to requirements of Section 02751 - Concrete Paving.

2.02 METER BOXES

A. Provide meter boxes for 5/8-inch through 1-inch meters of the following materials:

1. Non-traffic bearing locations: Cast iron, concrete or plastic.

2. Traffic bearing locations: Cast iron.

B. Provide meter boxes for 1 1/2-inch and 2-inch meters of cast iron.

C. Provide meter box with reading lid. Provide lids with spring-type latching devices. Lids shall contain sufficient metal that meter box can be easily located with metal detector. Cast words “CITY OF HOUSTON” and "WATER METER" into lid with letters of 1/2-inch height and raised 3/32 inch.

D. Meter box dimensions shall conform to the following approximate dimensions:

1. Length: At top – 15 1/2 inches; at bottom 20 inches

2. Width: At top – 12 1/2 inches; at bottom 14 3/4 inches

3. Height: 12 inches

E. Extensions: Meter box extensions 3 inches and 6 inches in height shall be available from manufacturer as standard item.

2.03 CAST-IRON METER BOXES

A. Cast-Iron Boxes: Clean and free from sand blow-holes or other defects conforming to requirements of ASTM A 48, Class 30B. Bearing surfaces shall be machined so that covers seat evenly in frames.

B. Boxes and lids shall have dipped, coal-tar-pitch, varnish finish.

C. Provide lock-type meter boxes when required by Drawings. Lock mechanisms shall work with ease.

2.04 CONCRETE METER BOXES

A. Concrete Meter Boxes: Made of Class A concrete, with minimum 4000 psi compressive strength, conforming to requirements of Section 03315 - Concrete for Utility Construction. Construct to dimensions shown on Drawings.

B. Castings: Free from fractures, large or deep cracks, blisters or surface roughness or any other defects that may affect serviceability.

2.05 PLASTIC METER BOXES

A. Plastic Meter Boxes: Made of high density polyethylene conforming to the following ASTM standards:

ASTM	REQUIREMENT
D 256	Impact Strength = 1.9 ft.-lb./inch (Izod, Notched)
D 256	Impact Strength = 6.4 ft.-lb./inch (Izod, Un-Notched)
D 638	Tensile Strength (2.0 min.) = 3400 psi
D 648	Deflection Temperature = 170 degrees F
D 2240	Shore D, Hardness, 55-65 Impact Strength, Falling Dart Method, 160 inch-lb.
D 790	Flexural Modulus = 90,000 psi

B. Meter boxes shall meet the following test requirements:

1. Static Load: Not less than 2500 pounds using 6-inch disc with direct compression exerted at center of top of meter box with solid plastic lid.

2. Deflection: Not less than 1000 pounds load required to deflect top edge of meter box 1/8- inch.

C. Meter box body, without lid, shall weigh approximately 7 pounds.

2.06 METER VAULTS

A. Meter vaults may be constructed of precast concrete, cast-in-place concrete to the specified dimensions in the City of Houston Detail Drawings.

B. Concrete for Meter Vaults: Class A concrete, conforming to requirements of Section 03315 - Concrete for Utility Construction with minimum compressive strength of 4000 psi at 28 days.

C. Reinforcing steel for meter vaults: Conform to requirements of Section 03315 Concrete for Utility Construction.

D. Grates and Covers: Conform to requirements of Section 02091 – Non Metallic Frames, Grates, Rings, and Covers.

PART 3 E X E C U T I O N

3.01 EXAMINATION

A. Obtain approval from Project Manager for location of meter vault.

B. Verify lines and grade are correct.

C. Verify compacted subgrade will support loads imposed by vaults.

3.02 VALVE BOXES

A. Install riser pipe with suitable length for depth of cover indicated on Drawings or to accommodate actual finish grade.

1. Install with bell on top of valve

2. Place riser pipe in plumb, vertical position

B. Install valve box and riser piping plumbed in a vertical position. Provide 6-inches telescoping freeboard space between riser pipe top butt end, and interior contact flange of valve box, for vertical movement damping. End of pipe resting on valve shall be notched out sufficiently to provide a snug fit around the valve bonnet and to center valve inside of pipe.

C. Set, align, and adjust valve box so that lid is level with final grade.

D. Paint covers of new valve boxes in fluorescent orange when installed. After completion and acceptance by City, repaint covers black.

3.03 METER BOXES

A. Install cast iron or plastic boxes in accordance with manufacturer's instructions.

B. Construct concrete meter boxes to dimensions shown on City of Houston Detail Drawings.

C. Adjust top of meter boxes to conform to cover elevations specified in Paragraph 3.05, Frame and Cover for Meter Vaults.

D. Do not locate under paved areas unless approved by Project Manager. Use approved traffic-type box with cast iron lid when meter must be located in paved areas.

3.04 METER VAULTS

A. Construct concrete meter vaults to dimensions shown on City of Houston Detail Drawings. Do not cast in presence of water. Make bottom uniform. Verify lines and grades are correct and compacted subgrade will support loads imposed by vaults. Interior meter vault depth is not allowed to exceed more than 4 feet unless approved by OCE.

B. Precast Meter Vaults:

1. Install precast vaults in accordance with manufacturer's recommendations. Set level on a minimum 3-inch-thick bed of sand conforming to requirements of Section 02320 - Utility Backfill Materials.

2. Seal lifting holes with cement-sand mortar or non-shrink grout.

C. Meter Vault Floor Slab:

1. Construct floor slabs of 6-inch-thick reinforced concrete. Slope floor 1/4 inch per foot toward sump. Make sump 12 inches in diameter, or 12 inches square, and 4 inches deep, unless other dimensions are required by Drawings. Install dowels at maximum of 18 inches, center-to-center for keying walls to floor slab.

2. Precast floor slab elements may be used for precast vault construction

D. Cast-in-Place Meter Vault Walls:

1. Key walls to floor slab and form to dimensions shown on Drawings. Minimum wall thickness shall be 4 inches.

2. Cast walls monolithically. One cold joint will be allowed when vault depth exceeds 12 feet.

3. Set frame for cover in concrete

3.05 FRAME AND COVER FOR METER VAULTS

A. Set cast iron frame in a mortar bed and adjust elevation of cover as follows:

1. In unpaved areas, set top of meter box or meter vault cover 2 to 3 inches above natural grade

2. In paved areas, set top of meter box or meter vault cover flush with adjacent concrete but no higher than 1/2-inch

3.06 BACKFILL

A. Provide bank run sand in accordance with Section 02320 - Utility Backfill Materials and backfill and compact in accordance with Section 02317 - Excavation and Backfill for Utilities.

B. In unpaved areas, slope backfill around meter boxes and vaults to provide a uniform slope 1-to-5 slope from top to natural grade.

C. In paved areas, slope concrete down from meter box or vault to meet adjacent paved area.

END OF SECTION

SECTION 02136

WASTE MATERIAL HANDLING, TESTING AND DISPOSAL

PART 1 GENERAL

1.01 SECTION INCLUDES

Handling, testing and disposal of hazardous and non-hazardous waste material.

A. Material present inside of existing tanks to be repaired or demolished, i.e., silt, sludge and other residue deposits generated by normal water production usage of the tanks.

B. Existing coatings removed from existing tanks.

C. Spent abrasives used and debris generated in the execution of the work.

D. All spent thinners, coating materials or other products brought on site for execution of work that require disposal as a hazardous or non-hazardous waste.

E. Soil that may be contaminated due to the execution of the work.

F. Petroleum soaked sand foundation material removed from demolished tank sites.

1.02 MEASUREMENT AND PAYMENT

A. No separate measurement and payment will be made for handling, testing or disposal of non-hazardous or hazardous material, debris or material identified as contaminated material on the site prior to the bid date except as indicated in section 1.02 B and 1.02 C. The Contractor shall include the cost for this work in the Contract bid price for work of which this is a component part.

B. Payment for hazardous waste material handling, removal, testing, transporting and disposal of material identified as hazardous after the bid date will be paid for at the unit price bid for "Hazardous Waste Handling, Removal, Transporting" if such an item is provided in the contract.

C. Removal and disposal of potentially petroleum soaked sand foundation material will be measured per cubic yard which shall include testing, removing, storing, transporting and disposing of material and will be paid for at the unit price bid for "Removal and Disposal of Potentially Petroleum Soaked Sand". Basis of payment will be Class I Industrial Waste having a Total Petroleum Hydrocarbon (TPH) level greater than 1500 ppm.

1.03 REFERENCES

The following is a list of applicable requirements to this project. It is not intended to be a complete listing of all laws and regulations to which the Contractor must comply.

A. Environmental Protection Agency - Code of Federal Regulations

1. 40 CFR Part 261 - Identification and Testing of Hazardous Waste

2. 40 CFR 261, Appendix II EPA - Toxicity Characteristic Leaching Procedure

3. 40 CFR Part 262 - Standards Applicable to Generators of Hazardous Waste

4. 40 CFR Part 263 - Standards Applicable to Transporters of Hazardous Waste

5. 40 CFR Part 264 - Standards for Owner and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities

6. 40 CFR Part 265 - Interim Status for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities

7. 40 CFR 265, Subpart C EPA - Preparedness and Prevention

8. 40 CFR 265, Subpart D EPA - Contingency Plan and Emergency Procedures

9. 40 CFR 265.16 EPA - Personnel Training

10. 40 CFR Part 268 - Land Disposal Restrictions

11. 49 CFR Parts 173,178 and 179: (USDOT/ Hazardous Materials, Shipping, Containers.)

12. 40 CFR Part 355 - Emergency Planning and Notification

B. EPA Methods

1. 3050 - Acid Digestion of Sediment, Sludge, and Soils

2. SW 846 - Test Methods for Evaluating Solid Waste - Physical/Chemical Methods

C. Texas Commission on Environmental Quality

1. TAC Title 30, Chapter 305 "Consolidated Permits"

2. TAC Title 30, Chapter 335 "Industrial Solid Waste and Municipal Hazardous Waste"

3. TAC Title 30, Chapter 343 "Oil and Hazardous Substances"

D. TWC Technical Guidelines

1. Document #1, Waste Evaluation/Classification

E. NIOSH Methods

1. 7082 Lead

F. Society for Protective Coatings

1. SSPC 91-18 - Industrial Lead Paint Removal Handbook

2. Guide 6 - Guide for Containing Debris Generated During Paint Removal Operations

3. Guide 7 - Guide for the Disposal of Lead Contaminated Surface Preparation Debris

1.04 SUBMITTALS

A. Submittals shall conform to requirements of Section 01330 – Submittal Procedures.

B. Submittals shall conform to appropriate codes for regulatory requirements.

C. Obtain and submit disposal permits for proposed disposal sites, if required by local ordinances.

1.05 TESTING AND IDENTIFICATION

A. The Owner is the Generator of the debris for permitting purposes, and will obtain the EPA Identification number, but the Contractor is responsible for assuring that all testing, handling, storage, transportation, and disposal requirements are properly implemented, including satisfactory training of job site personnel and the cleaning of all reusable items and equipment prior to removal from the site.

B. Prior to the bid date, if testing has been performed by the City and if hazardous material has been identified in the debris material in an existing tank, the paint to be removed from an existing tank, the work site soil, or the foundation material, the material or test results will be indicated in section 01110. It is the responsibility of the Contractor to properly test and to determine if any wastes generated as a result of this project are hazardous in accordance with 40 CFR Part 261.

1.06 DEFINITIONS

(Note Definitions applicable to this section are also presented elsewhere.)

A. Hazardous Waste (lead paint debris): Waste that is classified as hazardous due to its concentrations of regulated hazardous substances. Paint debris is classified as hazardous waste if, after testing by the Toxicity Characteristic Leaching Procedure (TCLP), the leachate contains any

of the 8 metals or other substances in concentrations at or above limits established in 40 CFR 261.

B. Lead Containing Dust and Debris: Dust and debris generated during the project which contains lead in any amount, including but not limited to pulverized paint, spent abrasive, filters (wet and dry), and containment materials upon which lead is still present.

C. RCRA: Resource Conservation and Recovery Act. Federal law pertaining to hazardous waste management. EPA implementing regulations are contained in 40 CFR 240-280.

D. TACB: Texas Air Control Board. Texas State Agency joined into the TCEQ and responsible for writing and enforcement of rules and regulations relating to air quality.

E. TCEQ: Texas Commission on Environmental Quality. State of Texas Commission responsible for planning, oversight, monitoring and management of natural resources.

F. TCLP: Toxicity Characteristic Leaching Procedure. Laboratory tests conducted on wastes that determine the amount of hazardous materials that leach out into a test solution. The test is intended to simulate the properties of water as it leaches through a solid waste landfill. TCLP testing is defined in 40 CFR 261, Appendix II.

G. TWC: Texas Water Commission. Texas State Agency joined into the TCEQ and responsible for writing and enforcement of rules and regulations relating to water quality and solid waste programs.

PART 2 NOT USED

PART 3 EXECUTION

3.01 WASTE HANDLING AND STORAGE

A. All chemicals to be brought on site by the contractor must be stored and used in a safe and proper manner in accordance with all applicable Federal, State and local laws and regulations as well as the manufacturers recommendations. Material Safety Data Sheets (MSDSs) shall be maintained on-site for all hazardous chemicals used.

B. Hazardous wastes are to be handled and stored according to the requirements of TAC 30 Chapter 335 "Industrial Solid Waste and Municipal Hazardous Waste" and 40CFR Part 262, with regard to on-site storage, and 40CFR Part 264 with regard to required notices, site security, personnel training, contingency planning and emergency procedures, recordkeeping and reporting, time of storage, amount of material stored, and use of proper containers. Hazardous waste will be stored in covered containers in accordance with the requirements of 40 CFR 262 and 49 CFR 172,178 and 179.

C. The contractor shall provide proper, segregated storage for hazardous and non-hazardous

materials to be used in the work area in order to ensure safe work conditions.

D. All material, waste and debris from removal of lead containing coatings, including those products and materials employed for chemical paint stripping , shall be considered hazardous waste and handled accordingly, until such time that testing and analysis indicates otherwise.

1. Sampling of materials for TCLP testing of initial containers of debris shall be completed prior to or during filling. Until the TCLP test results are received, the containers shall be labeled as lead-containing debris. Hazardous waste labels shall be applied after the test results are received, if the debris tests hazardous.

2. Hazardous waste shall not be stored at the project site for more than 90 days. Non-hazardous wastes shall be removed at a minimum of once per month (30 days).

3. Special attention shall be given to the time of storage, storage conditions, amount of material stored at any one time, use of proper containers, and personnel training.

E. Hazardous waste shall be placed on pallets over protected ground, be located in a secure area enclosed by a fence with signs around the perimeter, and be shielded adequately to prevent dispersion of the waste by wind or water. Under no circumstances shall the waste be stored within a flood plain area. Any evidence of improper storage shall be cause for immediate shutdown of the project until corrective action is taken. The storage area shall be within a security fence with a locked gate.

3.02 ENVIRONMENTAL CONTAMINATION

The contractor shall not contaminate the air, soils or surface and ground waters with any hazardous waste. Spills, releases and discharges of hazardous or toxic materials which inadvertently occur shall be reported in accordance with 40 CFR 265 and TAC 30 Chapter 343.

A. Contingency Plan and Training: The Contractor shall comply with TCEQ Title 30 Regulations and EPA 40 CFR 265, Subpart C in the event of a spill or release of waste, EPA 40 CFR 265 Subpart D, and TCEQ regulations.

B. All personnel associated with the handling of hazardous waste shall complete a formal training program in accordance with 40 CFR 265.16 and TCEQ Title 30 Regulations. Training records of all employees must be maintained and kept on file.

3.03 WASTE CLASSIFICATION

A. Testing

1. All solid waste generated by the paint removal activities shall be tested in accordance with 40 CFR 261, Appendix II, Method 1311 Toxicity Characteristic Leaching Procedure (TCLP), to determine if it is hazardous.

2. In the case of wet methods of preparation, the use of chemical strippers, or containerized hygiene water, all liquids and sludge shall also be tested. When chemical strippers are used, the testing shall include pH to determine corrosivity. All waste water shall be tested for total lead.

3. Representative samples of the debris for each waste stream generated from the work on this project shall be collected. A minimum of four of the samples representative of each waste stream shall be analyzed to establish a waste is non-hazardous. Note that more than four initial samples of each waste stream shall be collected in order to obtain the four representative samples for analysis. Results from one test sample are sufficient to identify a waste as hazardous.

4. The collection of the initial representative samples of each waste stream and selection of the minimum of four for testing shall be accomplished using a random sampling technique and shall comply with the following: a minimum of one representative sample for each 55 gallons of waste, or a minimum of four representative samples for each gondola or roll-off box of waste. Samples shall be collected in accordance with SW-846, "Test Methods for Evaluating Solid Waste - Physical/ Chemical Methods".

5. Sampling and testing shall be performed by a certified laboratory acceptable to the Owner. The name, address, and qualifications of the laboratory shall be provided for approval. The Owner shall be provided with copies of the test results as soon as they are received by the Contractor.

B. Classification

1. Lead paint debris is classified as hazardous waste if, after testing by TCLP, the leachate contains any of the 8 metals or other hazardous substances in concentrations at or above limits established in 40 CFR 261:

Arsenic -	5.0 mg/L
Barium -	100.0 mg/L
Cadmium -	1.0 mg/L
Chromium -	5.0 mg/L
Lead -	5.0 mg/L
Mercury -	0.2 mg/L
Selenium -	1.0 mg/L
Silver -	5.0 mg/L

2. The above includes only the eight (8) characteristic metals listed by EPA among which are elements typically associated with paints. Other substances may be present which may cause debris to be classified as hazardous waste as defined in 40 CFR 261 (such as a pH <=2.0 or >=12.5 resulting in corrosivity), and must be taken into account.

3.04 DISPOSAL

A. The contractor shall arrange to have wastes and debris transported from the site in accordance with all City Ordinances and State and Federal Laws. If wastes and/or debris is determined to be hazardous, transporting to be in accordance with TAC 30 Chapter 335 -Industrial Solid Waste and Municipal Hazardous Waste, 40CFR Part 263 - Standards Applicable to Transporters of Hazardous Waste and the applicable sections of 49 CFR Parts 171 through 179.

B. Manifest and Reporting: The Contractor shall comply with all of the manifesting, certification, and reporting requirements of EPA 40 CFR 262, 40 CFR 268, and Texas regulations, including certificates of final disposal for each shipment.

C. Copies of all records and reports, test sample chain of custody forms, TCLP and other test results shall be provided to the Owner.

D. The contractor shall dispose of wastes and debris at a licensed site acceptable to the Owner. Hazardous wastes and debris shall be disposed of in accordance with 40CFR Part 265 and 40CFR Part 268 Land Disposal Restrictions. Manifesting of hazardous wastes shall be in accordance with 40CFR Part 262, Subpart B.

E. Waste water resulting from surface preparation, washing, personal hygiene or decontamination shall not be discharged without testing and through arrangement with the local Publicly Owned Treatment Works (POTW) or other approved means.

END OF SECTION

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Section 02221

REMOVING EXISTING PAVEMENTS, STRUCTURES, WOOD, AND DEMOLITION DEBRIS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Removing concrete paving, asphaltic concrete pavement, brick pavement and base courses.

B. Removing concrete curbs, concrete curbs and gutters, sidewalks and driveways.

C. Removing pipe culverts, sewers, and sewer leads.

D. Removing waterlines and water services lines including asbestos cement pipe per OSHA guidelines.

E. Removing existing inlets and manholes.

F. Removing and disposing of pre-stressed concrete beams and drill shafts.

G. Removing miscellaneous structures of concrete or masonry.

H. Removing existing bridge.

I. Removing existing wood and demolition debris.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for removing and disposing of asphaltic surfacing with or without base, regardless of thickness encountered, is on square yard basis measured between lips of gutters.

2. Payment for removing and disposing of reinforced concrete pavement, with or without asphalt overlay, regardless of its thickness, is on square yard basis measured from back-to-back of curbs. Payment includes concrete pavement, esplanade curbs, curbs and gutters, and paving headers.

3. Payment for removing and disposing of cement stabilized shell base course, with or without asphaltic surfacing, is on square yard basis.

4. Payment for removing and disposing of concrete sidewalks and driveways is on square yard basis.

5. Payment for removing asphaltic pavement surface by milling shall be in accordance with Section 2960.

6. Payment for removing and disposing of miscellaneous concrete and masonry is on cubic yard basis of structure in place.

7. Payment for removing and disposing of pipe culverts, sewers, and sewer leads, is on linear foot basis for each diameter and each material type of pipe removed.

8. Payment for removing and disposing of waterlines and water service lines including asbestos cement pipe is on linear foot basis for each diameter pipe and each material type of pipe removed.

9. Payment for removing and disposing of existing inlets is on unit price basis for each inlet removed.

10. Payment for removing and disposing of prestressed concrete piles and drill shafts is on linear foot basis.

11. Payment for removing and disposing of existing bridge, including piles and abutments to minimum of 4 feet below ground level, is on a lump sum basis.

12. Payment for removing and disposing of existing manholes is on unit price basis for each manhole removed.

13. Payment for removing and disposing of miscellaneous wood and demolition debris is on cubic yard basis.

14. No payment for saw cutting of pavement, curbs, or curbs and gutters will be made under this section. Include cost of such work in unit prices for items listed in bid form requiring saw cutting.

15. No payment will be made for work outside maximum payment limits indicated on Drawings, or for pavements or structures removed for Contractor's convenience.

    a. For utility installations: Match actual pavement replaced but no greater than maximum pavement replacement limits shown on Drawings. Limits of measurement will be as shown on Street Cut Pavement Replacement Rules.

16. Refer to Section 01270 - Measurement and Payment for unit price procedures

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REGULATORY REQUIREMENTS

A. Conform to applicable codes for disposal of debris.

B. Coordinate removal work with utility companies.

C. For removal of asbestos containing materials, or material that could potentially contain asbestos, comply with applicable provisions of OSHA 29 CFR 1926.1101 – Asbestos, OSHA 29 CFR 1926.32 – General Safety and Health Provisions, and EPA 40 CFR 61 Subpart M – National Emission Standard for Asbestos.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Obtain advance approval from Project Manager for dimensions and limits of removal work.

B. Identify known utilities below grade. Stake and flag locations.

C. For removal of asbestos-containing materials, or materials that oculd potentially contain asbestos, comply with the following:

1. Crew members must be trained in accordance with OSHA 29 CFR 1926.1101 – Asbestos.

2. Conduct negative exposure assessment to demonstrate asbestos exposure below permissible exposure limit (PEL) in accordance with OSHA 29 CFR 1926.1101 – Asbestos and EPA 40 CFR 763 – Asbestos.

3. If negative exposure assessment not conducted, or if results are above PEL, provide respiratory protection in accordance with Paragraph 3.02 of this Section.

3.02 PROTECTION

A. Protect following from damage or displacement:

1. Adjacent public and private property.

2. Trees, plants, and other landscape features designated to remain.

3. Utilities designated to remain.

4. Pavement and utility structures designated to remain.

4. Bench marks, monuments, and existing structures designated to remain.

B. When required, provide respiratory protection in accordance with OSHA 29 CFR 1910.134 – Respiratory Protection, and National Institute of Occupational Safety and Health (NIOSH).

3.03 REMOVALS

A. Remove pavements and structures by methods that will not damage underground utilities. Do not use drop hammer near existing underground utilities.

B. Minimize amount of earth loaded during removal operations.

C. Where existing pavement is to remain, make straight saw cuts in existing pavement to provide clean breaks prior to removal. Do not break concrete pavement or base with drop hammer unless concrete or base has been saw cut to minimum depth of 2 inches.

D. When street and driveway saw cut location is greater than one-half of pavement lane width, remove pavement for full lane width or to nearest longitudinal joint as directed by Project Manager.

E. Remove sidewalks and curbs to nearest existing dummy, expansion, or construction joint.

F. Where existing end of pipe culvert or end of sewer is to remain, install 8-inch-thick masonry plug in pipe end prior to backfill in accordance with requirements of Section 02316 - Excavation and Backfill for Structures.

G. Labeling of Asbestos Cement (AC) Pipe:

1. Label leak-tight container with warning statement of hazardous asbestos content in accordance with OSHA 29 CFR 1926.1101 and as noted below.

2. Label waste material with following warning:

DANGER
CONTAINS ASBESTOS FIBERS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
DO NOT BREATHE DUST
AVOID CREATING DUST

3. Neatly print labels in letters of sufficient size and contrast so label is easily visible and legible.

3.04 BACKFILL

A. Backfill of removal areas shall be in accordance with requirements of Section 02316 - Excavation and Backfill for Structures.

3.05 DISPOSAL

A. Inlet frames, grates, and plates; and manhole frames and covers, may remain City property. Disposal shall be in accordance with requirements of Section 01576 - Waste Material Disposal.

B. Remove from site, debris resulting from work under this section in accordance with requirements of Section 01576 - Waste Material Disposal.

C. For asbestos-containing materials:

1. Comply with 40 CFR Part 61 and 30 TAC Sections 330.137(b) for Industrial Class 1 waste.

2. Inspect load to ensure correct packaging and labeling.

3. Line vehicles with two layers of 6-mil polyethylene sheeting.

4. Remove asbestos-containing waste from site daily.

END OF SECTION

Section 02222

ABANDONMENT OF SEWERS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Abandonment in place of existing sewers, junction structures, manholes, and force mains.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for grout fill and abandonment of existing sewers, including boxes and elliptical shaped sewers, is on linear foot basis for each diameter of sewer being abandoned. Measurement will be along centerline of sewer from centerline to centerline of manholes.

2. Payment for grout fill and abandonment of sewer manholes or junction structure is by each manhole or junction structure abandoned in conformance with this Section.

3. Payment will be full compensation for all material, equipment, and labor required for complete abandonment grouting, including air venting, testing, temporary plugs, fill lines, excavations, and incidentals.

4. No separate payment will be made for plugging and abandoning sewer force mains. Include cost of such abandonment in related work.

5. Refer to Section 01270 - Measurement and Payment for unit price procedures.

6. Acceptability of grout material is based on achieving average strength within range of 75 to 150 psi as defined in Paragraph 2.01B.1. Grout that is out of range after placement may be accepted with price adjustment of 1.0 percent price deduction for each psi average compressive strength below 75 psi and 0.5 percent price deduction for each psi average compressive strength above 150 psi, as applicable to material volume represented by test series. Shrinkage in grout material placements shall be remedied by Contractor according to Paragraph 3.04H without additional compensation.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.03 DEFINITIONS

A. Abandonment. Sewer abandonment consists of demolition and removal of portion of manholes existing within specified depth of surface, and abandonment in place of sewer lines and manholes as specified in this Section.

B. Flowable Fill. Flowable fill (abandonment grout) shall be controlled low-strength material consisting of fluid mixture of cement, fly ash, aggregate, water and with admixtures as necessary to provide workable properties. Placement of flowable fill may be by grouting techniques in sewer pipes or other restricted areas, or as mass placement by chutes or tremie methods in unrestricted locations with open access. Long-term hardened strength shall be within specified range.

C. Ballast. Large aggregate either replaced with voids subsequently filled with flowable fill injected by grouting method; or in areas with open access, placed individually and sequentially at same time as flowable fill placement.

D. Backgrouting. Secondary stage pressure grouting to ensure that voids have been filled within abandoned sewer. Backgrouting will only be required at critical locations indicated on Drawings or if there is evidence of incomplete flowable fill placements.

1.04 REFERENCE STANDARDS

A. ASTM C 150 - Standard Specification for Portland Cement.

B. ASTM C 494 - Standard Specification for Chemical Admixture for Concrete.

C. ASTM C 618 - Standard Specification for Fly Ash and Raw or Calcinated Natural Pozzolan for use as Mineral Admixture in Portland Cement Concrete.

D. ASTM C 937 - Standard Specification for Grout Fluidifier for Pre-placed Aggregate Concrete.

E. ASTM C 940 - Standard Test Method for Expansion and Bleeding of Freshly Mixed Grout for Replaced Aggregate Concrete in the Laboratory.

F. ASTM C 1017 - Standard Specification for Chemical Admixture for Use in Producing Flowing Concrete.

G. ASTM C 1107 - Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.
B. Flowable fill mix design report:

1. Flowable fill type and production method. Describe if fill will be mixed to final proportions and consistency in batch plant or if constituents will be added in transit mixer at placement location.

2. Use of ballast. Provide percentage of ballast of total placement and size limits for ballast if fill is intended to be used with ballast.

3. Aggregate gradation of fill. Aggregate gradation of mix (excluding ballast) shall be used as pilot curve for quality control during production.

4. Fill mix constituents and proportions including materials by weight and volume, and air content but excluding ballast. Give types and amounts of admixtures including air entrainment or air generating compounds.

5. Fill densities and viscosities, including wet density at point of placement.

6. Initial time of set.

7. Bleeding and shrinkage.

8. Compressive strength.

C. Technical information for equipment and operational procedures including projected slurry injection rate, grout pressure, method of controlling grout pressure, bulkhead and vent design, and number of stages of grout application.

D. Experience record for proposed crew, showing minimum of 100 cubic yards of flowable fill placed using proposed or similar equipment and methods.

E. At least 60 days prior to commencing abandonment activities, submit plan for abandonment, describing proposed grouting sequence, bypass pumping requirements and plugging, if any, and other information pertinent to completion of work.

PART 2 P R O D U C T S

2.01 FLOWABLE FILL

A. Design Mix Criteria. Provide design of one or more mixes to meet design criteria and conditions for placement. Present information required by Paragraph 1.05B in mix design report including following:

1. Cement: ASTM C 150 Type I or II. Volume and weight per cubic yard of fill. Provide minimum cement content of 100 pounds per cubic yard.

2. Fly ash: ASTM C 618 Class C or F. Volume and weight per cubic yard of fill. Provide minimum Fly ash content of 200 pounds per cubic yard.

3. Potable water: Volume and weight per cubic yard of fill. Amount of water determined by mix design testing.

4. Aggregate gradation: 100 percent passing 3/8-inch sieve and not more than 10 percent passing No. 200 sieve. Mix design report shall define pilot gradation based on following sieve sizes 3/8-inch, Nos. 4, 8, 16, 30, 50, 100, and 200. Do not deviate from pilot gradation by more than plus or minus 10 percentage points for any sieve for production material.

5. Aggregate source material: Screened or crushed aggregate, pit or bank run fine gravels or sand, or crushed concrete. If crushed concrete is used, add at least 30 percent of natural aggregate to provide workability.

6. Admixtures: Use admixtures meeting ASTM C 494 and ASTM C 1017 as needed to improve pumpability, to control time of set, and reduce bleeding.

7. Fluidifier: Use fluidifier meeting ASTM C 937 as necessary to hold solid constituents in suspension. Add shrinkage compensator if necessary.

8. Performance additive: Use flowable fill performance additive, such as Darafill or approved equal, to control fill properties.

B. Flowable Fill Requirements

1. Unconfined compressive strength: minimum 75 psi and maximum 150 psi at 56 days as determined based on an average of three tests for same placement. Present at least three acceptable strength tests for proposed mix design in mix design report.

2. Placement characteristics: self-leveling.

3. Shrinkage characteristics: non-shrink.

4. Water bleeding for fill to be placed by grouting method in sewers: not to exceed 2 percent according to ASTM C 940.

5. Minimum wet density: 90 pounds per cubic foot.

2.02 BALLAST

A. Ballast Material: Natural rock or concrete pieces with minimum size equal to at least 10 times maximum aggregate size of flowable fill and maximum size of 24 inches. Maximum dimension shall not be more than 20 percent of minimum dimension of space to be filled.

B. Ballast Composition: Free of regulated waste material.

2.03 PLUGS FOR FORCE MAINS

A. Grout Plugs: Cement-based dry-pack grout conforming to ASTM C 1107, Grade B or C.

B. Manufactured Plug: Commercially available plug or cap specifically designed and manufactured to be used with pipe being abandoned.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Have fill mix design reports and other submittals required by Paragraph 1.05 accepted by Project Manager prior to start of placement. Notify Project Manager at least 24 hours in advance of grouting with flowable fill.

B. Select fill placement equipment and follow procedures with sufficient safety and care to avoid damage to existing underground utilities and structures. Operate equipment at pressure that will not distort or imperil portion of work, new or existing.

C. Clean sewer lines and video with closed circuit television to identify connections, locate obstructions, and assess condition of pipe. Locate previously unidentified connections, which have not been redirected and reconnected as part of this project, and report them to Project Manager. During placement of fill, compensate for irregularities in sewer pipe, such as obstructions, open joints, or broken pipe to ensure no voids remain unfilled.

D. Perform demolition work prior to starting fill placement. Clean placement areas of sewers and manholes of debris that may hinder fill placement. Remove excessive amounts of sludge and other substances that may degrade performance of fill. Do not leave sludge or other debris in place if filling more than 2 percent of placement volume. Dispose of waste material in compliance with Section 01576 - Waste Material Disposal.

E. Remove free water prior to starting fill placement.

3.02 EQUIPMENT

A. Mix flowable fill in automated batch plant and deliver it to site in ready-mix trucks. Performance additives may be added at placement site if required by mix design.

B. Use concrete or grout pumps capable of continuous delivery at planned placement rate.

3.03 DEMOLITION OF SEWER MANHOLES, PIPELINE STRUCTURES, AND FORCE MAINS PRIOR TO ABANDONMENT

A. Remove manhole frames and covers and castings from other existing pipeline structures. Deliver castings to nearest City of Houston maintenance facility for future use. Alternatively,

salvaged castings may be used upon approval by Project Manager, for constructing new manholes on this project.

B. Demolish and remove precast concrete adjustment rings and corner section, or brick and mortar corbel and chimney, or other pipeline structure, to minimum depth of 4 feet below finished grade. Structure may be removed to greater depth, but not deeper than 18 inches above crown of abandoned sewer.

C. When adjacent sewer lines are not to be filled, place temporary plugs in each line connecting to manhole, in preparation for filling manhole.

D. Excavate overburden from force mains to be abandoned at locations indicated on Drawings, conforming to Section 02317 - Excavation and Backfill for Utilities. Cut existing force main, when necessary, to provide an end surface perpendicular to axis of pipe and suitable for plug to be installed. Remove force main piping material remaining outside of segment to be abandoned.

3.04 INSTALLATION

A. Abandon sewer lines by completely filling sewer line with flowable fill. Abandon manholes and other structures by filling with flowable fill, together with ballast as applicable, within depth of structures left in place.

B. Place flowable fill to fill volume between manholes. Continuously place flowable fill from manhole to manhole with no intermediate pour points, but not exceeding 500 feet in length.

C. Have filling operation performed by experienced crews with equipment to monitor density of flowable fill and to control pressure.

D. Temporarily plug sewer lines which are to remain in operation during pouring/pumping to keep lines free of flowable fill.

E. Pump flowable fill through bulkheads constructed for placement of two 2-inch PVC pipes or use other suitable construction methods to contain flowable fill in lines to be abandoned. These pipes will act as injection points or vents for placement of flowable fill.

F. Place flowable fill under pressure flow conditions into properly vented open system until flowable fill emerges from vent pipes. Pump flowable fill with sufficient pressure to overcome friction and to fill sewer from downstream end, to discharge at upstream end.

G. Inject flowable fill through replaced ballast using grouting equipment and series of grout pipes discharging at bottom of placement, allowing fill to rise through ballast effectively filling all voids. Alternatively, sequentially place individual pieces of ballast at same time as flowable fill is placed. Do not fill with ballast more than 50 percent of volume at any level, to prevent nesting and void formation.

H. Remediate placement of flowable fill which does not fill voids in sewer, in manhole or other structures, or where voids develop due to excessive shrinkage or bleeding of fill, by using pressure grouting either from inside sewer or from surface. Pressure grout shall conform to Section 02431 - Tunnel Grout.

I. Plug each end of force main being abandoned.

J. Force main abandonment

1. Clean inside surface of force main at least 12 inches from ends to achieve firm bond and seal grout plug or manufactured plug to pipe surface. Similarly, clean and prepare exterior pipe surface if manufactured cap is to be used.

2. When using grout plug, place temporary plug or bulkhead approximately 12 inches inside pipe. Fill pipe end completely with dry-pack grout mixture.

3. When using manufactured plug or cap, install fitting as recommended by manufacture's instructions, to form water tight seal.

K. Backfill to surface, above pipe or structures left in place, with flowable fill in restricted areas, compacted bank run sand in unrestricted areas to be paved or select fill in unrestricted areas outside of pavement. Place and compact backfill, other than flowable fill, in compliance with Section 02317 - Excavation and Backfill for Utilities.

L. Collect and dispose of excess flowable fill material and other debris in accordance with Section 01576 - Waste Material Disposal.

3.05 FIELD QUALITY CONTROL

A. Provide batch plant tickets for each truck delivery of flowable fill. Note on tickets addition of admixtures at site.

B. Check flow characteristics and workability of fill as placement proceeds.

C. Obtain at least three test cylinders for each placement area for determination of 56-day compressive strength and bleeding. Acceptance of placement will be based on average strength of three tests.

D. Record volume of ballast together with flowable fill placement for same space to demonstrate that voids have been filled.

3.06 PROTECTION OF PERSONS AND PROPERTY

A. Provide safe working conditions for employees throughout demolition and removal operations. Observe safety requirements for work below grade.

B. Maintain safe access to adjacent property and buildings. Do not obstruct roadways, sidewalks or passageways adjacent to work.

END OF SECTION

Section 02233

CLEARING AND GRUBBING

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Removing surface debris and rubbish.

B. Clearing site of plant life and grass.

C. Removing trees and shrubs.

D. Removing root system of trees and shrubs.

E. Fence removal.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for clearing and grubbing is on per acre basis.

2. <u>No separate payment will be made for clearing and grubbing of wastewater projects, include payment in unit prices for related items.</u>

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REGULATORY REQUIREMENTS

A. Conform to applicable codes for disposal of debris.

B. Coordinate clearing work with utility companies.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Verify that existing plant life and features designated to remain are identified and tagged.

3.02 PROTECTION

A. Protect following from damage or displacement:

1. Living trees located 3 feet or more outside of intersection of side slopes and original ground line.

2. Plants other than trees and landscape features designated to remain.

3. Utilities designated to remain.

4. Bench marks, monuments, and existing structures designated to remain.

3.03 CLEARING

A. Remove stumps, main root ball, and root system to:

1. Depth of 24 inches below finished subgrade elevation in area bounded by lines two feet behind back of curbs.

2. Depth of 24 inches below finished surface of required cross section for other areas.

B. Clear undergrowth and deadwood without disturbing subsoil.

C. Remove vegetation from top soil scheduled for reuse.

3.04 REMOVAL

A. Remove debris, rubbish, and extracted plant material life from site in accordance with requirements of Section 01576 - Waste Material Disposal.

B. Remove on site fences. Materials generated from removal of fences become property of Contractor. Properly dispose of in accordance with applicable local, state and federal laws.

END OF SECTION

Section 02260

TRENCH SAFETY SYSTEM

PART G E N E R A L

1.01 SECTION INCLUDES

A. Trench safety system for the construction of trench excavations.

B. Trench safety system for excavations which fall under provisions of State and Federal trench safety laws.

C. This Standard Specification Section replaces previously published Section 01561-Trench Safety System.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. Measurement for trench safety systems used on trench excavations is on a linear foot basis measured along the centerline of the trench, including manholes and other line structures.

2. No payment will be made under this section for trench safety systems for structural excavations, tunnel shafts, auger pits, or excavation for trenchless installations, and also for any necessary non trenchless installations included in the aforementioned methods of construction unless included as a bid item in Documents 00410 – Bid Form. Include payment for trench safety systems in applicable structural or utility installation sections.

3. Refer to Section 01270 - Measurement and payment for unit price procedures.

B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.03 DEFINITIONS

A. A trench shall be defined as a narrow excavation (in relation to its depth) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet.

B. The trench safety system requirements will apply to larger open excavations if the erection of structures or other installations limits the space between the excavation slope and these installation to dimensions equivalent of a trench as defined.

C. Trench Safety Systems include but are not limited to sloping, sheeting, trench boxes or trench shields, sheet piling, cribbing, bracing, shoring, dewatering or diversion of water to provide adequate drainage.

D. Trench Safety Program is the safety procedures governing the presence and activities of individuals working in and around trench excavations.

1.04 SUBMITTALS

A. Submittals shall conform to requirements of Section 01330 - Submittal Procedures.

B. Submit a safety program specifically for the construction of trench excavation. Design the trench safety program to be in accordance with OSHA 29CFR standards governing the presence and activities of individuals working in and around trench excavations.

C. Construction and shop drawings containing deviations from OSHA standards or special designs shall be sealed by a licensed Engineer retained and paid by Contractor.

D. Review of the safety program by the City Engineer will only be in regard to compliance with this specification and will not constitute approval by the City Engineer nor relieve Contractor of obligations under State and Federal trench safety laws.

E. Submit certification that trench safety system will not be subjected to loads exceeding those which the system was designed to withstand according to the available construction and geotechnical information.

1.05 REGULATORY REQUIREMENTS

A. Install and maintain trench safety systems in accordance with the detail specifications set out in the provision of Excavations, Trenching, and Shoring, Federal Occupation Safety and Health Administration (OSHA) Standards, 29CFR, Part 1926, Subpart P, as amended, including Final Rule, published in the Federal Register Vol. 54, No. 209 on Tuesday, October 31, 1989. The sections that are incorporated into these specifications by reference include Sections 1926-650 through 1926-652.

B. A reproduction of the OSHA standards included in "Subpart P - Excavations" from the Federal Register Vol. 54, No. 209 is available upon request to Contractors bidding on City projects. The City assumes no responsibility for the accuracy of the reproduction. The Contractor is responsible for obtaining a copy of this section of the Federal Register.

C. Legislation that has been enacted by the Texas Legislature with regard to Trench Safety Systems, is hereby incorporated, by reference, into these specifications. Refer to Texas Health and Safety Code Ann., §756.021 (Vernon 1991).

D. Reference materials, if developed for a specific project, will be issued with the Bid Documents, including the following:

1. Document 00830 - Trench Safety Geotechnical Information: Geotechnical information obtained for use in design of the trench safety system.

1.06 INDEMNIFICATION

A. Contractor shall indemnify and hold harmless the City, its employees and agents, from any and all damages, costs (including, without limitation, legal fees, court costs, and the cost of investigation), judgements or claims by anyone for injury or death of persons resulting from the collapse or failure of trenches constructed under this Contract.

B. Contractor acknowledges and agrees that this indemnity provision provides indemnity for the City in case the City is negligent either by act or omission in providing for trench safety, including, but not limited to safety program and design reviews, inspections, failures to issue stop work orders, and the hiring of the Contractor.

PART P R O D U C T S - Not Used

PART E X E C U T I O N

3.01 INSTALLATION

A. Install and maintain trench safety systems in accordance with provisions of OSHA 29CFR.

B. Install specially designed trench safety systems in accordance with the Contractor’s trench excavation safety program for the locations and conditions identified in the program.

C. A competent person, as identified in the Contractor’s Trench Safety Program, shall verify that trench boxes and other premanufactured systems are certified for the actual installation conditions.

3.02 INSPECTION

A. Contractor, or Contractor's independently retained consultant, shall make daily inspections of the trench safety systems to ensure that the installed systems and operations meet OSHA 29CFR and other personnel protection regulations requirements.

B. If evidence of possible cave-ins or slides is apparent, Contractor shall immediately stop work in the trench and move personnel to safe locations until the necessary precautions have been taken by Contractor to safeguard personnel entering the trench.

C. Maintain a permanent record of daily inspections.

3.03 FIELD QUALITY CONTROL

A. Contractor shall verify specific applicability of the selected or specially designed trench safety systems to each field condition encountered on the project.

END OF SECTION

Section 02316

EXCAVATION AND BACKFILL FOR STRUCTURES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Excavation, backfilling, and compaction of backfill for structures.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No payment will be made for structural excavation and backfill under this Section. Include payment in unit price or lump sum for construction of structures.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 DEFINITIONS

A. Unsuitable Material: Unsuitable soil materials are the following:

1. Materials that are classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.

2. Materials that cannot be compacted to required density due to gradation, plasticity, or moisture content.

3. Materials that contain large clods, aggregates, stones greater than 4 inches in any dimension, debris, vegetation, waste or any other deleterious materials.

4. Materials that are contaminated with hydrocarbons or other chemical contaminants.

B. Suitable Material: Suitable soil materials are those meeting specification requirements. Unsuitable soils meeting specification requirements for suitable soils after treatment with lime or cement shall be considered suitable, unless otherwise indicated.

C. Select Material: Material as defined in Section 02320 - Utility Backfill Materials.

D. Backfill: Material meeting specified quality requirements, placed and compacted under controlled conditions around structures.

E. Foundation Backfill Materials: Natural soil or manufactured aggregate meeting Class I requirements and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill where needed to provide stable support for structure foundation base. Foundation backfill materials may include concrete fill and seal slabs.

F. Foundation Base: For foundation base material, use crushed stone aggregate with filter fabric as required, cement stabilized sand, or concrete seal slab. Foundation base provides smooth, level working surface for construction of concrete foundation.

G. Foundation Subgrade: Foundation subgrade is surface of natural soil which has been excavated and prepared to support foundation base or foundation backfill, where needed.

H. Ground Water Control Systems: Installations external to excavation such as well points, eductors, or deep wells. Ground water control includes dewatering to lower ground water, intercepting seepage which would otherwise emerge from side or bottom of excavation, and depressurization to prevent failure or heaving of excavation bottom. Refer to Section 01578 - Control of Ground Water and Surface Water.

I. Surface Water Control: Diversion and drainage of surface water runoff and rain water away from excavation. Remove rain water and surface water which accidentally enters excavation as part of excavation drainage.

J. Excavation Drainage: Removal of surface and seepage water in excavation by sump pumping and using French drains surrounding foundation to intercept water.

K. Over-Excavation and Backfill: Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below foundation as shown on Drawings, and backfilled with foundation backfill material.

L. Shoring System: Structure that supports sides of an excavation to maintain stable soil conditions and prevent cave-ins.

1.04 REFERENCES

A. ASTM D 698 - Standard Test Methods for Laboratory Compaction of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600kN-m/m^3)).

B. ASTM D 1556 - Standard Test Method for Density of Soil in Place by Sand-Cone Method.

C. ASTM D 2922 - Standard Test Methods for Density of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

D. ASTM D 3017 - Standard Test Method for Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depths).

E. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

F. TxDOT Tex-101-E - Preparing Soil and Flexible Base Materials for Testing.

G. TxDOT Tex-110-E - Particle Size Analysis of Soils.

H. Federal Regulations, 29 CFR, Part 1926, Standards - Excavation, Occupational Safety and Health Administration (OSHA).

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit work plan for excavation and backfill for each structure with complete written description which identifies details of proposed method of construction and sequence of operations for construction relative to excavation and backfill activities. Use descriptions, with supporting illustrations, sufficiently detailed to demonstrate to Project Manager that procedures meet requirements of Specifications and Drawings.

C. Submit excavation safety system plan.

1. Submit excavation safety system plan in accordance with applicable OSHA requirements for excavations.

2. Submit excavation safety system plan in accordance with requirements of Section 02260 - Trench Safety System, for excavations that fall under State and Federal trench safety laws.

D. Submit ground and surface water control plan in accordance with requirements in this Section and Section 01578 - Control of Ground Water and Surface Water.

E. Submit backfill material sources and product quality information in accordance with requirements of Section 02320 - Utility Backfill Materials.

F. Submit project record documents under provisions of Section 01785 - Project Record Documents. Record location of utilities, as installed, referenced to survey benchmarks. Include location of utilities encountered or rerouted. Give horizontal dimensions, elevations, inverts and gradients.

1.06 TESTS

A. Testing and analysis of backfill materials for soil classification and compaction during construction will be performed by an independent laboratory provided by City in accordance with requirements of Section 01454 - Testing Laboratory Services and as specified in this Section.

B. Perform embedment and backfill material source qualification testing in accordance with requirements of Section 02320- Utility Backfill Materials.

PART 2 P R O D U C T S

2.01 EQUIPMENT

A. Perform excavation with equipment suitable for achieving requirements of this Specification.

B. Use equipment which will produce degree of compaction specified. Compact backfill within 3 feet of walls with hand operated equipment. Do not use equipment weighing more than 10,000 pounds closer to walls than a horizontal distance equal to depth of fill at that time. Use hand operated power compaction equipment where use of heavier equipment is impractical or restricted due to weight limitations.

2.02 MATERIAL CLASSIFICATIONS

A. Use backfill materials conforming to classifications and product descriptions of Section 02320 - Utility Backfill Materials. Use classification or product description for backfill applications as shown on Drawings and as specified.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Conduct an inspection to determine condition of existing structures and other permanent installations.

B. Set up necessary street detours and barricades in preparation for excavation if construction will affect traffic. Conform to requirements of Section 01555 - Traffic Control and Regulation. Maintain barricades and warning devices at all times for streets and intersections where work is in progress, or where construction work is considered hazardous to traffic movements.

C. Perform work in accordance with OSHA standards. Employ an excavation safety system as specified in Section 02260 - Trench Safety Systems.

D. Remove existing pavements and structures, including sidewalks and driveways, in accordance with requirements of Section 02221 - Removing Existing Pavements and Structures.

E. Install and operate necessary dewatering and surface water control measures in accordance with requirements of Section 01578 - Control of Ground Water and Surface Water.

3.02 PROTECTION

A. Protect trees, shrubs, lawns, existing structures, and other permanent objects outside of grading limits and within grading limits as designated on Drawings, and in accordance with requirements of Section 01562 - Tree and Plant Protection.

B. Protect and support above-grade and below-grade utilities which are to remain.

C. Restore damaged permanent facilities to pre-construction conditions unless replacement or abandonment of facilities is indicated on Drawings.

D. Prevent erosion of excavations and backfill. Do not allow water to pond in excavations.

E. Maintain excavation and backfill areas until start of subsequent work. Repair and recompact slides, washouts, settlements, or areas with loss of density at no additional cost to City.

3.03 EXCAVATION

A. Perform excavation work so that underground structure can be installed to depths and alignments shown on Drawings. Use caution during excavation work to avoid disturbing surrounding ground and existing facilities and improvements. Keep excavation to absolute minimum necessary. No additional payment will be made for excess excavation not authorized by Project Manager.

B. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue work at that location. Notify Project Manager and obtain instructions before proceeding in such areas.

C. Immediately notify agency or company owning any line which is damaged, broken or disturbed. Obtain approval from Project Manager and agency for any repairs or relocations, either temporary or permanent.

D. Avoid settlement of surrounding soil due to equipment operations, excavation procedures, vibration, dewatering, or other construction methods.

E. Provide surface drainage during construction to protect work and to avoid nuisance to adjoining property. Where required, provide proper dewatering and piezometric pressure control during construction.

F. Conduct hauling operations so that trucks and other vehicles do not create dirt nuisance in streets. Verify that truck beds are sufficiently tight and loaded in such a manner such that objectionable materials will not spill onto streets. Promptly clear away any dirt, mud, or other materials that spill onto streets or are deposited onto streets by vehicle tires.

G. Maintain permanent benchmarks, monumentation, and other reference points. Unless otherwise directed, replace those which are damaged or destroyed by Work.

H. Provide sheeting, shoring, and bracing where required to safely complete Work, to prevent excavation from extending beyond limits indicated on Drawings, and to protect Work and

adjacent structures or improvements. Use sheeting, shoring, and bracing to protect workmen and public conforming to requirements of Section 02260 - Trench Safety Systems.

I. Prevent voids from forming outside of sheeting. Immediately fill voids with grout, cement stabilized sand, or other material approved by Project Manager and compact to 95 percent standard density.

J. After completion of structure, remove sheeting, shoring, and bracing unless shown on Drawings to remain in place or directed by Project Manager in writing that such temporary structures may remain. Remove sheeting, shoring and bracing in such a manner as to maintain safety during backfilling operations and to prevent damage to Work and adjacent structures or improvements.

K. Immediately fill and compact voids left or caused by removal of sheeting with cement stabilized sand or other material approved by Project Manager and compact to 95 percent standard density.

3.04 HANDLING EXCAVATED MATERIALS

A. Classify excavated materials. Place material which is suitable for use as backfill in orderly piles at sufficient distance from excavation to prevent slides or cave-ins.

B. Provide additional backfill material in accordance with requirements of Section 02319 - Borrow, if adequate quantities of suitable material are not available from excavation and trenching operations at site.

3.05 DEWATERING

A. Provide ground water control per Section 01578 - Control of Ground Water and Surface Water.

B. Keep ground water surface elevation minimum of 2 feet below bottom of foundation base.

C. Maintain ground water control as directed by Section 01578 - Control of Ground Water and Surface Water and until structure is sufficiently complete to provide required weight to resist hydrostatic uplift with minimum safety factor of 1.2.

3.06 FOUNDATION EXCAVATION

A. Notify Project Manager at least 48 hours prior to planned completion of foundation excavations. Do not place foundation base until excavation is accepted by Project Manager.

B. Excavate to elevations shown on Drawings, as needed to provide space for foundation base, forming level undisturbed surface, free of mud or soft material. Remove pockets of soft or otherwise unstable soils and replace with foundation backfill material or material as directed by Project Manager. Prior to placing material over it, recompact subgrade where indicated on

Drawings, scarifying as needed, to 95 percent of maximum Standard Dry Density according to ASTM D 698. If specified level of compaction cannot be achieved, moisture condition subgrade and recompact until 95 percent is achieved, over-excavate to provide minimum layer of 24 inches of foundation backfill material, or other means acceptable to Project Manager.

C. Fill unauthorized excessive excavation with foundation backfill material or other material as directed by Project Manager.

D. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in satisfactory, undisturbed condition. Keep excavations free of standing water and completely free of water during concrete placement.

E. Remove soils which become unsuitable due to inadequate dewatering or other causes, after initial excavation to required subgrade, and replace with foundation backfill material, as directed by Project Manager, at no additional cost to City.

F. Place foundation base, or foundation backfill material where needed, over subgrade on same day that excavation is completed to final grade. Where base of excavations are left open for longer periods, protect them with seal slab or cement-stabilized sand.

G. Use filter fabric as specified in Section 02621 - Geotextile to separate crushed aggregate, and other free draining Class I materials from native soils or select material backfill. Overlap fabric minimum of 12 inches beyond where another material stops contact with soil.

H. Place crushed aggregate, and other Class I materials, in uniform layers of 8-inch maximum thickness. Perform compaction by means of at least two passes of vibratory compactor.

3.07 FOUNDATION BASE.

A. Place foundation base after subgrade is properly prepared, including placement of foundation backfill where needed. Use foundation base consisting of 12-inch layer of crushed stone aggregate or cement stabilized sand. Alternately, seal slab with minimum thickness of 4 inches may be placed. Extend foundation base minimum of 12 inches beyond edge of structure foundation, unless shown otherwise on Drawings.

B. Where foundation base and foundation backfill are of same material, both can be placed in one operation.

3.08 BACKFILL

A. Complete backfill to surface of natural ground or to lines and grades shown on Drawings. Remove forms, lumber, trash and debris from structures. Deposit backfill in uniform layers and compact each layer as specified.

1. Unless otherwise shown on Drawings, for structures under pavement or within one foot back of curb, use cement stabilized sand up to the top of the proposed structure. Use suitable on-site material (random backfill) up to 12 inches below pavement base

or subgrade. Place minimum of 12 inches of select backfill below pavement base or subgrade.

2. Unless otherwise shown on Drawings, for structures not under pavement, use random backfill of suitable material up to the surface.

B. Do not place backfill against concrete walls or similar structures until laboratory test breaks indicate that concrete has reached minimum of 85 percent of specified compressive strength. Where walls are supported by slabs or intermediate walls, do not begin backfill operations until slab or intermediate walls have been placed and concrete has attained sufficient strength.

C. Remove concrete forms before starting backfill and remove shoring and bracing as work progresses.

D. Maintain backfill material at no less than 2 percent below nor more than 2 percent above optimum moisture content, unless otherwise approved by Project Manager. Place fill material in uniform 8-inch maximum loose layers. Compact fill to at least 95 percent of maximum Standard Proctor Density according to ASTM D 698 below paved areas. Compact fill to at least 90 percent around structures below unpaved areas.

E. Where backfill is placed against sloped excavation surface, run compaction equipment across boundary of cut slope and backfill to form compacted slope surface for placement of next layer of backfill.

F. Place backfill using cement stabilized sand in accordance with Section 02321 - Cement Stabilized Sand.

3.09 FIELD QUALITY CONTROL

A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.

B. Tests will be performed initially on minimum of one different sample of each material type for plasticity characteristics, in accordance with ASTM D 4318, and for gradation characteristics, in accordance with Tex-101-E and Tex-110-E. Additional classification tests will be performed whenever there is noticeable change in material gradation or plasticity.

C. In-place density tests of compacted subgrade and backfill will be performed according to ASTM D 1556, or ASTM D 2922 and ASTM D 3017, and at following frequencies and conditions:

1. Minimum of one test for every 50 to 100 cubic yards of compacted backfill material as directed by Project Manager.

2. A minimum of three density tests for each full work shift.

3. Density tests will be performed in all placement areas.

4. Number of tests will be increased when inspection determines that soil types or moisture contents are not uniform or when compacting effort is variable and not considered sufficient to attain uniform density.

5. Identify elevation of test with respect to natural ground.

6. Record approximate depth of lift tested.

D. At least one test for moisture-density relationships will be initially performed for each type of backfill material in accordance with ASTM D 698. Perform additional moisture-density relationship test once a month or whenever there is noticeable change in material gradation or plasticity.

E. When tests indicate work does not meet specified compaction requirements, recondition, recompact, and retest at Contractor's expense.

3.10 DISPOSAL OF EXCESS MATERIAL

Dispose of excess materials in accordance with requirements of Section 01576 - Waste Material Disposal.

END OF SECTION

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Section 02317

EXCAVATION AND BACKFILL FOR UTILITIES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Excavation, trenching, foundation, embedment, and backfill for installation of utilities, including manholes and other pipeline structures.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices

1. No additional payment will be made for trench excavation, embedment and backfill under this Section. Include cost in unit price for installed underground piping, sewer, conduit, or duct work.

2. When Project Manager directs Contractor to over excavate trench bottom, Contractor will be paid by unit price bid per linear foot under bid item - 6" Over Excavation of Trench Bottom.

   a. No payment will be paid if Project Manager does not direct Contractor to over excavate trench bottom.

   b. No over excavation will be measured or paid when unsuitable conditions result from dewatering system not in conformance with Section 01578 - Control of Ground Water and Surface Water.

3. No additional payment will be made for performing Critical Location exploratory excavation. Include cost in unit price for installed underground piping, sewer, conduit, or duct work.

4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price

1.03 DEFINITIONS

A. Pipe Foundation: Suitable and stable native soils that are exposed at trench subgrade after excavation to depth of bottom of bedding as shown on Drawings, or foundation backfill material placed and compacted in over-excavations.

B. Pipe Bedding: Portion of trench backfill that extends vertically from top of foundation up to level line at bottom of pipe, and horizontally from one trench sidewall to opposite sidewall.

C. Haunching: Material placed on either side of pipe from top of bedding up to springline of pipe and horizontally from one trench sidewall to opposite sidewall.

D. Initial Backfill: Portion of trench backfill that extends vertically from springline of pipe (top of haunching) up to level line 12 inches above top of pipe, and horizontally from one trench sidewall to opposite sidewall.

E. Pipe Embedment: Portion of trench backfill that consists of bedding, haunching and initial backfill.

F. Trench Zone: Portion of trench backfill that extends vertically from top of pipe embedment up to pavement subgrade or up to final grade when not beneath pavement.

G. Unsuitable Material: Unsuitable soil materials are the following:

1. Materials that are classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.

2. Materials that cannot be compacted to required density due to gradation, plasticity, or moisture content.

3. Materials that contain large clods, aggregates, stones greater than 4 inches in any dimension, debris, vegetation, waste or any other deleterious materials.

4. Materials that are contaminated with hydrocarbons or other chemical contaminants.

H. Suitable Material: Suitable soil materials are those meeting specification requirements. Materials mixed with lime, fly ash, or cement that can be compacted to required density and meeting requirements for suitable materials may be considered suitable materials, unless otherwise indicated.

I. Backfill: Suitable material meeting specified quality requirements placed and compacted under controlled conditions.

J. Ground Water Control Systems: Installations external to trench, such as well points, eductors, or deep wells. Ground water control includes dewatering to lower ground water, intercepting seepage which would otherwise emerge from side or bottom of trench excavation, and depressurization to prevent failure or heaving of excavation bottom. Refer to Section 01578 - Control of Ground Water and Surface Water.

K. Surface Water Control: Diversion and drainage of surface water runoff and rain water away from trench excavation. Rain water and surface water accidentally entering trench shall be controlled and removed as part of excavation drainage.

L. Excavation Drainage: Removal of surface and seepage water in trench by sump pumping and using drainage layer, as defined in ASTM D 2321, placed on foundation beneath pipe bedding or thickened bedding layer of Class I material.

M. Trench Conditions are defined with regard to stability of trench bottom and trench walls of pipe embedment zone. Maintain trench conditions that provide for effective placement and compaction of embedment material directly on or against undisturbed soils or foundation backfill, except where structural trench support is necessary.

1. Dry Stable Trench: Stable and substantially dry trench conditions exist in pipe embedment zone as result of typically dry soils or achieved by ground water control (dewatering or depressurization) for trenches extending below ground water level.

2. Stable Trench with Seepage: Stable trench in which ground water seepage is controlled by excavation drainage.

   a. Stable Trench with Seepage in Clayey Soils: Excavation drainage is provided in lieu of or to supplement ground water control systems to control seepage and provide stable trench subgrade in predominately clayey soils prior to bedding placement.

   b. Stable Wet Trench in Sandy Soils: Excavation drainage is provided in embedment zone in combination with ground water control in predominately sandy or silty soils.

3. Unstable Trench: Unstable trench conditions exist in pipe embedment zone if ground water inflow or high water content causes soil disturbances, such as sloughing, sliding, boiling, heaving or loss of density.

N. Sub-trench: Sub-trench is special case of benched excavation. Sub-trench excavation below trench shields or shoring installations may be used to allow placement and compaction of foundation or embedment materials directly against undisturbed soils. Depth of sub-trench depends upon trench stability and safety as determined by Contractor.

O. Trench Dam: Placement of low permeability material in pipe embedment zone or foundation to prohibit ground water flow along trench.

P. Over-excavation and Backfill: Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below top of foundation as shown on Drawings, and backfilled with foundation bedding.

Q. Foundation Bedding: Natural soil or manufactured aggregate of controlled gradation, and geotextile filter fabrics as required, to control drainage and material separation. Foundation bedding is placed and compacted as backfill to provide stable support for bedding. Foundation bedding materials may include concrete seal slabs.

R. Trench Safety Systems include both protective systems and shoring systems as defined in Section 02260 - Trench Safety Systems.

S. Trench Shield (Trench Box): Portable worker safety structure moved along trench as work proceeds, used as protective system and designed to withstand forces imposed on it by cave in, thereby protecting persons within trench. Trench shields may be stacked if so designed or placed in series depending on depth and length of excavation to be protected.

T. Shoring System: Structure that supports sides of an excavation to maintain stable soil conditions and prevent cave-ins, or to prevent movement of ground affecting adjacent installations or improvements.

U. Special Shoring: Shoring system meeting special shoring as specified in Paragraph 1.08, Special Shoring Design Requirements, for locations identified on Drawings.

V. Vacuum Excavation: An excavation technique performed by an experienced subcontractor in which water or air jetting is used to slough off and vacuum away soil.

W. Large Diameter Water Line (LDWL): Water line that is 24-inches in diameter or larger.

X. Emergency Action Plan (EAP): The EAP document should include a discussion of procedures for timely and reliable detection, classification (level of emergency) and response procedure to a potential emergency condition associated with a large diameter water line.

Y. Subsurface Utility Exploration (SUE): Non-destructive excavation, unless otherwise approved by project manager.

1.04 REFERENCES

A. ASTM C 12 - Standard Practice for Installing Vitrified Clay Pipe Lines.

B. ASTM D 558 - Standard Test Methods for Moisture-Density Relations of Soil Cement Mixtures.

C. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft).

D. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.

E. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.

F. ASTM D 2487 - Standard Classification of Soils for Engineering Purposes.

G. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

H. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

I. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

J. TxDOT Tex-101-E - Preparing Soil and Flexible Base Materials for Testing.

K. TxDOT Tex-110-E - Particle Size Analysis of Soils.

L. Federal Regulations, 29 CFR Part 1926, Standards-Excavation, Occupational Safety and Health Administration (OSHA).

M. ASTM C76- Standard Specification for Reinforced Concrete Culverts, Storm Drain, and Sewer Pipe.

1.05 SCHEDULING

A. Schedule work so that pipe embedment can be completed on same day that acceptable foundation has been achieved for each section of pipe installation, manhole, or other structures.

B. For proposed utility adjacent to or across existing LDWL:

1. Conduct a meeting between contractor, Drinking Water Operations and Utility Maintenance Branch prior to beginning excavation to coordinate the EAP in the event a water line shut down becomes necessary.

2. Notify Drinking Water Operations a minimum of 1 week prior to beginning construction activities.

3. Notify Drinking Water Operations a minimum of 48 hours prior to beginning SUE work near LDWL.

4. Unless otherwise approved by City Engineer, perform construction activities between 7 AM and 7 PM, Monday through Friday. No work permitted around a LDWL on weekends or City Holiday.

5. A City Inspector must be present during SUE or construction activities occurring within four feet or one diameter of the LDWL, whichever is greater, from a LDWL or appurtenance.

1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit planned typical method of excavation, backfill placement and compaction including:

1. Trench widths.

2. Procedures for foundation and pipe zone bedding placement, and trench backfill compaction.

3. Procedures for assuring compaction against undisturbed soil when pre-manufactured trench safety systems are proposed.

C. Submit backfill material sources and product quality information in accordance with requirements of Section 02320 - Utility Backfill Materials.

D. Submit trench excavation safety program in accordance with requirements of Section 02260 - Trench Safety System. Include designs for special shoring meeting requirements defined in Paragraph 1.08, Special Shoring Design Requirements contained herein.

E. Submit record of location of utilities as installed, referenced to survey control points. Include locations of utilities encountered or rerouted. Give stations, horizontal dimensions, elevations, inverts, and gradients.

F. Submit 11 inch by 17 inch or 12 inch by 18 inch copy of Drawing with plotted utility or obstruction location titled "Critical Location Report" to Project Manager.

G. For installation of proposed utility adjacent to or across existing LDWL, prepare and submit the following to Drinking Water Operations prior to beginning construction activities. Obtain approval from Drinking Water Operations prior to commencing prelocate or utility work near LDWL.

1. Trench details, shoring system designs, installation sequences, and flowable fill mix designs.

2. Emergency Action Plan (EAP) to address contingency plans in the event of damage to or failure of LDWL. Include the following:

   a. Contact personnel and agencies including primary and secondary telephone numbers,

   b. Contractor's hierarchy of responsible personnel,

   c. Traffic control measures, and

   d. Identification of resources to be available on or near project site in event of damage to or failure of LDWL.

1.07 TESTS

A. Testing and analysis of backfill materials for soil classification and compaction during construction will be performed by an independent laboratory provided by City in accordance with requirements of Section 01454 - Testing Laboratory Services and as specified in this Section.

B. Perform backfill material source qualification testing in accordance with requirements of Section 02320- Utility Backfill Materials.

1.08 SPECIAL SHORING DESIGN REQUIREMENTS

A. Have special shoring designed or selected by Contractor's Professional Engineer to provide support for sides of excavations, including soils and hydrostatic ground water pressures as applicable, and to prevent ground movements affecting adjacent installations or improvements such as structures, pavements and utilities. Special shoring may be a premanufactured system selected by Contractor's Professional Engineer to meet project site requirements based on manufacturer's standard design.

PART 2 P R O D U C T S

2.01 EQUIPMENT

A. Perform excavation with hydraulic excavator or other equipment suitable for achieving requirements of this Section.

B. Use only hand-operated tamping equipment until minimum cover of 12 inches is obtained over pipes, conduits, and ducts. Do not use heavy compacting equipment until adequate cover is attained to prevent damage to pipes, conduits, or ducts.

C. Use trench shields or other protective systems or shoring systems which are designed and operated to achieve placement and compaction of backfill directly against undisturbed native soil.

D. Use special shoring systems where required which may consist of braced sheeting, braced soldier piles and lagging, slide rail systems, or other systems meeting requirements as specified in Paragraph 1.08, Special Shoring Design Requirements.

2.02 MATERIAL CLASSIFICATIONS

A. Embedment and Trench Zone Backfill Materials: Conform to classifications and product descriptions of Section 02320 - Utility Backfill Materials and Section 02321 – Cement Stabilized Sand.

B. Concrete Backfill: Conform to requirements for Class B concrete as specified in Section 03315 - Concrete for Utility Construction.

C. Geotextile (Filter Fabric): Conform to requirements of Section 02621- Geotextile.

D. Concrete for Trench Dams: Concrete backfill or 3 sack premixed (bag) concrete.

PART 3 E X E C U T I O N

3.01 STANDARD PRACTICE

A. Install flexible pipe, including "semi-rigid" pipe, to conform to standard practice described in ASTM D 2321, and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.

B. Install rigid pipe to conform to standard practice described in ASTM C 12 or C76 as applicable, and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.

3.02 PREPARATION

A. Establish traffic control to conform to requirements of Section 01555 - Traffic Control and Regulation. Maintain barricades and warning lights for streets and intersections affected by Work, and are considered hazardous to traffic movements.

B. Perform work to conform to applicable safety standards and regulations. Employ trench safety system as specified in Section 02260 - Trench Safety Systems.

C. Immediately notify agency or company owning any existing utility line which is damaged, broken, or disturbed. Obtain approval from Project Manager and agency for any repairs or relocations, either temporary or permanent.

D. Remove existing pavements and structures, including sidewalks and driveways, to conform to requirements of Section 02221 - Removing Existing Pavements and Structures, as applicable.

E. Install and operate necessary dewatering and surface-water control measures to conform to Section 01578 - Control of Ground Water and Surface Water. Provide stable trench to allow installation in accordance with Specifications.

F. Maintain permanent benchmarks, monumentation, and other reference points. Unless otherwise directed in writing, replace those which are damaged or destroyed in accordance with Section 01725 - Field Surveying.

3.03 CRITICAL LOCATION INVESTIGATION

A. Horizontal and vertical location of various underground lines shown on Drawings, including but not limited to water lines, gas lines, storm sewers, sanitary sewers, telecommunication lines, electric lines or power ducts, pipelines, concrete and debris, are based on best information available but are only approximate locations. Unless otherwise approved by Project Manager, at Critical Locations shown on Drawings, perform vacuum excavation to field verify horizontal and vertical locations of such lines within a zone 2 feet vertically and 4 feet horizontally of proposed work exclude water jetting at PCCP water line.

1. Verify location of existing utilities minimum of 7 working days in advance of pipe laying activities based on daily pipe laying rate or prior to beginning installation of auger pit or tunnel shaft. Use extreme caution and care when uncovering utilities designated by Critical Locate.

2. Notify Project Manager in writing immediately upon identification of obstruction. In event of failure to identify obstruction in minimum of 7 days, Contractor will not be entitled to extra cost for downtime including, but not limited to, payroll, equipment, overhead, demobilization and remobilization, until 7 days has passed from time Project Manager is notified of obstruction.

B. Notify involved utility companies of date and time that investigation excavation will occur and request that their respective utility lines be marked in field. Comply with utility or pipeline company requirements that their representative be present during excavation. Provide Project Manager with 48 hours notice prior to field excavation or related work.

C. Survey vertical and horizontal locations of obstructions relative to project baseline and datum and plot on 12 inch by 18 inch copy of Drawings. For large diameter water lines, submit to Project Manager for approval, horizontal and vertical alignment dimensions for connections to existing lines, tied into project baseline, signed and sealed by R.P.L.S.

D. LDWL Prelocate Requirements:

1. Field-locate LDWL, appurtenances and laterals connected directly to LDWL through use of non-probing method such as a vacuum truck (non-water jetting method) at no greater than 50 foot intervals. Locate upstream and downstream of proposed work or utility installation.

2. Record crown and side of LDWL adjacent to proposed work or utility installation. Record LDWL locations horizontally and vertically using same coordinate system employed on proposed utility drawings.

3. Tie horizontal and vertical coordinates into project baseline. Submit recordings performed by R.P.L.S to City a minimum of 14 days prior to mobilizing to site

3.04 PROTECTION

A. Protect trees, shrubs, lawns, existing structures, and other permanent objects outside of grading limits and within grading limits as designated on Drawings, and in accordance with requirements of Section 01562 - Tree and Plant Protection.

B. Protect and support above-grade and below-grade utilities which are to remain.

C. Restore damaged permanent facilities to pre-construction conditions unless replacement or abandonment of facilities is indicated on Drawings.

D. Take measures to minimize erosion of trenches. Do not allow water to pond in trenches. Where slides, washouts, settlements, or areas with loss of density or pavement failures or potholes occur, repair, re-compact, and pave those areas at no additional cost to City.

E. Contingency plans for proposed work or utility installation adjacent to or across a LDWL:

1. Conduct on-site emergency drill prior to commencing proposed utility installation, and at three month intervals to assure EAP is current.

2. In the event a LDWL shut down becomes necessary, secure site and provide assistance to City personnel to access pipe and isolation valves as needed.

3.05 EXCAVATION

A. Except as otherwise specified or shown on Drawings, install underground utilities in open cut trenches with vertical sides.

B. Perform excavation work so that pipe, conduit, and ducts can be installed to depths and alignments shown on Drawings. Avoid disturbing surrounding ground and existing facilities and improvements.

C. Determine trench excavation widths using following schedule as related to pipe outside diameter (O.D.). Excavate trench so that pipe is centered in trench.

Nominal Pipe Size, Inches	Minimum Trench Width, Inches
Less than 18	O.D. + 18
18 to 30	O.D. + 24
36 to 42	O.D. + 36
Greater than 42	O.D. + 48

Do not obstruct sight distance for vehicles utilizing roadway or detours with stockpiled materials.

D. Use sufficient trench width or benches above embedment zone for installation of well point headers or manifolds and pumps where depth of trench makes it uneconomical or impractical to pump from surface elevation. Provide sufficient space between shoring cross braces to permit equipment operations and handling of forms, pipe, embedment and backfill, and other materials.

E. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue work at that location. Notify Project Manager and obtain instructions before proceeding.

F. Shoring of Trench Walls.

1. Install Special Shoring in advance of trench excavation or simultaneously with trench excavation, so that soils within full height of trench excavation walls will remain laterally supported at all times.

2. For all types of shoring, support trench walls in pipe embedment zone throughout installation. Provide trench wall supports sufficiently tight to prevent washing trench wall soil out from behind trench wall support.

3. Leave sheeting driven into or below pipe embedment zone in place to preclude loss of support of foundation and embedment materials, unless otherwise directed by Project Manager. Leave rangers, walers, and braces in place as long as required to support sheeting, which has been cut off, and trench wall in vicinity of pipe zone.

4. Employ special methods for maintaining integrity of embedment or foundation material. Before moving supports, place and compact embedment to sufficient depths to provide protection of pipe and stability of trench walls. As supports are moved, finish placing and compacting embedment.

5. If sheeting or other shoring is used below top of pipe embedment zone, do not disturb pipe foundation and embedment materials by subsequent removal. Maximum thickness of removable sheeting extending into embedment zone shall be equivalent of 1-inch-thick steel plate. As sheeting is removed, fill in voids left with grouting material.

G. Use of Trench Shields. When trench shield (trench box) is used as worker safety device, the following requirements apply:

1. Make trench excavations of sufficient width to allow shield to be lifted or pulled freely, without damage to trench sidewalls.

2. Move trench shields so that pipe, and backfill materials, after placement and compaction, are not damaged nor disturbed, nor degree of compaction reduced. Re-compact after shield is moved if soil is disturbed.

3. When required, place, spread, and compact pipe foundation and bedding materials beneath shield. For backfill above bedding, lift shield as each layer of backfill is placed and spread. Place and compact backfill materials against undisturbed trench walls and foundation.

4. Maintain trench shield in position to allow sampling and testing to be performed in safe manner.

5. Conform to applicable Government regulations.

H. Voids under paving area outside shield caused by Contractor's work will require removal of pavement, consolidation and replacement of pavement in accordance with Contract Documents. Repair damage resulting from failure to provide adequate supports.

I. Place sand or soil behind shoring or trench shield to prevent soil outside shoring from collapsing and causing voids under pavement. Immediately pack suitable material in outside voids following excavation to avoid caving of trench walls.

J. Coordinate excavation within 15 feet of pipeline with company's representative. Support pipeline with methods agreed to by pipeline company's representative. Use small, rubber-tired excavator, such as backhoe, to do exploratory excavation. Bucket that is used to dig in close proximity to pipelines shall not have teeth or shall have guard installed over teeth to approximate bucket without teeth. Excavate by hand within 1 foot of Pipeline Company’s line. Do not use larger excavation equipment than normally used to dig trench in vicinity of pipeline until pipelines have been uncovered and fully exposed. Do not place large excavation and hauling equipment directly over pipelines unless approved by Pipeline Company’s representative.

K. When, during excavation to uncover pipeline company's pipelines, screwed collar or an oxy-acetylene weld is exposed, immediately notify Project Manager. Provide supports for collar or welds. Discuss with Pipeline Company’s representative and determine methods of supporting collar or weld during excavation and later backfilling operations. When collar is exposed, request Pipeline Company to provide welder in a timely manner to weld ends of collar prior to backfilling of excavation.

L. Excavation and shoring requirements for proposed work or utility installation adjacent to or across a LDWL:

1. Identify LDWL area in field and barricade off from construction activities. Allow no construction related activities including, but not limited to, loading of dump trucks and material staging or storage, on top of LDWL.

2. Employ a groundwater control system when performing excavation activities within ten feet of LDWL to:

   a. Effectively reduce hydrostatic pressure affecting excavations,

   b. Develop substantially dry and stable subgrade for subsequent construction operations,

   c. Prevent loss of fines, seepage, boils, quick condition or softening of foundation strata, and

   d. Maintain stability of sides and bottom of excavations.

3. When edge of proposed trench or shoring is within a distance equal to one diameter of LDWL from outside of wall of LDWL, valve or appurtenance:

   a. Maintain minimum of four (4) feet horizontal clearance and minimum of two (2) feet vertical clearance between proposed utility and

   LDWL. b. Auger Construction

      i. Maintain minimum of four (4) feet horizontal clearance between proposed utility and LDWL.
      ii. Dry auger method required when auger hole is 12-inches and larger in diameter.

   c. Open Cut Construction and Auger pits
      i. Perform hand excavation when within four (4) feet of LDWL.
      ii. Employ hydraulic or pneumatic shoring system. Do not use vibratory or impact driven shoring or piling.
      iii. Expose no more than 30-feet of trench prior to backfilling.
      iv. A maximum of one (1) foot of vertical trench shall be un-braced at a time to maintain constant pressure on face of excavated soil.
      v. Upon removal of shoring system, inject flowable fill into void space left behind by shoring system. Comply with Standard Specification 02322 - Flowable Fill.

d. When edge of utility excavation is greater than one diameter of LDWL from outside wall of LDWL, use a shielding system as required by Project Manager and proposed utility standards and practices.

3.06 HANDLING EXCAVATED MATERIALS

A. Use only excavated materials, which are suitable as defined in this Section and conforming to Section 02320 - Utility Backfill Materials. Place material suitable for backfilling in stockpiles at distance from trench to prevent slides or cave-ins.

B. When required, provide additional backfill material conforming to requirements of Section 02320 - Utility Backfill Materials.

C. Do not place stockpiles of excess excavated materials on streets and adjacent properties. Protect backfill material to be used on site. Maintain site conditions in accordance with Section 01504 - Temporary Facilities and Controls. Excavate trench so that pipe is centered in trench. Do not obstruct sight distance for vehicles utilizing roadway or detours with stockpiled materials.

3.07 TRENCH FOUNDATION

A. Excavate bottom of trench to uniform grade to achieve stable trench conditions and satisfactory compaction of foundation or bedding materials.

B. When wet soil is encountered on trench bottom and dewatering system is not required, over excavate an additional 6 inches with approval by Project Manager. Place non-woven geotextile fabric and then compact 12 inches of crushed stone in one lift on top of fabric. Compact crushed stone with four passes of vibratory-type compaction equipment.

C. Perform over excavation, when directed by Project Manager, in accordance with Paragraph 3.07B above. Removal of unstable or unsuitable material may be required if approved by Project Manager;

1. Even though Contractor has not determined material to be unsuitable, or

2. If unstable trench bottom is encountered and an adequate ground water control system is installed and operating according to Section 01578 - Control of Ground Water and Surface Water.

D. Place trench dams in Class I foundations in line segments longer than 100 feet between manholes and not less than one in every 500 feet of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than 5 feet from manholes.

3.08 PIPE EMBEDMENT, PLACEMENT, AND COMPACTION

A. Remove loose, sloughing, caving, or otherwise unsuitable soil from bottoms and sidewalls of trenches immediately prior to placement of embedment materials.

B. Place embedment including bedding, haunching, and initial backfill as shown on Drawings.

C. For pipe installation, manually spread embedment materials around pipe to provide uniform bearing and side support when compacted. Protect flexible pipe from damage during placing of pipe zone bedding material. Perform placement and compaction directly against undisturbed soils in trench sidewalls, or against sheeting which is to remain in place.

D. Do not place trench shields or shoring within height of embedment zone unless means to maintain density of compacted embedment material are used. If moveable supports are used in embedment zone, lift supports incrementally to allow placement and compaction of material against undisturbed soil.

E. Place geotextile to prevent particle migration from in-situ soil into open-graded (Class I) embedment materials or drainage layers.

F. Do not damage coatings or wrappings of pipes during backfilling and compacting operations. When embedding coated or wrapped pipes, do not use crushed stone or other sharp, angular aggregates.

G. Place haunching material manually around pipe and compact it to provide uniform bearing and side support. If necessary, hold small-diameter or lightweight pipe in place during compaction of haunch areas and placement beside pipe with sand bags or other suitable means.

H. Place electrical conduit, if used, directly on foundation without bedding.

I. Shovel in-place and compact embedment material using pneumatic tampers in restricted areas, and vibratory-plate compactors or engine-powered jumping jacks in unrestricted areas. Compact each lift before proceeding with placement of next lift. Water tamping is not allowed.

J. For water lines construction embedment, use bank run sand, concrete sand, gem sand, pea gravel, or crushed limestone as specified in Section 02320 - Utility Backfill Material. Adhere to the following subparagraph numbers 1 and 2.

1. Class I, II and III Embedment Materials:

   a. Maximum 6 inches compacted lift thickness.

   b. Compact to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D 698.

   c. Moisture content to be within -3 percent to +5 percent of optimum as determined according to ASTM D 698, unless otherwise approved by Project Manager.

2. Cement Stabilized Sand (where required for special installations):

a. Maximum 6 inches compacted thickness.

b. Compact to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D 698.

c. Moisture content to be on dry side of optimum as determined according to ASTM D 698 but sufficient for effective hydration.

K. For Sanitary Sewers adhere to subparagraph number 1 and 2. For Storm Sewers provide cement stabilized sand per paragraph 2. This provision does not apply to Storm Sewers constructed of HDPE pipe installed under pavement.

1. Class I Embedment Materials.

a. Maximum 6-inches compacted lift thickness.

b. Systematic compaction by at least two passes of vibrating equipment. Increase compaction effort as necessary to effectively embed pipe to meet deflection test criteria.

c. Moisture content as determined by Contractor for effective compaction without softening soil of trench bottom, foundation or trench walls.

2. Class II Embedment and Cement Stabilized Sand.

a. Maximum 6-inches compacted thickness.

b. Compaction by methods determined by Contractor to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D 698 for Class II materials and according to ASTM D 558 for cement stabilized materials.

c. Moisture content of Class II materials within 3 percent of optimum as determined according to ASTM D 698. Moisture content of cement stabilized sands on dry side of optimum as determined according to ASTM D 558 but sufficient for effective hydration.

L. For Storm Sewers constructed of HDPE pipe and installed under pavement provide flowable fill pipe embedment as specified in Section 02322 Flowable Fill.

M.. Place trench dams in Class I embedment in line segments longer than 100 feet between manholes, and not less than one in every 500 feet of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than 5 feet from manholes.

3.09 TRENCH ZONE BACKFILL PLACEMENT AND COMPACTION

A. Place backfill for pipe or conduits and restore surface as soon as practicable. Leave only minimum length of trench open as necessary for construction.

B. For water lines, under pavement and to within one foot back of curb, use backfill materials described below:

1. For water lines 20 inches in diameter and smaller, use bank run sand or select backfill materials up to pavement base or subgrade.

2. For water lines 24 inches in diameter and larger, backfill with suitable on-site material (random backfill) up to 12 inches below pavement base or subgrade. Place minimum of 12 inches of select backfill below pavement base or subgrade.

C. For sewer pipes (Storm and Sanitary), use backfill materials described by trench limits. For "trench zone backfill" under pavement and to within one foot back of curb, use cement stabilized sand for pipes of nominal sizes 36 inches in diameter and smaller to level 12 inches below the pavement. For sewer pipes 42 inches in diameter and larger, under pavement or natural ground, backfill from 12 inches above top of pipe to 12 inches below pavement with suitable on-site material or select backfill. Use select backfill for rigid pavements or flexible base material for asphalt pavements for 12- inch backfill directly under pavement. For backfill materials reference Section 02320 - Utility Backfill Materials. This provision does not apply where a Storm Sewer is constructed of HDPE pipe.

D. For Storm Sewers constructed of HDPE pipe and installed under pavement provide flowable fill as specified in Section 02322 Flowable Fill. For Storm Sewers constructed of HDPE pipe and not installed under pavement provide cement stabilized sand.

E. Where damage to completed pipe installation work is likely to result from withdrawal of sheeting, leave sheeting in place. Cut off sheeting 1.5 feet or more above crown of pipe. Remove trench supports within 5 feet from ground surface.

F. Unless otherwise shown on Drawings. Use one of the following trench zone backfills under pavement and to within one foot of edge of pavement. Place trench zone backfill in lifts and compact. Fully compact each lift before placement of next lift.

1. Class I, II, or III or combination thereof :

a. Place in maximum 12-inch thick loose layers.

b. Compact by vibratory equipment to minimum of 95 percent of maximum dry density determined according to ASTM D 698.

c. Moisture content within zero percent to 5 percent above optimum determined according to ASTM D 698, unless otherwise approved by Project Manager.

2. Cement-Stabilized Sand:

a. Maximum lift thickness determined by Contractor to achieve uniform placement and required compaction, but do not exceed 12 inches.

b. Compact by vibratory equipment to minimum of 95 percent of maximum dry density determined according to ASTM D 558.

c. Moisture content on dry side of optimum determined according to ASTM D 558 but sufficient for cement hydration.

3. Class IVA and IVB (Clay Soils):

a. Place in maximum 8-inch thick loose lifts.

b. Compaction by vibratory Sheepfoot roller to minimum of 95 percent of maximum dry density determined according to ASTM D 698.

c. Moisture content within zero percent to 5 percent above optimum determined according to ASTM D 698, unless approved by Project Manager.

G. Unless otherwise shown on Drawings, for trench excavations not under pavement, random backfill of suitable material may be used in trench zone. This provision does not apply to HDPE storm sewers.

1. Fat clays (CH) may be used as trench zone backfill outside paved areas at Contractor's option. When required density is not achieved, at any additional cost to City, rework, dry out, use lime stabilization or other approved methods to achieve compaction requirements, or use different suitable material.

2. Maximum 9-inch compacted lift thickness for clayey soils and maximum 12-inch lift thickness for granular soils.

3. Compact to minimum of 90 percent of maximum dry density determined according to ASTM D 698.

4. Moisture content as necessary to achieve density.

H. For electric conduits, remove form work used for construction of conduits before placing trench zone backfill.

3.10 MANHOLES, JUNCTION BOXES AND OTHER PIPELINE STRUCTURES

A. Below paved areas or where shown on Drawings, encapsulate manhole with cement stabilized sand; minimum of 2 foot below base, minimum 2 foot around walls, up to pavement subgrade or natural ground. Compact in accordance with Paragraph 3.09.F.2 of this Section

B. In unpaved areas, use select fill for backfill. Existing material that qualifies as select material may be used, unless indicated otherwise on Drawings. Deposit backfill in uniform layers and compact each layer as specified. Maintain backfill material at no less than 2 percent below nor more than 5 percent above optimum moisture content, unless otherwise approved by Project Manager. Place fill material in uniform 8-inch maximum loose layers. Compact fill to at least 95 percent of maximum Standard Proctor Density according to ASTM D 698.

C. For LDWL projects, encapsulate manhole with cement stabilized sand; minimum of 1 foot below base, minimum of 2 feet around walls, up to within 12 inches of pavement subgrade or natural ground. For manholes over water line, extend encapsulation to bottom of trench. Compact in accordance with Paragraph 3.09 F.2 of this Section.

3.11 FIELD QUALITY CONTROL

A. Test for material source qualifications as defined in Section 02320 - Utility Backfill Materials.

B. Provide excavation and trench safety systems at locations and to depths required for testing and retesting during construction at no additional cost to City.

C. Tests will be performed on minimum of three different samples of each material type for plasticity characteristics, in accordance with ASTM D 4318, and for gradation characteristics, in accordance with Tex-101-E and Tex-110-E. Additional classification tests will be performed whenever there is noticeable change in material gradation or plasticity, or when requested by Project Manager.

D. At least three tests for moisture-density relationships will be performed initially for backfill materials in accordance with ASTM D 698, and for cement- stabilized sand in accordance with ASTM D 558. Perform additional moisture-density relationship tests once a month or whenever there is noticeable change in material gradation or plasticity.

E. In-place density tests of compacted pipe foundation, embedment and trench zone backfill soil materials will be performed according to ASTM D 1556, or ASTM D 2922 and ASTM D 3017, and at following frequencies and conditions.

1. For open cut construction projects and auger pits: Unless otherwise approved by Project Manager, successful compaction to be measured by one test per 40 linear feet measured along pipe for compacted embedment and two tests per 40 linear feet measured along pipe for compacted trench zone backfill material. Length of auger pits to be measured to arrive at 40 linear feet.

2. A minimum of three density tests for each full shift of Work.

3. Density tests will be distributed among placement areas. Placement areas are: foundation, bedding, haunching, initial backfill and trench zone.

4. The number of tests will be increased if inspection determines that soil type or moisture content are not uniform or if compacting effort is variable and not considered sufficient to attain uniform density, as specified.

5. Density tests may be performed at various depths below fill surface by pit excavation. Material in previously placed lifts may therefore be subject to acceptance/rejection.

6. Two verification tests will be performed adjacent to in-place tests showing density less than acceptance criteria. Placement will be rejected unless both verification tests show acceptable results.

7. Recompacted placement will be retested at same frequency as first test series, including verification tests.

8. Identify elevation of test with respect to natural ground or pavement.

F. Recondition, re-compact, and retest at Contractor's expense if tests indicate Work does not meet specified compaction requirements. For hardened soil cement with nonconforming density, core and test for compressive strength at Contractor's expense.

G. Acceptability of crushed rock compaction will be determined by inspection.

3.12 DISPOSAL OF EXCESS MATERIAL

A. Dispose of excess materials in accordance with requirements of Section 01576 - Waste Material Disposal.

END OF SECTION

Section 02318

EXTRA UNIT PRICE WORK FOR EXCAVATION AND BACKFILL

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Measurement and payment applicable to extra unit price work items for excavation and backfill made necessary by unusual or unforeseen circumstances encountered during utility installations.

B. Extra unit price work for excavation and backfill is paid only when authorized in advance by Project Manager.

1.02 MEASUREMENT AND PAYMENT

A. UNIT PRICES

1. Excavation Around Obstructions: Payment for excavation around obstructions is on cubic yard basis, measured in place, without deduction for volume occupied by portions of pipes, ducts, or other structures left in place across trenches excavated under this item.

2. Extra Hand Excavation: Payment for extra hand excavation is on cubic yard basis, measured in place.

3. Extra Machine Excavation: Payment for extra machine excavation is on cubic yard basis, measured in place.

4. Extra Placement of Backfill Material: Payment for extra placement of backfill material is on cubic yard basis, measured in place, for material installed as part of Work. At discretion of Project Manager, measurement of cubic yards may be calculated from volume of Extra Hand Excavation or Extra Machine Excavation for which replacement is made, minus volume of any Extra Placement of Granular Backfill authorized in conjunction with Work.

5. Extra Placement of Granular Backfill: Payment for extra placement of granular backfill material is on cubic yard basis, measured in place.

6. Extra Select Backfill: Payment for extra select backfill is on cubic yard basis, measured in place for a theoretical minimum trench width. The project Manager may authorize extra select backfill when soil from the excavation work does not include adequate quantities for placement of suitable on-site material (random backfill).

7. Refer to Section 01270 – Measurement and payment for unit price procedures.

1.03 DEFINITIONS

A. Excavation Around Obstructions: Excavation necessitated by obstruction of pipes (other than service connections 3 inches in diameter or less), ducts, or other structures, not shown on Drawings, and of an unusual or unforeseen nature which interfere with installation of utility piping by normal methods of excavation or auguring.

B. Extra Hand Excavation: Excavation by manual labor made necessary by unusual or unforeseen circumstances at locations approved in advance by Project Manager.

C. Extra Machine Excavation: Excavation by machine at or near project site to perform related work not included in original project scope but added for convenience of City, as approved in advance by Project Manager.

D. Extra Replacement of Backfill Material: Handling, backfill, and compaction of excavated material authorized under extra work bid items for Extra Hand Excavation or Extra Machine Excavation. Placement and compaction shall conform to requirements specified for excavation and backfill in Sections 02316 – Excavation and Backfill for Structures and 02317 – Excavation and Backfill for Utilities.

E. Extra Placement of Granular Backfill: Hauling, placing, and compacting granular backfill materials as approved by Project Manager in conjunction with Extra Replacement of Backfill Material. Materials placed under this item shall conform to requirements for Bank Run Sand, Cement Stabilized Sand, Concrete Sand, Gem Sand, Crushed Stone, or Crushed Concrete specified for backfill material in Sections 02316 – Excavation and Backfill for Structures and 02317 – Excavation and Backfill for Utilities..

F. Extra Select Backfill: Unsuitable material removed from the project and select backfill material hauled to the project, or conditioning unsuitable material on the site to make it select backfill. Provide select backfill material specified in Section 02320 – Utility Backfill Materials.

PART 2 P R O D U C T S Not Used

PART 3 E X E C U T I O N Not Used

END OF SECTION

Section 02320

UTILITY BACKFILL MATERIALS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Material Classifications.

B. Utility Backfill Materials:

1. Concrete sand
2. Gem sand
3. Pea gravel
4. Crushed stone
5. Crushed concrete
6. Bank run sand
7. Select backfill
8. Random backfill
9. Cement stabilized sand

C. Material Handling and Quality Control Requirements.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No payment will be made for backfill material. Include payment in unit price for applicable utility installation.
2. Payment for backfill material, when included as separate pay item or when directed by Project Manager, is on cubic yard basis for material placed and compacted within theoretical trench width limits and thickness of material according to Drawings, or as directed by Project Manager.
3. Payment for backfill of authorized over-excavation is in accordance with Section 02318 - Extra Unit Price Work for Excavation and Backfill.

4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 DEFINITIONS

A. Unsuitable Material:

1. Materials classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.

2. Materials that cannot be compacted to required density due to gradation, plasticity, or moisture content.

3. Materials containing large clods, aggregates, or stones greater than 4 inches in any dimension; debris, vegetation, or waste; or any other deleterious materials.

4. Materials contaminated with hydrocarbons or other chemical contaminants.

B. Suitable Material:

1. Materials meeting specification requirements.

2. Unsuitable materials meeting specification requirements for suitable soils after treatment with lime or cement.

C. Foundation Backfill Materials: Natural soil or manufactured aggregate meeting Class I requirements and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill where needed to provide stable support for structure foundation base. Foundation backfill materials may include concrete fill and seal slabs.

D. Foundation Base: Crushed stone aggregate with filter fabric as required, cement stabilized sand, or concrete seal slab. Foundation base provides smooth, level working surface for construction of concrete foundation.

E. Backfill Material: Classified soil material meeting specified quality requirements for designated application as embedment or trench zone backfill.

F. Embedment Material: Soil material placed under controlled conditions within embedment zone extending vertically upward from top of foundation to an elevation 12 inches above top of pipe, and including pipe bedding, haunching and initial backfill.

G. Trench Zone Backfill: Classified soil material meeting specified quality requirements and placed under controlled conditions in trench zone from top of embedment zone to base course in paved areas or to surface grading material in unpaved areas.

H. Foundation: Either suitable soil of trench bottom or material placed as backfill of over-excavation for removal and replacement of unsuitable or otherwise unstable soils.

I. Source: Source selected by Contractor for supply of embedment or trench zone backfill material. Selected source may be project excavation, off-site borrow pits, commercial borrow pits, or sand and aggregate production or manufacturing plants.

J. Refer to Section 02317 - Excavation and Backfill for Utilities for other definitions regarding utility installation by trench construction.

1.04 REFERENCES

A. ASTM C 33 - Standard Specification for Concrete Aggregate.

B. ASTM C 40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.

C. ASTM C 123 - Standard Test Method for Lightweight Particles in Aggregate.

D. ASTM C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in Los Angeles Machine.

E. ASTM C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

F. ASTM C 142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregates.

G. ASTM D 1140 - Standard Test Method for Amount of Material in Soils Finer Than No. 200 Sieve.

H. ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

I. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

J. ASTM D 4643 - Standard Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Method.

K. TxDOT Tex-110-E - Determining Particle Size Analysis of Soils.

L. TxDOT Tex-460-A - Material Finer Than 75 Φm (No.200) Sieve In Mineral Aggregates (Decantation Test for Concrete Aggregates).

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit description of source, material classification and product description, production method, and application of backfill materials.

C. Submit test results for samples of off-site backfill materials. Comply with Paragraph 2.03, Material Testing.

D. Before stockpiling materials, submit copy of approval from landowner for stockpiling backfill material on private property.

E. Provide delivery ticket which includes source location for each delivery of material that is obtained from off-site sources or is being paid as specific bid item.

1.06 TESTS

A. Perform tests of sources for backfill material in accordance with Paragraph 2.03B.

B. Verification tests of backfill materials may be performed by City in accordance with Section 01454 - Testing Laboratory Services and in accordance with Paragraph 3.03.

PART 2 P R O D U C T S

2.01 MATERIAL CLASSIFICATIONS

A. Classify materials for backfill for purpose of quality control in accordance with Unified Soil Classification Symbols as defined in ASTM D 2487. Material use and application is defined in utility installation specifications and Drawings either by class, as described in Paragraph 2.01B, or by product descriptions, as given in Paragraph 2.02.

B. Class Designations Based on Laboratory Testing:

1. Class I: Well-graded gravels and sands, gravel-sand mixtures, crushed well-graded rock, little or no fines (GW, SW):

a. Plasticity index: non-plastic.

b. Gradation: D_{60}/D_{10} - greater than 4 percent; amount passing No. 200 sieve - less than or equal to 5 percent.

2. Class II: Poorly graded gravels and sands, silty gravels and sands, little to moderate fines (GM, GP, SP, SM):

a. Plasticity index: non-plastic to 4.

b. Gradations:
   1) Gradation (GP, SP): amount passing No. 200 sieve - less than 5 percent.
   2) Gradation (GM, SM): amount passing No. 200 sieve - between 12 percent and 50 percent.
   3) Borderline gradations with dual classifications (e.g., SP-SM): amount passing No. 200 sieve - between 5 percent and 12 percent.

3. Class III: Clayey gravels and sands, poorly graded mixtures of gravel, sand, silt, and clay (GC, SC, and dual classifications, e.g., SP-SC):

   a. Plasticity index: greater than 7.

   b. Gradation: amount passing No. 200 sieve - between 12 percent and 50 percent.

4. Class IVA: Lean clays (CL).

   a. Plasticity Indexes:
      1) Plasticity index: greater than 7, and above A line.
      2) Borderline plasticity with dual classifications (CL-ML): PI between 4 and 7.

   b. Liquid limit: less than 50.

   c. Gradation: amount passing No. 200 sieve - greater than 50 percent.

   d. Inorganic.

5. Class IVB: Fat clays (CH)

   a. Plasticity index: above A line.

   b. Liquid limit: 50 or greater.

   c. Gradation: amount passing No. 200 sieve - greater than 50 percent.

   d. Inorganic.

6. Use soils with dual class designation according to ASTM D 2487, and which are not defined above, according to more restrictive class.

2.02 PRODUCT DESCRIPTIONS

A. Soils classified as silt (ML) silty clay (CL-ML with PI of 4 to 7), elastic silt (MH), organic clay and organic silt (OL, OH), and organic matter (PT) are not acceptable as backfill materials. These soils may be used for site grading and restoration in unimproved areas as approved by Project Manager. Soils in Class IVB, fat clay (CH) may be used as backfill materials where allowed by applicable backfill installation specification. Refer to Section 02316 - Excavation and Backfill for Structures and Section 02317 - Excavation and Backfill for Utilities.

B. Provide backfill material that is free of stones greater than 6 inches, free of roots, waste, debris, trash, organic material, unstable material, non-soil matter, hydrocarbon or other contamination, conforming to following limits for deleterious materials:

1. Clay lumps: Less than 0.5 percent for Class I, and less than 2.0 percent for Class II, when tested in accordance with ASTM C 142.

2. Lightweight pieces: Less than 5 percent when tested in accordance with ASTM C 123.

3. Organic impurities: No color darker than standard color when tested in accordance with ASTM C 40.

C. Manufactured materials, such as crushed concrete, may be substituted for natural soil or rock products where indicated in product specification, and approved by Project Manager, provided that physical property criteria are determined to be satisfactory by testing.

D. Bank Run Sand: Durable bank run sand classified as SP, SW, or SM by Unified Soil Classification System (ASTM D 2487) meeting following requirements:

1. Less than 15 percent passing number 200 sieve when tested in accordance with ASTM D 1140. Amount of clay lumps or balls may not exceed 2 percent.

2. Material passing number 40 sieve shall meet the following requirements when tested in accordance with ASTM D 4318: Plasticity index: not exceeding 7.

E. Concrete Sand: Natural sand, manufactured sand, or combination of natural and manufactured sand conforming to requirements of ASTM C 33 and graded within following limits when tested in accordance with ASTM C 136:

Sieve	Percent Passing
3/8"	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30

No. 100	2 to 10

F. Gem Sand: Sand conforming to requirements of ASTM C 33 for course aggregates specified for number 8 size and graded within the following limits when tested in accordance with ASTM C 136:

Sieve	Percent Passing
3/8”	95 to 100
No. 4	60 to 80
No. 8	15 to 40

G. Pea Gravel: Durable particles composed of small, smooth, rounded stones or pebbles and graded within the following limits when tested in accordance with ASTM C 136:

Sieve	Percent Passing
1/2”	100
3/8”	85 to 100
No. 4	10 to 30
No. 8	0 to 10
No. 16	0 to 5

H. Crushed Aggregates: Crushed aggregates consist of durable particles obtained from an approved source and meeting the following requirements:

1. Materials of one product delivered for same construction activity from single source, unless otherwise approved by Project Manager.

2. Non-plastic fines.

3. Los Angeles abrasion test wear not exceeding 45 percent when tested in accordance with ASTM C 131.

4. Crushed aggregate shall have minimum of 90 percent of particles retained on No. 4 sieve with 2 or more crushed faces as determined by Tex-460-A, Part I.

5. Crushed stone: Produced from oversize plant processed stone or gravel, sized by crushing to predominantly angular particles from naturally occurring single source. Uncrushed gravel is not acceptable materials for embedment where crushed stone is shown on applicable utility embedment drawing details.

6. Crushed Concrete: Crushed concrete is an acceptable substitute for crushed stone as utility backfill. Gradation and quality control test requirements are same as crushed stone. Provide crushed concrete produced from normal weight concrete of uniform quality; containing particles of aggregate and cement material, free from other substances such as asphalt, reinforcing steel fragments, soil, waste gypsum (calcium sulfate), or debris.

7. Gradations, as determined in accordance with Tex-110-E.

Sieve	Percent Passing by Weight for Pipe Embedment by Ranges of Nominal Pipes Sizes		
	>15"	15" - 8"	<8"
1"	95 - 100	100	-
3/4"	60 - 90	90 - 100	100
1/2"	25 - 60	-	90 - 100
3/8"	-	20 - 55	40 - 70
No. 4	0 - 5	0 - 10	0 - 15
No. 8	-	0 - 5	0 - 5

I. Select Backfill: Class III clayey gravel or sand or Class IV lean clay with plasticity index between 7 and 20 or clayey soils treated with lime in accordance with Section 02951 - Pavement Repair and Restoration to meet plasticity criteria.

J. Random Backfill: Any suitable soil or mixture of soils within Classes I, II, III and IV; or fat clay (CH) whe allowed by applicable backfill installation specification. Refer to Section 02316 - Excavation and Backfill for Structures and Section 02317 - Excavation and Backfill for Utilities.

K. Cement Stabilized Sand: Conform to requirements of Section 02321 - Cement Stabilized Sand.

L. Concrete Backfill: Conform to Class B concrete as specified in Section 03315 - Concrete for Utility Construction.

M. Flexible Base Course Material: Conform to requirements of applicable portions of Section 02711 - Hot Mix Asphaltic Base Course, Section 02712 - Cement Stabilized Base Course, and Section 02713 - Recycled Crushed Concrete Base Course.

2.03 MATERIAL TESTING

A. Source Qualification. Perform testing to obtain tests by suppliers for selection of material sources and products not from the project site. Test samples of processed materials from

current production representing material to be delivered. Use tests to verify that materials meet specification requirements. Repeat qualification test procedures each time source characteristics change or there is planned change in source location or supplier. Include the following qualification tests, as applicable:

1. Gradation. Report complete sieve analyses regardless of specified control sieves from largest particle through No. 200 sieve.

2. Plasticity of material passing No. 40 sieve

3. Los Angeles abrasion wear of material retained on No. 4 sieve

4. Clay lumps

5. Lightweight pieces

6. Organic impurities

B. Production Testing. Provide reports to Project Manager from an independent testing laboratory that backfill materials to be placed in Work meet applicable specification requirements.

C. Assist Project Manager in obtaining material samples for verification testing at source or at production plant.

PART 3 E X E C U T I O N

3.01 SOURCES

A. Use of existing material in trench excavations is acceptable, provided applicable specification requirements are satisfied.

B. Identify off-site sources for backfill materials at least 14 days ahead of intended use so that Project Manager may obtain samples for verification testing.

C. Materials may be subjected to inspection or additional verification testing after delivery. Materials which do not meet requirements of specifications will be rejected. Do not use material which, after approval, has become unsuitable for use due to segregation, mixing with other materials, or by contamination. Once material is approved by Project Manager, expense for sampling and testing required to change to different material will be credited to City through change order.

D. Bank run sand, select backfill, and random backfill, if available in project excavation, may be obtained by selective excavation and acceptance testing. Obtain additional quantities of these materials and other materials required to complete work from off-site sources.

E. City does not represent or guarantee that any soil found in excavation work will be suitable and acceptable as backfill material.

3.02 MATERIAL HANDLING

A. When backfill material is obtained from either commercial or non-commercial borrow pit, open pit to expose vertical faces of various strata for identification and selection of approved material to be used. Excavate selected material by vertical cuts extending through exposed strata to achieve uniformity in product.

B. Establish temporary stockpile locations for practical material handling, control, and verification testing by Project Manager in advance of final placement. Obtain approval from landowner for storage of backfill material on adjacent private property.

C. When stockpiling backfill material near project site, use appropriate covers to eliminate blowing of materials into adjacent areas and prevent runoff containing sediments from entering drainage system.

D. Place stockpiles in layers to avoid segregation of processed materials. Load material by making successive vertical cuts through entire depth of stockpile.

3.03 FIELD QUALITY CONTROL

A. Quality Control

1. The Project Manager may sample and test backfill at:

a. Sources including borrow pits, production plants and Contractor's designated off-site stockpiles.

b. On-site stockpiles.

c. Materials placed in Work.

2. The Project Manager may re-sample material at any stage of work or location if changes in characteristics are apparent.

B. Production Verification Testing: City's testing laboratory will provide verification testing on backfill materials, as directed by Project Manager. Samples may be taken at source or at production plant, as applicable.

END OF SECTION

Section 02321

CEMENT STABILIZED SAND

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Cement stabilized sand.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for work performed under this Section. Include cost of such work in Contract unit prices for items listed in bid form requiring cement stabilized sand.

2. Refer to Paragraph 3.04 for material credit.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. ASTM C 33 - Standard Specification for Concrete Aggregates (Fine Aggregate).

B. ASTM C 40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.

C. ASTM C 42 - Standard Test Methods for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

D. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.

E. ASTM C 123 - Standard Test Method for Lightweight Particles in Aggregate.

F. ASTM C 142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregates.

G. ASTM C 150 - Specification for Portland Cement.

H. ASTM D 558 - Standard Test Method for Moisture-Density Relations of Soil Cement-Mixtures.

I. ASTM D 1632 - Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory

J. ASTM D 1633 - Standard Test Method for Compressive Strength of Molded Soil-Cement Cylinders.

K. ASTM D 2487 - Standard Test Method for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

L. ASTM D2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

M. ASTM D 3665 - Standard Practice for Random Sampling of Construction Materials.

N. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit proposed target cement content and production data for sand-cement mixture in accordance with requirements of Paragraph 2.03, Materials Qualifications.

1.05 DESIGN REQUIREMENTS

A. Use sand-cement mixture producing minimum unconfined compressive strength of 100 pounds per square inch (psi) in 48 hours.

1. Design will be based on strength specimens molded in accordance with ASTM D 558 at moisture content within 3 percent of optimum and within 4 hours of batching.

2. Determine minimum cement content from production data and statistical history. Provide no less than 1.1 sacks of cement per ton of dry sand.

PART 2 P R O D U C T S

2.01 MATERIALS

A. Cement: Type I Portland cement conforming to ASTM C 150.

B. Sand: Clean, durable sand meeting grading requirements for fine aggregates of ASTM C 33, or requirements for bank run sand of Section 02320 - Utility Backfill Materials, and the following requirements:

1. Classified as SW, SP, SW-SM, SP-SM, or SM by Unified Soil Classification System of ASTM D 2487.

2. Deleterious materials:

   a. Clay lumps, ASTM C 142 - less than 0.5 percent.

   b. Lightweight pieces, ASTM C 123; less than 5.0 percent.

   c. Organic impurities, ASTM C 40, color no darker than standard color.

3. Plasticity index of 4 or less when tested in accordance with ASTM D 4318.

C. Water: Potable water, free of oils, acids, alkalies, organic matter or other deleterious substances, meeting requirements of ASTM C 94.

2.02 MIXING MATERIALS

A. Add required amount of water and mix thoroughly in pugmill-type mixer.

B. Stamp batch ticket at plant with time of loading. Reject material not placed and compacted within 4 hours after mixing.

2.03 MATERIAL QUALIFICATION

A. Determine target cement content of material as follows:

1. Obtain samples of sand-cement mixtures at production facility representing range of cement content consisting of at least three points.

2. Complete molding of samples within 4 hours after addition of water.

3. Perform strength tests (average of two specimens) at 48 hours and 7 days.

4. Perform cement content tests on each sample.

5. Perform moisture content tests on each sample.

6. Plot average 48-hour strength vs. cement content.

7. Record scale calibration date, sample date, sample time, molding time, cement feed dial settings, and silo pressure (if applicable).

B. Test raw sand for following properties at point of entry into pug-mill:

1. Gradation

2. Plasticity index

3. Organic impurities

4. Clay lumps and friable particles

5. Lightweight pieces

6. Moisture content

7. Classification

C. Present data obtained in format similar to that provided in sample data form attached to this Section.

D. The target content may be adjusted when statistical history so indicates. For determination of minimum product performance use formula:

f'_c% 1/2 standard deviation

PART 3 E X E C U T I O N

3.01 PLACING

A. Place sand-cement mixture in maximum 12-inch-thick loose lifts and compact to 95 percent of maximum density as determined in accordance with ASTM D 558, unless otherwise specified. Refer to related specifications for thickness of lifts in other applications. Target moisture content during compaction is $\pm$3 percent of optimum. Perform and complete compaction of sand-cement mixture within 4 hours after addition of water to mix at plant.

B. Do not place or compact sand-cement mixture in standing or free water.

C. Where potable water lines cross wastewater line, embed wastewater line with cement stabilized sand in accordance with Texas Administrative Code §290.44(e)(4)(B):

1. Provide minimum of 10% cement per cubic yard of cement stabilized sand mixture, based on loose dry weight volume. Use at least 2.5 bags of cement per cubic yard of mixture (2 sacks per ton of dry sand).

2. Unless otherwise shown on Drawings, embed wastewater main or lateral minimum of six inches above and below.

3. Use brown coloring in cement stabilized sand for wastewater main or lateral bedding for identification of pressure rated wastewater mains during future construction.

3.02 FIELD QUALITY CONTROL

A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.

B. One sample of cement stabilized sand shall be obtained for each 150 tons of material placed per day with no less than one sample per day of production. Random samples of delivered cement stabililized sand shall be taken in the field at point of delivery in accordance with ASTM 3665. Obtain three individual samples of approximately 12 to 15 lb each from the first, middle, and last third of the truck and composite them into one sample for test purpose.

C. Prepare and mold four specimens (for each sample obtained) in accordance with ASTM D 558, Method A, without adjusting moisture content. Samples will be molded at approximately same time material is being used, but no later than 4 hours after water is added to mix.

D. After molding, specimens will be removed from molds and cured in accordance with ASTM D 1632.

E. Specimens will be tested for compressive strength in accordance with ASTM D 1633, Method A. Two specimens will be tested at 48 hours plus or minus 2 hours and two specimens will be tested at 7 days plus or minus 4 hours.

F. A strength test will be average of strengths of two specimens molded from same sample of material and tested at same age. Average daily strength will be average of strengths of all specimens molded during one day's production and tested at same age.

G. Precision and Bias: Test results shall meet recommended guideline for precision in ASTM D 1633 Section 9.

H. Reporting: Test reports shall contain, as a minimum, the following information:

1. Supplier and plant number
2. Time material was batched
3. Time material was sampled
4. Test age (exact hours)
5. Average 48-hour strength
6. Average 7-day strength

7. Specification section number
8. Indication of compliance / non-compliance
9. Mixture identification
10. Truck and ticket numbers
11. The time of molding
12. Moisture content at time of molding
13. Required strength
14. Test method designations
15. Compressive strength data as required by ASTM D 1633
16. Supplier mixture identification
17. Specimen diameter and height, in.
18. Specimen cross-sectional area, sq. in.

3.03 ACCEPTANCE

A. Strength level of material will be considered satisfactory if:

1. The average 48-hour strength is greater than 100 psi with no individual strength test below 70 psi.

2. All 7-day individual strength tests (average of two specimens) are greater than or equal to 100 psi.

B. Material will be considered deficient when 7-day individual strength test (average of two specimens) is less than 100 psi but greater than 70 psi. See Paragraph 3.04 Adjustment for Deficient Strength.

C. The material will be considered unacceptable and subject to removal and replacement at Contractor=s expense when individual strength test (average of two specimens) has 7-day strength less than 70 psi.

D. When moving average of three daily 48-hour averages falls below 100 psi, discontinue shipment to project until plant is capable of producing material, which exceeds 100 psi at 48 hours. Five 48-hour strength tests shall be made in this determination with no individual strength tests less than 100 psi.

E. Testing laboratory shall notify Contractor, Project Manager, and material supplier by facsimile of tests indicating results falling below specified strength requirements within 24 hours.

F. If any strength test of laboratory cured specimens falls below the specified strength, Contractor may, at his own expense, request test of cores drilled from the area in question in accordance with ASTM C42. In such cases, three (3) cores shall be taken for each strength test that falls below the values given in 3.03.A.

G. Cement stabilized sand in an area represented by core tests shall be considered satisfactory if the average of three (3) cores is equal to at least 100 psi and if no single core is less that 70 psi. Additional testing of cores extracted from locations represented by erratic core strength results will be permitted.

3.04 ADJUSTMENT FOR DEFICIENT STRENGTH

A. When mixture produces 7-day compressive strength greater than or equal to 100 psi, then material will be considered satisfactory and bid price will be paid in full.

B. When mixture produces 7-day compressive strength less than 100 psi and greater than or equal to 70 psi, material shall be accepted contingent on credit in payment. Compute credit by the following formula:

$$\text{Credit per Cubic Yard} = \frac{\$30.00 \times 2\,(100\text{ psi} - \text{Actual psi})}{100}$$

C. When mixture produces 7-day compressive strength less than 70 pounds per square inch, then remove and replace cement-sand mixture and paving and other necessary work at no cost to City.

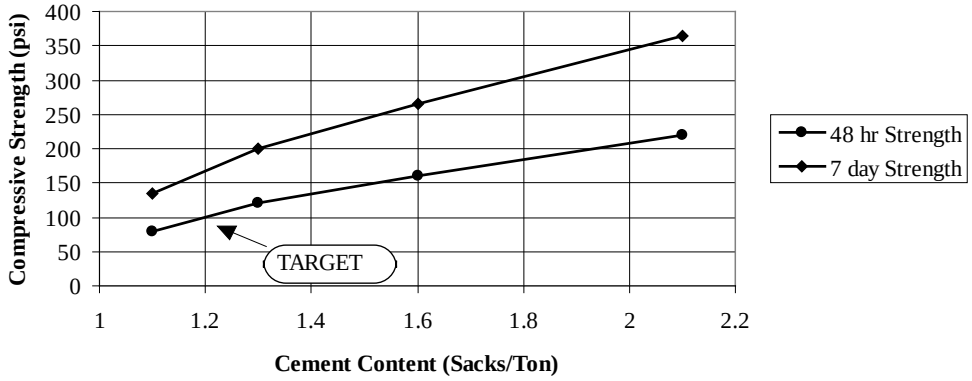
Supplier: City Stabilized Sand	**Plant No:** 1 - Main Street	**Date of Tests:** January 1, 1997

Item	Raw Sand	1.1 Sack	100 psi	1.5 Sack	2.0 Sack
Moisture Content	10.9	15.7	14.0	13.8	13.7
Cement Feed Dial Setting	--	2.25	2.5	2.75	3.75
Silo Pressure (psi)	--	4	4	4	4
Batch Time	10:00	10:10	10:15	10:20	10:25
Sample Time	--	10:10	10:15	10:20	10:25
Molding Time	--	12:30	12:45	1:00	1:15
Cement Content (sacks/ton)	--	1.1	1.3	1.6	2.1
Compressive Strength at 48 hrs. (avg of 2)	--	80	120	160	220
Compressive Strength at 7 days(avg of 2)	--	135	200	265	365

Sieve size	Percent Passing	COH Spec. Section 02320
3/8 Inch	100	--
No. 16	100	--
No. 40	100	--
No. 50	99	--
No. 100	41	--
No. 200	11	0 to 15

Raw Sand Tests	**Result**	**City of Houston**
Plasticity Index	Non-Plastic	4 Maximum
Organic Impurities	Passing	No Darker Than
Clay Lumps & Friable Parts (%)	0.0	0.5 % Maximum
Lightweight Pieces (%)	0.0	5.0 % Maximum
Classification	SP-SM	SW, SP, SW-SM, SP-SM, SM

Compressive Strength vs Cement Content



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Section 02476

CAISSON FOR LIFT STATION

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Constructing external walls of lift station wet well structures by caisson method, including base slab and excavation cell partitions. Valve/pump chamber to be constructed by open cut.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for lift station construction using caisson method. Include cost for caisson construction in lump sum for lift station.

2. No separate measurement will be made for payment of concrete in wet well caisson except listed in an approved schedule of values.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 DEFINITION

A. Caisson is defined as external walls of concrete structure, together with excavation cell partition walls, erected at-grade or in starter pit and sunk by gravity to final position through excavation inside structure under dry or wet conditions. Complete caisson includes structural base slab. Caisson walls provide ground support during construction and for permanent installation.

B. Dry construction means that Contractor operates sufficient external ground water control system to maintain ground water level and piezometric head safely below excavation bottom within caisson.

C. Wet construction means that external hydrostatic ground water pressure is counteracted by water or slurry within caisson.

1.04 REFERENCE STANDARDS

A. ASTM D 698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3 (600 kN-m/m^3)).

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit safety plan to meet OSHA requirements. These procedures will not be subject to approval by Project Manager and are for record purposes only. Address in plan, as minimum but not limited to the following:

1. Protection against caisson instability, soil instability, and ground water inflow.

2. Safety for caisson access and exit, including ladders, stairs, walkways, and hoists.

3. Protection against equipment operations, and for lifting and hoisting equipment and material.

4. Support of surcharge weights.

5. Ventilation systems.

6. Monitoring for hazardous gases.

7. Protection against flooding of caisson and inflow into sewers when connected to caisson structure.

8. Protection of workers and public, including traffic barriers, accidental or unauthorized entry, and falling objects.

9. Safety supervising responsibilities.

C. Building and Structures Assessment. Submit for review prior to construction, Building and Structures Assessment Plan. Provide preconstruction and post-construction assessment reports for buildings and structures located within distance equal to depth of caisson but at least 50 feet in plan from proposed caisson perimeter. Include photographs or video of existing damage to structures in vicinity of caisson in assessment reports.

PART 2 P R O D U C T S

2.01 CONCRETE

A. Concrete is to be in accordance with Section 03310 - Structural Concrete.

2.02 REINFORCEMENT

A. Reinforcement is to be in accordance with Section 03211 - Concrete Reinforcement.

2.03 EMBEDDED ITEMS

A. Embedded items are to be in accordance with Section 15140 - Pipe Hangers, Supports, and Restraints.

2.04 BACKFILL

A. Select material is to be in accordance with Section 02316 - Excavation and Backfill for Structures.

B. Cement stabilized sand is to be in accordance with Section 02321 - Cement Stabilized Sand.

2.05 GROUT

A. Use grout conforming to Section 02431 - Tunnel Grout.

PART 3 E X E C U T I O N

3.01 SITE PREPARATION

A. Perform site preparation for site clearing and for grading of site to required elevation. Provide for site drainage.

B. Relocate and protect utilities to remain that may be affected by caisson construction area, including starter pit.

C. Install security fencing around caisson construction areas to prevent accidental or unauthorized entry.

D. Provide for control of ground water and surface water according to Section 01578 - Control of Ground Water and Surface Water.

E. Compact disturbed soils to 95 percent of maximum density as determined by ASTM D 698. Compact soil at moisture content sufficient to develop the required density.

3.02 CAISSON WALL CONSTRUCTION

A. Place concrete as specified in Section 03310 - Structural Concrete.

B. Inspect concrete surfaces after form removal and repair defects before wall section is sunk into ground.

3.03 CAISSON CLEAN UP AND INSPECTION

A. Clean interior of caisson after seal slab has been poured. Remove soil, mud, slurries, spilled grout or concrete, or other materials not part of structure from caisson and clean surfaces.

B. Inspect caisson for possible structural damage or damage to embedded items occurring during excavation and caisson sinking. Notify and allow Project Manager to witness caisson inspection. Repair and replace damage before proceeding with construction.

3.04 CAISSON CONSTRUCTION TOLERANCES

A. Maximum acceptable deviation of caisson from vertical is 1 inch in 5 feet.

B. Maximum acceptable horizontal deviation from design location of center of caisson at ground surface level is 12 inches.

C. Install elevation of base of caisson structure equal to or lower than elevation shown in Drawings. Show top of caisson structure elevation on Drawings.

D. Provide block-outs with allowance for pipe entry deviations of plus or minus 1.5 inches vertically and plus or minus 6 inches horizontally, plus caisson construction tolerances.

E. Tolerances defined above are only acceptable provided that Contractor can adjust sewer connections, structural, mechanical and electrical components to resolve deviation from plumpness and horizontal or vertical location as approved by Project Manager. Adjustments must be made without adversely affecting operation or maintenance of lift station.

F. Monitor caisson installation to verify that no settlement or heave is observed for 10 consecutive days starting not later than 50 days after structural completion.

3.05 BACKFILL

A. Remove starter pit shoring to depth of at least 8 feet below ground surface and for at least 5 feet from pipes and tunnels penetrating shoring. Remove shoring concurrent with backfilling operations. Perform shoring removal and backfilling so that stability of pit is maintained.

B. Compact backfill material in accordance with Sections 02316 - Excavation and Backfill for Structures.

3.06 MONITORING

A. Settlement. Install series of settlement monitoring points on ground and structures within area of potential influence due to soil movements at caisson, before start of caisson or starter pit construction.

1. As minimum, equally space 4 monitoring points around caisson at distance of 15 feet and 4 more at distance 30 feet from caisson for total of 8 monitoring points.

2. Survey monitoring point elevations before start of caisson excavation and weekly thereafter until structure has been completed and dewatering terminated.

B. Caisson

1. Determine plumpness of caisson at least once each shift at two locations, 90 degrees apart, during caisson sinking operations until caisson is secured by grout and base slab hardened, .

2. As soon as caisson has been secured, install 3 benchmarks, 120 degrees apart, on top concrete placement for settlement monitoring of installed caisson. Transfer benchmarks to higher elevation on structure as required due to continued lift station construction. Continue weekly monitoring of settlement points until 60 days after completed construction of structure.

3. Install and monitor borehole heave points in caisson for dry construction as defined on Drawings. Survey heave points before excavation starts and upon retrieval when final excavation bottom has been reached.

C. Submit monitoring results to Project Manager weekly.

3.07 CAISSON SURVEY

A. When caisson has been secured, seal slab poured, and, in case of wet construction, when fluid has been pumped out, survey installed caisson for compliance with tolerances defined in Paragraph 3.04, Caisson Construction Tolerances. Include in Survey:

1. Location of center of caisson at ground level

2. Elevation of top and bottom of caisson and structural slab connection

3. Elevation and locations of penetrations and embedded items and other support points for lift station installation completion

4. Deviation from plumb from caisson top to structural slab at two locations 90 degrees apart

3.08 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 03310 - Structural Concrete and Section 01450 - Contractor's Quality Control.

3.09 DISPOSAL OF EXCESS MATERIAL

A. Remove excavated material from job site in accordance with Section 01576 - Waste Material Disposal.

END OF SECTION

Section 02501

DUCTILE IRON PIPE AND FITTINGS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Ductile iron pipe and fittings for water lines, wastewater force mains, gravity sanitary sewers, and storm sewers.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for ductile iron pipe and fittings under this Section, with the exception of extra fittings in place. Include cost in unit prices for work as specified in the following Sections, as applicable:

   a. Section 02511 - Water lines

   b. Section 02531 - Gravity Sanitary Sewers

   c. Section 02532 - Sanitary Sewage Force Mains

   d. Section 02631 - Storm Sewers

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Extra Ductile Iron Compact Fittings in Place shall be for additional fittings required to complete job. This is not to exclude extension of pipe across driveway or intersection for purpose of terminating line in more advantageous position. This determination shall be at discretion of Project Manager. This bid item includes additional fittings as may be necessary to complete job in conformance with intent of Drawings.

C. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. ANSI A 21.4 (AWWA C 104) - Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings, for Water.

B. ANSI A 21.10 (AWWA C 110) - Standard for Ductile-Iron and Gray-Iron Fittings, 3-in. through 48-in.

C. ANSI A 21.11 (AWWA C 111) - Standard for Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

D. ANSI A 21.15 (AWWA C 115) - Standard for Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges.

E. ANSI A21.16 (AWWA C 116) - Protective Fusion Bonded Epoxy Coating for the Interior and Exterior Surfaces of Ductile Iron and Grey iron Fittings for Water Supply Service.

F. ANSI A 21.50 (AWWA C 150) - Standard for Thickness Design of Ductile-Iron Pipe.

G. ANSI A 21.51 (AWWA C 151) - Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water and Other Liquids.

H. ANSI A 21.53 (AWWA C 153) - Standard for Ductile Iron Compact Fittings, 3 inches through 24 inches and 54 inches through 64 inches for Water Service.

I. ANSI/AWS D11.2 –Guide for Welding Iron Castings

J. ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings.

K. ASTM D 1248 - Standard Specification Polyethylene Plastics Molding and Extrusion Materials for Wire and Cable.

L. ASTM F 477 - Elastomeric Seals (gaskets) for Joining Plastic Pipe.

M. ASTM G 62 - Standard Test Methods for Holiday Detection in Pipeline Coatings.

N. AWWA C 105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.

O. AWWA C 300 - Standard for Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and other Liquids.

P. AWWA C 600 - Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.

Q. SSPC-SP 6 - Steel Structures Painting Council, Commercial Blast Cleaning.

R. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering.

S. American Association of State Highway Transportation Officials (AASHTO).

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. For pipes 16 inches and greater submit shop drawings signed and sealed by Professional Engineer registered in State of Texas showing the following:

1. Manufacturer's pipe design calculations.

2. Provide lay schedule of pictorial nature indicating alignment and grade, laying dimensions, fitting, flange, and special details, with plan view of each pipe segment sketched, detailing pipe invert elevations, horizontal bends, restrained joints, and other critical features. Indicate station numbers for pipe and fittings corresponding to Drawings. Do not start production of pipe and fittings prior to review and approval by Project Manager. Provide final approved lay schedule on CD-ROM in Adobe portable document format (*.PDF).

3. Calculations and limits of thrust restraint shall be based on AWWA M41 or DIPRA Thrust Restraint for Ductile Iron Pipe, latest edition.

4. Class and length of joint.

C. Submit manufacturer's certifications that ductile iron pipe and fittings meet provisions of this Section and have been hydrostatically tested at factory and meet requirements of ANSI A 21.51.

D. Submit certifications that pipe joints have been tested and meet requirements of ANSI A 21.11.

E. Submit affidavit of compliance in accordance with ANSI A21.16 for fittings with fusion bonded epoxy coatings or linings.

PART 2 P R O D U C T S

2.01 DUCTILE IRON PIPE

A. Ductile Iron Pipe Barrels: Shall conform to AWWA C115, C150 and C151 and bear mark of Underwriters' Laboratories approval. Provide minimum thickness Class 52 for sanitary sewers. Unless otherwise shown on Drawings, use a minimum Pressure Class 250 for water lines less than or equal to 20-inch diameter. For 24-inch and larger, design for project specific hydraulics as per AWWA C150. Use minimum Pressure Class 350 for water lines in casing or trenchless construction and for flanged pipe.

B. Provide pipe sections in standard lengths, not less than 18 feet long, except for special fittings and closure sections as indicated on shop drawings.

C. For 24-inch and larger water lines, furnish and install cathodic protection in accordance with Section 16640 - Cathodic Protection for Pipelines.

D. For sanitary sewer lines, modify pipe for cathodic protection in accordance with Section 16640 - Cathodic Protection for Pipelines. In lieu of furnishing ductile iron pipe with cathodic protection system, furnish ductile iron pipe with polyethylene encasement, provided the following criteria is met:

1. Provide minimum thickness class.

2. Provide polyethylene encasement material and installation in accordance with AWWA C105, and backfill as specified. Minimum of two complete wraps of 8-mil-thick polyethylene.

3. Use polyethylene encasement for open cut installations only. For augered sections or sections installed inside a casing, provide coating in accordance with paragraph 2.05 D.1.

4. Adhere to other requirements specified herein (e.g., insulation kits, etc.).

E. For use of pressure class pipe for water lines, design pipe and fittings to withstand most critical simultaneous application of external loads and internal pressures. Base design on minimum of AASHTO HS-20 loading, AREMA E-80 loads and depths of bury as indicated on Drawings. Design pipes with Marston's earth loads for a transition width trench for zero to 16 feet of cover. Use Marston's earth loads for a trench width of O.D. (of pipe) + 4 feet for pipe greater than 16 feet of cover. Use Marston's equations for a trench condition in both open-cut and tunnel applications. Design for most critical groundwater level condition. Pipe design conditions:

1. Working pressure = 150 psi.

2. Hydrostatic field test pressure = 150 psi.

3. Maximum pressure due to surge = 225 psi.

4. Minimum Pressure due to surge = -10 psi.

5. Design tensile stress due to surge or hydrostatic test pressure: No greater than 50% minimum yield.

6. Design bending stress due to combined earth loads and surge or hydrostatic test

pressure: No greater than 48,000 psi.

7. Unit weight of fill ≥ 120 pcf.

8. Deflection lag factor (D_l) = 1.2.

9. Bedding constant (K) = 0.1.

10. Moment coefficient = 0.16.

11. Fully saturated soil conditions hw=h=depth of cover above top of pipe.

F. Hydrostatic Test of Pipe: AWWA C 151, Section 5.2.1, at point of manufacture. Hold test for a minimum 2 minutes for thorough inspection of pipe. Repair or reject pipe revealing leaks or cracks.

G. Pipe Manufacturer for large diameter water lines: Minimum of 5 years of successful pipe installations in continuous service. Manufacturer must maintain on site or in plant enough fittings to satisfy the following requirements:

Line Diameter	**Required Bends***
20 and 24 inches	Four 45° bends per 5,000 LF of water line
> 24 inches	Four 22.5^o bends per 10,000 LF of water line
*Based on total length of contract (minimum of four). Any combination of bends may be substituted at manufacturer's option (i.e. two 22.5^o bends are equivalent to one 45° bend) and will be counted as one fitting.	

Manufacturer or supplier must be capable of delivering bends to job site within 12 hours of notification. Use fittings at direction of Project Manager where unforeseen obstacles are encountered during construction. These fittings are in addition to any fittings called out in construction documents and must be available at all times.

H. Provide flange adapter with insulating kit as required when connecting new piping to existing piping and piping of different materials, unless otherwise approved by Project Manager.

I. Clearly mark pipe section to show location and thickness/pressure class color coded.

J. No welding will be permitted on Ductile Iron Pipe except at restrained joint spigots or fittings as per ANSW/AWS D11.2. No field welding is allowed.

2.02 JOINTS

A. Joint Types: ANSI A 21.11 push-on; ANSI A 21.11 mechanical joint; or ANSI A 21.16 flanged end. Provide push-on joints unless otherwise indicated on the Drawings or required by these specifications. For sanitary sewer lines with bolted joints, conform to requirements of AWWA C111; provide minimum 304 stainless steel for restraint joints. For water lines with bolted joints, conform to requirements of AWWA C111; provide Denso or approved equal petrolatum based tape coating system for exposed portion of nuts and bolts.

B. Where required by Drawings, provide approved restrained joints for buried service. Refer to City's List of Approval Products for approved joint restraint mechanisms.

C. Threaded or grooved-type joints which reduce pipe wall thickness below minimum required are not acceptable.

D. Provide for restrained joints designed to meet test pressures required under Section 02515 - Hydrostatic Testing of Pipelines or Section 02532 - Sanitary Sewer Force Mains, as applicable. Provide restrained joints for test pressure or maximum surge pressure as specified, whichever is greater for water lines. Do not use passive resistance of soil in determining minimum restraint lengths.

E. Electrical Bond Wires: Bond Wires; use stranded, copper cable furnished with high molecular weight polyethylene insulation (HMWPE). Use wire gauge (AWG) as shown on Drawings.

F. Make curves and bends by deflecting joints. Do not exceed maximum deflection recommended by pipe manufacturer for pipe joints or restraint joints. Submit details of other methods of providing curves and bends for consideration by Project Manager. When other methods are deemed satisfactory, install at no additional cost to City.

2.03 GASKETS

A. Furnish, when no contaminant is identified, plain rubber (SBR) gasket material in accordance with ANSI A21.11 or ASTM F 477; for flanged joints 1/8-inch-thick gasket in accordance with ANSI A 21.15.

B. For pipes to be installed in potentially contaminated areas, see Specification Section 02105 - Sampling and Analysis in PPCA.

C. For Pipes to be installed in any other contaminated areas, use gaskets as recommended by the Pipe Manufacturer, Engineer of the Record and approved by City Engineer prior to installation.

2.04 FITTINGS

A. Use fittings of same size as pipe. Reducers are not permitted to facilitate an off-size fitting. Reducing bushings are also prohibited. Make reductions in piping size by reducing fittings. Line and coat fittings as specified for pipe they connect to.

B. Push-on Fittings: ANSI A 21.10; ductile iron ANSI A 21.11 joints, gaskets, and lubricants; pressure rated at 250 psig.

C. Flanged Fittings: ANSI 21.10; ductile iron ANSI A 21.11 joints, gaskets, and lubricants; pressure rated at 250 psig.

D. Mechanical Joint Fittings: ANSI A 21.11; pressure rated at 250 psi.

E. Ductile Iron Compact Fittings: Shall conform to AWWA C153 and shall be:

1. Fusion bonded epoxy lined or

2. Cement mortar lined.

F. For tangential flanged outlets shown on Drawings, substitute with a tee with an equivalent sized outlet unless otherwise approved by Project Manager.

2.05 COATINGS AND LININGS

A. Water line Interiors: ANSI A21.4, cement lined with seal coat; ANSI A 21.16 fusion bonded epoxy coating for interior; comply with NSF 61.

B. Sanitary Sewer and Force Main Interiors:

1. Preparation: Commercial blast cleaning conforming to SSPC-SP6.

2. Liner thickness: Nominal 40 mils, for pipe barrel interior; minimum 6 to 10 mils at gasket groove and outside spigot end to 6-inches back from end.

3. Testing: ASTM G 62, Method B for voids and holidays; provide written certification.

4. Acceptable Lining Materials:

a. Provide approved virgin polyethylene conforming to ASTM D 1248, with inert fillers and carbon black to resist ultraviolet degradation during storage; heat bonded to interior surface of pipe and fittings.

b. Ceramic Epoxy – Protecto 401 or approved equal.

C. Sanitary Sewer Point Repair Pipe: For pipes which will be lined with high density polyethylene liner pipe or cured-in-place liner, provide cement-lined with seal coat in accordance with ANSI A 21.4. For pipes which will not be provided with named liner, provide pipe as specified in Paragraph 2.05B, Sanitary Sewer and Force Main Interiors.

D. Exterior:

1. Encasement and coating requirement for water lines

a. Open cut construction method:

1) Provide double wrap polyethylene encasement applied in accordance with AWWA C105 or
2) Provide Polyurethane coating in accordance with Section 02527 - Polyurethane Coatings on Steel and Ductile Iron Pipe.

b. Auger or casing construction method:

1) Provide Polyurethane coating in accordance with Section 02527 - Polyurethane Coatings on Steel and Ductile Iron Pipe or
2) Provide minimum thickness Class 52 pipe, double wrap with polyethylene encasement. Place circumferential wraps of tape or plastic tie straps at two-foot intervals along the barrel of the pipe, and thoroughly seal each end of the polyethylene tube.

c. Tunnel, Casing or Direct Bury: Conform to requirements of Paragraph 2.05E.

2. Sanitary Sewers: Prime coat and outside asphaltic coating conforming to ANSI A21.10, ANSI A21.15, or ANSI A21.51 for pipe and fittings in open cut excavation and in casings.

E. Polyethylene Wrap: For buried sanitary sewer pipes not cathodically protected, provide polyethylene wrap unless otherwise specified or shown. For water lines, provide polyethylene wrap unless otherwise specified or shown. Conform to requirements of Section 02528 - Polyethylene Wrap.

F. For flanged joints in buried service, provide petrolatum wrapping system, Denso, or equal, for the complete joint and alloy steel fasteners. Alternatively, sanitary sewer lines may use bolts made of Type 304 stainless steel.

G. Pipe to be installed in potentially contaminated areas shall have coatings and linings recommended by the manufacturer for maximum resistance to the contaminants identified in the Phase II Environmental Site Assessment Report. If no alternative coating is specified for water lines, provide polyethylene wrap in potentially contaminated areas.

2.06 MANUFACTURERS

A. Use pre-approved manufacturers listed in City of Houston approved products.

PART 3 E X E C U T I O N

3.01 INSTALLATION

A. Conform to installation requirements of Sections 02511 - Water Lines, 02531 - Gravity Sanitary Sewers, 02532 - Sanitary Sewer Force Mains 02631 - Storm Sewers and 02553 - Point Repairs and Obstruction Removal, except as modified in this Section.

B. Install in accordance with AWWA C 600 and manufacturer's recommendations.

C. Install double wrap polyethylene encasement in conformance with requirement of AWWA C105 and Section 02528 – Polyethylene Wrap.

D. Holiday Testing.

1. Polyurethane: Conform to requirements of Section 02527 - Polyurethane Coatings for Steel or Ductile Iron Pipe.

2. Fusion Bonded Epoxy: Conform to requirements for new fittings in ANSI A 21.16.

E. Provide electrical continuity bonding across buried mechanical and push-on joint assemblies, except where insulating flanges are required by Drawings.

1. Provide minimum number of bond wires shown on Drawings. Remove one inch of HMWPE insulation from each of bond wire prior to attaching.

2. Secure wire onto pipe using approved Thermite Welding procedures.

3. Coat bare metal and weld metal after weld is secure. Use coal-tar compound or other compatible coating. For polyurethane coated pipe, use compatible polyurethane coating.

4. Visually inspect Thermite Weld connections for electrical continuity, strength and suitable coating prior to backfilling or placing pipe in augered hole or casing.

3.02 FIELD REPAIR OF COATINGS

A. Polyurethane: Conform to requirements of Section 02527 - Polyurethane Coatings for Steel or Ductile Iron Pipe.

B. Fusion Bonded Epoxy: Conform to requirements for new fittings in ANSI A 21.16.

END OF SECTION

Section 02502

STEEL PIPE AND FITTINGS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Steel pipe and fittings for water lines for aerial crossings, aboveground piping, and encasement sleeves. Do not bury steel pipe, unless it is large diameter water line.

B. Specifications identify requirements for small-diameter less than or equal to 20 inches.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No payment will be made for steel pipe and fittings under this Section. Refer to Section 02511 - Water Lines for measurement and payment.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. AASHTO - Standard Specifications for Highway Bridges.

B. ASME B 16.1 - Cast-Iron Pipe Flanges and Flanged Fittings.

C. ASTM A 36 - Standard Specification for Carbon Structural Steel.

D. ASTM A 53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

E. ASTM A 105 - Standard Specification for Carbon Steel Pipe Forgings for Piping Applications

F. ASTM A 106 - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.

G. ASTM A 135 - Standard Specification for Electric-Resistance-Welded Steel Pipe.

H. ASTM A 139 - Standard Specification for Electric-Fusion (ARC) - Welded Steel Pipe (NPS 4 and Over).

I. ASTM A 1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

J. ASTM D 4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

K. AWWA C 200 - Standard for Steel Water Pipe 6 in. and Larger.

L. AWWA C 206 - Standard for Field Welding of Steel Water Pipe.

M. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 in. through 144 in.

N. AWWA C 210 - Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.

O. AWWA C 604 – Installation of Buried Steel Water Pipe – 4 In. and Larger.

P. AWWA M 11 – Steel Pipe – A Guide for Design and Installation.

O. SSPC Good Painting Practice, Volume 1.

P. SSPC SP 1 - Surface Preparation Specification No. 1 Solvent Cleaning.

Q. SSPC SP 5 - Joint Surface Preparation Standard White Blast Cleaning.

R. SSPC SP 6 - Surface Preparation Specification No. 6 Commercial Blast Cleaning.

S. SSPC SP 10 - Surface Preparation Specification No. 10 Near-White Blast Cleaning.

T. SSPC VIS 1 - Visual Standard for Abrasive Blast Cleaned Steel.

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures. For aerial crossings and above ground piping, include lay schedule of new pipe and fittings indicating alignment and grade, laying dimensions, lining and coating systems, proposed welding procedures, fabrication, fitting, flange, and special details. Show station numbers for pipe and fittings corresponding to Drawings.

B. Submit manufacturer's certifications that pipe and fittings are new and unused.

C. Submit manufacturer's certifications that pipe and fittings have been hydrostatically tested at factory in accordance with AWWA C 200.

D. Submit manufacturer's affidavits that coatings and linings comply with applicable requirements of this Section and:

1. Polyurethane coatings were applied in strict accordance with manufacturer's recommendation and allowed to cure at temperature 5 degrees above dew point.

2. Linings were applied and allowed to cure at temperature above 32 F.

E. Submit certification from NACE Certified Coatings Inspector, having Level III certification for coatings and linings, that steel pipe furnished on project was properly inspected and defective coatings detected were properly repaired.

1.05 QUALITY CONTROL

A. Prior to start of work, provide proof of certification of qualification for welders employed for type of work, procedures and positions involved. Provide welder qualifications in accordance with AWWA C 206.

B. Shop-applied coatings and linings; provide services of an independent coating and lining inspection service or testing laboratory with qualified coating inspectors. Perform inspection by NACE trained inspectors under supervision of NACE Level III Certified Coatings Inspector verifying compliance with same requirements specified in Paragraph 3.02.

C. Coatings: Measure temperature and dew point of ambient air before applying coatings. Inspect physical dimensions and overall condition of coatings. Inspect for visible surface defects, thickness, and adhesion of coating to surface and between layers.

D. Final Inspection:

1. Before shipment, inspect each finished pipe, fitting, special and accessory for markings, metal thickness, coating thickness, lining thickness (if shop applied), joint dimensions, and roundness.

2. Inspect for coating placement and defects. Test exterior coating for holidays.

a. Inspect linings for thickness, pitting, scarring, and adhesion.

E. Ensure workmen engaged in manufacturing are qualified and experienced in performance of their specific duties.

PART 2 P R O D U C T S

2.01 STEEL PIPE

A. Provide steel pipe and encasement sleeves designed and manufactured in conformance with AWWA C 200 and AWWA M 11 except as modified herein. Steel to be minimum of ASTM A106, ASTM A 36, ASTM A 1011 Grade 36, ASTM A 53 Grade B, ASTM A 135 Grade B, or ASTM A 139 Grade B.

B. Minimum Allowable Steel-Wall Thickness:

CARRIER PIPE			
Nom. Pipe Size	Min. Wall		Approx. Wt. Per L. F. Uncoated (Lb.)
	O.D (In.)	Thick. (In.)	
4	4.50	0.250	11.35
6	6.625	0.280	18.97
8	8.625	0.322	28.55
10	10.75	0.365	40.48
12	12.75	0.375	49.56
16	16.00	0.375	62.58
20	20.00	0.375	78.60

Notes for Carrier Pipe:

1. Review pipe and fitting design for conditions exceeding those specified herein.

2. Provide pipe with wall thickness of no less than listed in table above.

MINIMUM DIAMETER CASING PIPE (ENCASEMENT SLEEVES)			
Corresp. Casing Pipe Size (In.)	Min. Wall		Approx. Wt. Per L. F. Uncoated (Lb.)
	O.D. (In.)	Thick. (In.)	
8	8.625	0.219	19.64
10	10.75	0.219	24.60
12	12.75	0.219	29.28
16	16.00	0.219	36.86
18	18.00	0.25	47.39
20	20.00	0.250	52.73
24	24.00	0.250	63.41

Notes for Casing Pipe:

1. Provide casing pipe with wall thickness of no less than listed in table above.

2. Casing pipe: AWWA C 200 new uncoated welded steel.

3. Verify casing diameter required with dimensions of casing spacer.

C. Provide pipe sections in lengths of no less than 16 feet except as required for special sections, and no greater than 40 feet.

D. Provide short sections of steel pipe no less than 4 feet in length unless indicated on Drawings or specifically permitted by Project Manager.

E. Fittings: Factory forged for sizes 4 inches through 20 inches; long radius bends; beveled ends for field butt welding; wall thickness equal to or greater than pipe to which fitting is to be welded unless otherwise shown on Drawings.

F. Joints:

1. Standard field joint for steel pipe and encasement sleeve: AWWA C 206. Single-welded, butt joint.

2. Electrically isolate flanged joints between steel and cast iron by using flange isolation fittings as specified in paragraph 2.03 of Specification Section 15640 – Joint Bonding and Electrical Isolation. Use epoxy coated nuts and bolts to assemble the fittings.

3. Elbows to be standard weight seamless elbows per ASTM A106, Grade A or B.

G. Flanges: Refer to Specification Section 02511 – Water Lines.

2.02 INTERNAL LINING SYSTEMS FOR STEEL PIPE, ALL INSTALLATIONS

A. Supply steel pipe with epoxy lining, capable of conveying water at temperatures not greater than 140 degrees F. Provide linings conforming to American National Standards Institute/National Sanitation Foundation (ANSI/NFS) Standard 61 and certification to be from organization accredited by ANSI. Unless otherwise noted, coat exposed (wetted) steel parts of flanges, blind flanges, bolts, access manhole covers, etc., with epoxy lining, as specified.

B. Epoxy Lining AWWA C 210, White, or approved equal for shop and field applied, except as modified in this Section. Provide material from same manufacturer.

Surface Preparation as recommended by manufacturer	SSPC-10 Near White Blast Clean
Finish Coat	AWWA C210. Provide Devoe Bar Rust 233H or approved equal.

1. Provide dry film thickness in accordance with product manufacturer recommendations. Do not exceed maximum DFT as recommended by manufacturer.

2. Factory Testing: In accordance with AWWA C210.

2.03 EXTERNAL COATING SYSTEM FOR STEEL PIPE INSTALLED ABOVEGROUND AND IN VAULTS (EXPOSED)

A. Provide approved epoxy/polyurethane coating system as designated below. Provide material from same manufacturer.

Surface Preparation as recommended by manufacturer	SSPC SP 10 Near White Blast Clean
Intermediate Coat	Chemical Resistant Epoxy, or approved equal, AWWA C210
Finish Coat	Polyurethane, or approved equal Blue Fed Std. No. 15102 color as approved by Project Manager

B. Total Allowable Dry Film Thickness (DFT) for System: as recommended by manufacturer.

C. Factory and field testing: in accordance with AWWA C210.

D. Clean bare pipe free from mud, mill lacquer, oil, grease, or other contaminant. Inspect and clean surfaces according to SSPC-SP-1 to remove oil, grease, and loosely adhering deposits prior to blast cleaning. Remove visible oil and grease spots by solvent wiping. Use only approved safety solvents which do not leave residue. Use preheating to remove oil, grease, mill scale, water, and ice provided pipe is preheated in uniform manner to avoid distortion.

E. Remove surface imperfections such as slivers, scabs, burrs, weld spatter, and gouges. Grind weld bead for proper coating application as recommended by coating manufacturer. Presence of metallic defects may be cause for rejection of pipe.

PART 3 E X E C U T I O N

3.01 PIPING INSTALLATION

A. Conform to applicable provisions of Section 02511 - Water lines, except as modified in this Section.

B. Comply with the following:

1. Bedding and Backfilling: Conform to requirements of Section 02317 - Excavation and Backfill for Utilities.

2. For pipes with coating: Do not roll or drag pipe on ground, move pipe in such a manner as not to damage pipe or coating. Carefully inspect pipe for abrasions and repair damaged coating before pipe is installed.

C. Static Electricity:

1. Properly ground steel pipeline during construction as necessary to prevent build-up of static electricity.

2. Electrically test where required after installation is complete.

3.02 EXTERNAL COATING SYSTEM FOR STEEL PIPE INSTALLED ABOVE GROUND AND IN VAULTS (EXPOSED) AND EPOXY INTERNAL LINING SYSTEM.

A. Safety: Paints, coatings, and linings specified in this Section are hazardous materials. Vapors may be toxic or explosive. Protective equipment, approved by appropriate regulatory agency, is mandatory for personnel involved in painting, coating, and lining operations.

B. Workmanship:

1. Application: By qualified and experienced workers who are knowledgeable in surface preparation and application of high-performance industrial coatings.

2. Paint Application Procedures: SSPC Good Painting Practices, Volume 1.

C. Surface Preparation:

1. Prepare surfaces for painting by using abrasive blasting.

2. Schedule cleaning and painting so that detrimental amounts of dust or other contaminants do not fall on wet, newly-painted surfaces. Protect surfaces not intended to be painted from effects of cleaning and painting operations.

3. Prior to blasting, clean surfaces to be coated or lined of grease, oil and dirt by steaming or detergent cleaning in accordance with SSPC SP 1.

4. Metal and Weld Preparation: Remove surface defects such as gouges, pits, welding and torch-cut slag, welding flux and spatter by grinding to 1/4-inch minimum radius.

5. Abrasive Material:

a. Blast only as much steel as can be coated same day of blasting.

b. Use sharp, angular, properly graded abrasive capable of producing depth of profile specified herein. Transport abrasive to job site in moisture-proof bags or airtight bulk containers. Copper slag abrasives are not acceptable.

c. After abrasive blast cleaning, verify surface profile with replica tape such as Tes-Tex Coarse or Extra Coarse Press-O-Film Tape, or approved equal. Furnish tapes to Project Manager.

d. Do not blast if metal surface may become wet before priming commences, or when metal surface is less than 5 degrees F above dew point.

6. Evaluate degree of cleanliness for surface preparation with use of SSPC Pictorial Surface Preparation Standards for Painting Steel Surfaces, SSPC-Vis 1.

7. Remove dust and abrasive residue from freshly blasted surfaces by brushing or blowing with clean, dry air. Test cleanliness by placing ¾-inch by-4 inch piece of clear Scotch type tape on blasted surface, then removing and placing tape on 3x5 white index card. Reclean areas exhibiting dust or residue.

D. Coating and Lining Application:

1. Environmental Conditions: Do not apply coatings or linings when metal temperature is less than 50 degrees F; when ambient temperature is less than 5 degrees F above dew point; when expected weather conditions are such that ambient temperature will drop below 40 degrees F within 6 hours after application; or when relative humidity is above 85 percent. Measure relative humidity and dew point by use of sling psychrometer in conjunction with U.S. Department of Commerce Weather Bureau Psychometric Tables. Provide dehumidifiers for field-applied coatings and linings to maintain proper

humidity levels.

2. Application Procedures:

   a. Apply in accordance with manufacturer's recommendations and requirements of this Section. Provide finish free of runs, sags, curtains, pinholes, orange peel, fish eyes, excessive over spray, or delaminations.

   b. Thin materials only with manufacturers recommended thinners. Thin only amount required to adjust viscosity for temperature variations, proper atomization and flow-out. Mix material components using mechanical mixers.

   c. Discard catalyzed materials remaining at end of day.

3. Thoroughly dry pipe before primer is applied. Apply primer immediately after cleaning surface. Apply succeeding coats before contamination of undersurface occurs.

4. Cure a minimum of 24 hours at 77 degrees F before successive coats are applied. During curing process, provide force air ventilation in volume sufficient to maintain solvent vapor levels below published threshold limit value. Apply successive coats within recoat threshold time as recommended by coating or lining manufacturer on
printed technical data sheets or through written communications. Brush blast joints of pipe which have been shop primed and are to receive intermediate and finish coats in field prior to application of additional coats. After interior coatings are applied, provide forced air ventilation in sufficient volume and for sufficient length of time to ensure proper curing before filling pipe with water.

E. Testing of Coatings and Linings:

1. Inspect pipe for holidays and damage to coating:

   a. If test indicates no holidays and coating is damaged, remove damaged layers of coating and repair in accordance with coating manufacturer's recommendations.

2. Perform holiday test in accordance with NACE Standard Recommended Practice, RPO 188-90, Discontinuity (Holiday) Testing of Protective Coatings.

3. Begin testing of completed coating after coating has sufficiently cured, usually one to 5 days. Consult coating manufacturer for specific curing schedule.

4. Perform adhesion test on pipe in accordance with ASTM D 4541.

5. For coating thickness of 20 mils or less, test with wet sponge low-voltage holiday detector. For coating thickness in excess of 20 mils, test with high-voltage holiday detector. Perform electrical holiday test with 60-cycle current audio detector. Select test voltage as suggested in table below.

MINIMUM VOLTAGES FOR
HIGH VOLTAGE SPARK TESTING

Total Dry Film Thickness (mils)	Suggested Inspection (V)
20 to 40	3,000
41 to 55	4,000
56 to 80	6,000

3.03 JOINTS AND JOINTING

A. Welded Joints:

1. Conform to requirements of Section 02511 - Water Lines.

2. Field weld to be full penetration butt welded joints for steel pipe and encasement sleeves for entire circumference.

3. City will employ an independent certified testing laboratory to perform weld acceptance tests on welded joints. Testing Laboratory will test by X-ray methods for butt welds, for 100 percent of joint welds. Project Manager has final decision as to suitability of welds tested.

B. Flanged Joints: Conform to requirements of Section 02511 - Water Lines.

3.04 COATINGS AND LININGS INSPECTION RESPONSIBILITIES

A. Contractor is responsible for quality control of coatings and linings applications and testing and inspection stipulated in this Section. Project Manager is responsible for quality assurance and reserves the right to inspect or acquire services of an independent third-party inspector who is fully knowledgeable and qualified to inspect surface preparation and application of high-performance coatings at all phases of coatings and linings work, field- or shop-applied. Contractor is responsible for proper application and performance of coatings and linings whether or not Project Manager provides such inspection.

END OF SECTION

Section 02503

COPPER TUBING

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Copper tubing for water service lines.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No payment will be made for copper tubing under this Section. Include cost in unit price for water taps and service lines.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. ASTM B 88 - Standard Specification for Seamless Copper Water Tube.

B. AWWA C 800 - Standard for Underground Service Line Valves and Fittings.

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit certified test results of ASTM B 88.

C. Submit manufacturer's testing certification that copper tubing conforms to requirements of ASTM B 88. Number of samples for testing of each size of tubing is modified as follows:

1. For each 7500 feet of tubing: 1 sample

2. For each set of tubing less than 7500 feet: 1 sample

PART 2 P R O D U C T S

2.01 MATERIALS

A. Provide Type K annealed, seamless, copper tubing, 3/8 inch to 2 inch in diameter conforming to requirements of ASTM B 88.

B. Provide 3/8-inch and 1-inch tubing in coils of minimum 60 feet in length, and 11/2-inch and 2-inch tubing in coils 40 feet in length.

C. Provide tubing manufactured in United States of America. Tubing shall be inspected and tested by laboratory designated by Project Manager at point of manufacture or locally. Furnish tubing, at no additional cost to designated testing laboratory along with mill compliance certificates.

D. Provide flared or compression-type brass fittings for use with Type K annealed copper tubing in accordance with AWWA C 800.

PART 3 E X E C U T I O N

3.01 INSTALLATION

A. Conform to installation requirements of Section 02512 - Water Tap and Service Line Installation, except as modified in this Section.

3.02 JOINTS

A. Minimum joint spacing for 3/4-inch and 1-inch tubing shall be 60 feet and for 1 1/2-inch and 2-inch tubing shall be 40 feet.

B. Cut copper tubing squarely by using cutting tools designed specifically for purpose and avoid procedures that cause pipe to bend or pipe walls to flatten.

C. After tubing has been cut, but before flaring, use reamer to remove inside rolled lip from tubing. Expand flared ends by use of flaring tool using care to avoid splitting, crimping, or over stressing metal. Provide at least 10 inches of straight pipe adjacent to fittings.

D. When compression fittings are used, cut copper tubing squarely prior to insertion into fitting. Assemble in accordance with manufacturer's recommended procedure.

3.03 BENDS

A. Bend tubing by using appropriate sized bending tool. No kinks, dents, flats, or crimps shall be permitted. Cut out and replace damaged section. Install no bends with radius smaller than radius of coil of tubing as packaged by manufacturer. Copper tubing shipped in straight lengths conforms to the following:

1. For 2-inch diameter: Maximum of one 45-degree bend per 4-foot section.

2. For 1 1/2-inch diameter: Maximum of one 45-degree bend per 3-foot section.

END OF SECTION

Section 02505

HIGH DENSITY POLYETHYLENE (HDPE) SOLID AND PROFILE WALL PIPE

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. High density polyethylene (HDPE) pipe for gravity sanitary sewers and drains, including fittings.

B. High density polyethylene (HDPE) pipe for sanitary sewer force mains, including fittings.

C. High density polyethylene (HDPE) pipe for gravity storm sewers and drains, including fittings.

D. High density polyethylene (HDPE) pipe for storm sewers culverts.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for HDPE pipe under this Section. Include cost in unit prices for work, as specified in following sections:

   a. Section 02531 - Gravity Sanitary Sewers.

   b. Section 02532 - Sanitary Sewer Force Mains.

   c. Section 02550 - Sliplining Sanitary Sewers.

   d. Section 02571 - Pipe Bursting/Crushing Sanitary Sewers.

   e. Section 02631 - Storm Sewers.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. ASTM D 618 - Standard Practice for Conditioning Plastics for Testing.

B. ASTM D 1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable

C. ASTM D 2321 - Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Pipe.

D. ASTM D 2657 - Standard Practice for Heat Fusion Joining Polyolefin Pipe and Fittings.

E. ASTM D 2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.

F ASTM D 3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.

G. ASTM D 3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

H. ASTM D 3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

I. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

J. ASTM F 714 - Standard Specification for Polyethylene Plastic (PE) Pipe (SDR-PR) Based on Outside Diameter.

K. ASTM F 894 - Standard Specification for Polyethylene (PE) Large-Diameter Profile Wall Sewer and Drain Pipe.

L. ASTM F 2306 – Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.

M. ASTM F 2487 – Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Corrugated High Density Polyethylene Pipelines.

N. ASTM F 2510 – Standard Specification for Resilient Connectors between Concrete Manhole Structures and Corrugated High Density Polyethylene Drainage Pipes.

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit shop drawings showing design of pipe and fittings indicating alignment and grade, pipe length, laying dimensions, fabrication, fittings, flanges, gasket material, and special details.

C. Submit detailed calculations for pipe design.

D. Submit details of Pipe Joints and jointing procedure for HDPE pipe.

1.05 QUALITY CONTROL

A. Provide manufacturer's certificate of conformance to Specifications.

B. Furnish pipe and fittings that are homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. Provide pipe as uniform as commercially practical in color, opacity, density, and other physical properties.

C. Project Manager reserves right to inspect pipes or witness pipe manufacturing. Inspection shall in no way relieve manufacturer of responsibilities to provide products that comply with applicable standards and these Specifications.

1. Manufacturer's Notification: Should Project Manager wish to witness manufacture of specific pipes, manufacturer shall provide Project Manager with minimum three weeks notice of when and where production of those specific pipes will take place.

2. Failure to Inspect. Approval of products or tests is not implied by Project Manager’s decision not to inspect manufacturing, testing, or finished pipes.

D. Pipe manufacturer to provide services of experienced, competent, and authorized representative to visit site to advise and consult Contractor during jointing and installation of pipe.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with documented experience of minimum 5 years of pipe installations that have been in successful, continuous service for same type of service as proposed Work.

PART 2 P R O D U C T S

2.01 GENERAL

A. Provide products manufactured by companies listed on the City of Houston Standard Product List.

B. Furnish solid wall pipe with plain end construction for heat joining (butt fusion) conforming to ASTM D 2657. Utilize controlled temperatures and pressures for joining to produce fused leak-free joint.

C. Furnish profile-wall gravity sanitary sewer pipe with bell-and-spigot end construction conforming to ASTM D 3212. Joining will be accomplished with elastomeric gasket in accordance with manufacturer's recommendations. Use integral bell-and-spigot gasketed joint designed so that when assembled, elastomeric gasket, contained in machined groove on pipe spigot, is compressed radially in pipe bell to form positive seal. Design joint to avoid displacement of gasket when installed in accordance with manufacturer's recommendations.

D. Furnish solid wall pipe for sanitary sewer force mains with minimum working pressure rating of 150 psi, and with inside diameter equal to or greater than nominal pipe size indicated on Drawings.

E. Furnish corrugated profile-wall polyethylene (CPP) pipe for gravity storm sewer and storm sewer culvert pipe. Joints shall be installed such that connection of pipe sections will form continuous line free from irregularities in flow line. Suitable joints are:

1. Integral Bell and Spigot. Bell shall overlap minimum of two corrugations of spigot end when fully engaged.

2. Exterior Bell and Spigot. Bell shall be fully welded to exterior of pipe and overlap spigot end so that flow lines and ends match when fully engaged.

F. Jointing:

1. Gaskets:

a. Meet requirements of ASTM F 477. Use gasket molded into circular form or extruded to proper section and then spliced into circular form. When no contaminant is identified, use gaskets of properly cured, high-grade elastomeric compound. Basic polymer shall be natural rubber, synthetic elastomer, or blend of both.

b. HDPE Pipes are Not allowed to be installed in potentially contaminated areas, unless approved by City Engineer.

CONTAMINANT	**GASKET MATERIAL REQUIRED**
Petroleum (diesel, gasoline)	Nitrile Rubber
Other Contaminants	As recommended by pipe manufacturer

2. Lubricant. Use lubricant for assembly of gasketed joints which has no detrimental effect on gasket or on pipe, in accordance with manufacturer's recommendations.

2.02 MATERIALS FOR SANITARY SEWER

A. Pipe and Fittings: High density, high molecular weight polyethylene pipe material meeting requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D 1248. Material meeting requirements of cell classification 345434D or E, in accordance with ASTM D 3350, are also suitable for making pipe products under these specifications. Inner wall of pipe shall be of light color for television inspection purposes.

B. Other Pipe Materials: Materials other than those specified in Paragraph 2.02A, Pipe and Fittings, may be used as part of profile construction, e.g., as core tube to support shape of profile during processing, provided that these materials are compatible with base polyethylene material and are completely encapsulated in finished product and in no way compromise performance of pipe products in intended use. Examples of suitable material include polyethylene and polypropylene.

2.03 MATERIALS FOR GRAVITY STORM SEWERS AND STORM SEWER CULVERTS

A. Pipe and Fittings: High density, high molecular weight polyethylene HDPE virgin compound material meeting requirements of cell class outlined in ASTM D 3350.
Manufacturing shall meet requirements of ASTM F 2306.

2.04 TEST METHODS FOR SANITARY SEWER

A. Conditioning. Conditioning of samples prior to and during tests is subject to approval by Project Manager. When referee tests are required, condition specimens in accordance with Procedure A in ASTM D 618 at 73.4 degrees F plus or minus 3.6 degrees F and 50 percent relative humidity plus or minus 5 percent relative humidity for not less than 40 hours prior to test. Conduct tests under same conditions of temperature and humidity unless otherwise specified.

B. Flattening. Flatten three specimens of pipe, prepared in accordance with Paragraph 2.05A, in suitable press until internal diameter has been reduced to 40 percent of original inside diameter of pipe. Rate of loading shall be uniform and at 2 inches per minute. Test specimens, when examined under normal light and with unaided eye, shall show no evidence of splitting, cracking, breaking, or separation of pipe walls or bracing profiles.

C. Joint Tightness. Test for joint tightness in accordance with ASTM D 3212, except replace shear load transfer bars and supports with 6-inch-wide support blocks that can be either flat or contoured to conform to pipe's outer contour.

D. Purpose of Tests. Flattening and joint tightness tests are not intended to be routine quality control tests, but rather to qualify pipe to a specified level of performance.

2.05 TEST METHODS FOR GRAVITY STORM SEWERS AND STORM SEWER CULVERTS

A. All testing and material requirements shall be in accordance with ASTM F 2306.

2.06 MARKING

A. Mark each standard and random length of pipe in compliance with these Specifications with following information:

1. Pipe size.

2. Pipe class.

3. Production code.

4. Material designation.

PART 3 E X E C U T I O N

3.01 INSTALLATION

A. Conform to requirements of following Sections:

1. Section 02550 - Sliplining Sanitary Sewers.

2. Section 02531 - Gravity Sanitary Sewers.

3. Section 02532 - Sanitary Sewage Force Mains.

4. Section 02533 - Acceptance Testing for Sanitary Sewers.

5. Section 02571 - Pipe Bursting/Crushing Sanitary Sewers.

6. Section 02631 - Storm Sewers

B. Install pipe in accordance with the manufacturers recommended installation procedures and ASTM D 2774.

C. HDPE pipe is not approved in applications requiring augering of pipe.

D. Bedding and backfill: Conform to requirements of Section 02317 - Excavation and Backfill for Utilities.

E. Use only workmen trained in the installation of HDPE Pipe.

F. Do not store pipe uncovered direct in direct sunlight. Allow pipe temperature to approach ground temperature before each individual pipe section is terminally connected.

G. Joints: Join sections of HDPE pipe into continuous lengths above ground by thermal butt fusion method in accordance with AWWA C906 and pipe manufacturer's recommendations for specified service. Fusion joints: meeting minimum requirements of manufacturer for cool down time and other fusing requirements. Socket fusion and extrusion welding or hot gas welding will not be accepted.

H. Cutting pipe: Comply with pipe manufacturer's recommendations. After cutting, leave end pipe in accordance with manufacturer's recommendations.

END OF SECTION

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Section 02511

WATER LINES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Installation of water lines.

B. Specifications identify requirements for both small diameter water lines and large diameter water lines. When specifications for large diameter water lines differ from those for small diameter water lines, large diameter specifications will govern for large diameter pipe.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. Payment for water lines installed by open-cut, or trenchless construction or aerial crossing, with or without restrained joint, with or without welded joints, with or without thrust blocks, with or without casing, within limits of pipe offset section or within limits of Potentially Petroleum Contaminated Area (PPCA) or within limits of Fault Hazard Zone (FHZ) is on linear foot basis for each size of pipe installed. Separate pay items are used for each type of installation.

a. Mains: Measure along axis of pipe and include fittings and valves.

b. Branch Pipe: Measure from axis of water line to end of branch.

2. Payment for interconnection is on lump sum basis for each interconnection identified on Drawings. Payment will include tapping sleeve and valves piping, connections and other related work necessary for construction as shown on Drawings or specified herein.

3. Payment for removal of existing internal elliptical or dished head plug is on unit price basis for each internal elliptical or dished head plug removed. Payment will include deletion of plug, drainage or dewatering of water lines, repair of damaged linings, rechlorination and items incidental to operation.

4. Payment for plug and clamp is on a unit price basis for each size of pipe.

5. Payment for drainline connection with service manhole is on unit price basis for each drainline shown on drawings. Payment includes valve, access manhole and connection.

6. Payment for cylindrical corrosion barriers is on a unit price basis for each pipe fitting installed with one or more barriers.

7. When directed by Project Manager to install extra fittings as required to avoid unforeseen obstacles, payment will be based on the following:

   a. Each extra fitting requested by Project Manager and delivered to jobsite will be paid according to unit price for "Extra Fittings in Place."

   b. Payment will include and be full compensation for items necessary for installation and operation of water line.

8. No separate payment will be made for bell protection system for PVC pipe. Include cost in related unit price work.

9. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum): If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. ANSI A 21.11/AWWA C111 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

B. ANSI/NSF Standard 61 - Drinking Water System - Health Components.

C. ASTM A 36 - Standard Specification for Carbon Structural Steel.

D. ASTM A 536 - Standard Specification for Ductile Iron Castings.

E. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

F. ASTM B 21 - Standard Specification for Naval Brass Rod, Bar, and Shapes.

G. ASTM B 98 - Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.

H. ASTM B 301 - Standard Specification for Free-Cutting Copper Rod and Bar.

I. ASTM B 584 - Standard Specification for Copper Alloy Sand Casting for General Application.

J. ASTM E 165 - Standard Test Method for Liquid Penetrant Examination.

K. ASTM E 709 - Standard Guide for Magnetic Particle Examination.

L. ASTM F 1674 - Standard Test Method for Joint Restraint Products for Use with PVC Pipe.

M. AWWA C 206 - Standard for Field Welding of Steel Water Pipe.

N. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 Inches through 144 Inches.

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Conform to submittal requirements of applicable Section for type of pipe used.

C. Photographs: Submit photographs conforming to requirements of Section 01321 - Construction Photographs prior to commencement of construction.

D. Submit videotapes conforming to requirements of Section 01323 - Construction Videotapes, if applicable.

E. Submit Lone Star notification transmittal number prior to beginning excavation.

F. Submit, a minimum of 15 days before beginning pipe laying operations, layout drawing identifying proposed sections for disinfecting, hydrostatic testing and site restoration for entire project for review and approval. Layout drawing to identify sequence of sections for:

1. Disinfection; not to exceed 4,000 linear feet per section.

2. Hydrostatic testing and transfer of services; to immediately follow sequence of disinfected section.

3. Site restoration; not to exceed limits specified; sequence in order of disturbance.

G. For water lines to be field welded, submit proof of certification of field welders per AWWA C206. Indicate certified procedures and position each welder is qualified to perform. Provide documentation of the most recent weld qualification test date and continuity of use in each process for which the welder or welding operator is required.

PART 2 P R O D U C T S

2.01 PIPE MATERIALS

A. Install pipe materials which conform to following:

1. Section 02501 - Ductile Iron Pipe and Fittings.

2. Section 02502 - Steel Pipe and Fittings. Water line piping within plant site and aerial crossings to be welded joint steel pipe with flange or approved restraint joint connections, unless otherwise shown on Drawings.

3. Section 02506 - Polyvinyl Chloride Pipe.

4. Section 02507 - Prestressed Concrete Cylinder Pipe.

5. Section 02509 – Fiberglass Reinforced Pipe for Pressure Mains

6. Section 02518 - Steel Pipe and Fittings for Large Diameter Water Lines.

7. Section 02613 - Bar-Wrapped Steel Cylinder Pipe.

B. Conform to American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 61 and have certified by an organization accredited by ANSI.

C. Type of pipe materials used is Contractor's option unless specifically identified on Drawings.

D. Provide minimum of 3/8 inch inside joint recess between ends of pipe in straight pipe sections.

2.02 WELDED JOINT PROTECTION FITTING FOR SMALL DIAMETER STEEL PIPE

A. Cylindrical Corrosion Barrier: Provide approved cylindrical corrosion barrier.

B. O-rings: Conform to National Sanitary Foundation requirements.

2.03 RESTRAINED JOINTS

A. Ductile-Iron Pipe: See Section 02501 - Ductile Iron Pipe and Fittings.

B. PVC Pipe: See Section 02506 - Polyvinyl Chloride Pipe. Perform hydrostatic testing in accordance with ASTM F 1674.

C. Prestressed Concrete Cylinder Pipe, Bar-Wrapped Pipe and Steel Pipe: Welded joints (see Paragraph 3.06C).

D. Except for trenchless installation, restrained Joints where required on DIP and PVC pipe are allowed with the following requirements as an alternative to the pipe with an integral restrained joint system:

1. Restraint Devices: Manufacture of high-strength ductile iron, ASTM A 536. Working pressure rating twice that of design test pressure.

2. Bolts and Connecting Hardware: High-strength low-alloy material in accordance with ANSI A21.11/AWWA C111.

E. For ductile iron or PVC pipes in augered holes, provide restrained joints that are integral to both the bell and spigot ends, and do not extend beyond or increase the outside diameter of the bell.

F. For small diameter water lines crossing under sanitary sewer lines or laterals, provide ductile iron pipe with locking or bolted type restrained joints.

2.04 COUPLINGS AND APPURTENANCES FOR LARGE DIAMETER WATERLINE

A. Flexible (Dresser-type) Couplings:

1. Install where shown on Drawings or where allowed by Project Manager for Contractor's convenience. Use galvanized flexible couplings when installed on galvanized pipe which is cement lined, or when underground. Provide gaskets manufactured from neoprene or Buna-N.

2. For steel pipe, provide approved sleeve-type flexible couplings. Thickness of middle ring equal to or greater than thickness of pipe wall.

3. Provide approved flanged adapter couplings for steel pipe.

4. Use ASTM A193 Grade B7 high strength steel bolts and ASTM A194 heavy hex nuts where flexible couplings are installed underground. Provide cadmium plated hardware. Coat entire coupling with Denso or approved equal petrolatum-based tape.

B. Flap Valves: Provide approved flap valves on discharge of manhole drainline as shown on Drawings.

1. Body and Flap: ASTM A 126-B cast iron.

2. Seats: ASTM B 21-CA482 or ASTM B 301-CA145 bronze.

3. Resilient Seat:

4. Hinge Arms: ASTM B 584-CA865 high tensile bronze.

5. Hinge Pins: ASTM B 98-CA655 silicon bronze.

2.05 COUPLINGS AND APPURTENANCES FOR LARGE DIAMETER WATERLINE

A. Install Flexible Expansion Joints at locations indicated on drawings, within limits of Fault Hazard Zone (FHZ), in accordance with the manufacturer's recommendation.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Conform to applicable installation specifications for types of pipe used.

B. Employ workmen who are skilled and experienced in laying pipe of type and joint configuration being furnished. Provide watertight pipe and pipe joints.

C. Lay pipe to lines and grades shown on Drawings.

D. Confirm 9 feet minimum separation from gravity sanitary sewers and manholes or separation of 4 feet minimum from force mains as specified in this Section in all directions unless special design is provided on Drawings.

E. Where above clearances cannot be attained, and special design has not been provided on Drawings, obtain direction from Project Manager before proceeding with construction.

F. Inform Project Manager if unmetered sprinkler or fire line connections exist which are not shown on Drawings. Make transfer only after approval by Project Manager.

G. For projects involving multiple subdivisions or locations, limit water line installation to maximum of two project site locations. Maximizing two pipe installation crews shall be permitted, unless otherwise approved by Project Manager.

H. City of Houston Drinking Water Operations will handle, at no cost to Contractor, operations involving opening and closing valves for wet connections and for chlorination. Contractor is responsible for handling necessary installations and removal of blow-offs, chlorination and testing taps, and risers.

I. If asbestos-cement (A.C.) pipe is encountered, follow safety practices outlined in OSHA 29 CFR 1926.1101 – Asbestos. Refer to Section 02221 – Removing Existing Pavements, Structures, Wood, and Demolition Debris for removing and disposing of A.C. Pipe.

J. For pipe diameters 36 inches and greater, clearly mark each section of pipe and fitting with unique designation on inside of pipe along with pressure class. Locate unique

identifying mark minimum of 5 feet away from either end of each section of pipe. Provide one unique identifying mark in middle of each fitting. Place markings at consistent locations. Use permanent black paint and minimum letter height of 4 inches to mark designations.

K. Contractor is responsible for assuring chosen manufacturer fulfills requirements for extra fittings and, therefore, is responsible for costs due to downtime if requirements are not met.

L. Do not remove plugs or clamps during months of peak water demands; June, July and August, unless otherwise approved by Project Manager.

3.02 HANDLING, CLEANING AND INSPECTION

A. Handling:

1. Place pipe along project site where storm water or other water will not enter or pass through pipe.

2. Load, transport, unload, and otherwise handle pipe and fittings to prevent damage of any kind. Handle and transport pipe with equipment designed, constructed and arranged to prevent damage to pipe, lining and coating. Do not permit bare chains, hooks, metal bars, or narrow skids or cradles to come in contact with coatings. Where required, provide pipe fittings with sufficient interior strutting or cross bracing to prevent deflection under their own weight.

3. Hoist pipe from trench side into trench by means of sling of smooth steel cable, canvas, leather, nylon or similar material.

4. For large diameter water lines, handle pipe only by means of sling of canvas, leather, nylon, or similar material. Slings shall be wide enough so as to. not tear or wrinkle tape layers.

5. Use precautions to prevent injury to pipe, protective linings and coatings.

a. Package stacked pipe on timbers. Place protective pads under banding straps at time of packaging.

b. Pad fork trucks with carpet or other suitable material. Use nylon straps around pipe for lift when relocating pipe with crane or backhoe.

c. Do not lift pipe using hooks at each end of pipe.

d. Do not place debris, tools, clothing, or other materials on pipe.

e. Place pipe on timbers, tires or soil berms at the jobsite. Do not place pipe directly on ground.

6. Repair damage to pipe or protective lining and coating before final acceptance.

7. For cement mortar lined and coated steel pipe and PCCP, permit no visible cracks wider than 1/16”

a. In surface laitance of centrifugally cast mortar.

b. In sections of pipe with steel reinforcing collars or wrappers.

c. Within 12 inches of pipe ends.

8. Repair pipe with visible cracks that exceed project specifications. If cracks cannot be repaired to specification remove from project site.

B. Cleaning: Thoroughly clean and dry interior of pipe and fittings of foreign matter before installation, and keep interior clean until Work has been accepted. Keep joint contact surfaces clean until jointing is completed. Do not place debris, tools, clothing or other materials in pipe. After pipe laying and joining operations are completed, clean inside of pipe and remove debris.

C. Inspection: Before installation, inspect each pipe and fitting for defects. Reject defective, damaged or unsound pipe and fittings and remove them from site.

3.03 EARTHWORK

A. Conform to applicable provisions of Section 02317 - Excavation and Backfilling for Utilities.

3.04 PIPE CUTTING

A. Cut pipe 12 inches and smaller with standard wheel pipe cutters. Cut pipe larger than 12 inches in manner approved by Project Manager. Make cuts smooth and at right angles to axis of pipe. Bevel plain end with heavy file or grinder to remove sharp edges.

3.05 PIPING INSTALLATION

A. General Requirements:

1. When trench width below top of pipe becomes 4 feet wider than specified, install higher class of pipe or improved bedding, as determined by Project Manager. No additional payment will be made for higher class of pipe or improved bedding.

2. Lay pipe in subgrade free of water.

3. Properly form bedding to fully support bell without wedging or blocking up bell.

4. Open Cut Construction: Cover or backfill laid pipe if pipe laying operations are interrupted and during non-working hours. Place backfill carefully and simultaneously on each side of pipe to avoid lateral displacement of pipe and damage to joints. If adjustment of pipe is required after it has been laid, remove and re-lay as new pipe. Lay not more than 50 feet of pipe in trench ahead of backfilling operations.

5. Prevent damage to coating when placing backfill. Use backfill material free of large rocks or stones, or other material which could damage coatings.

B. Install pipe continuously and uninterrupted. Obtain approval of Project Manager prior to skipping any portion of Work.

1. Before assembling couplings, lightly coat pipe ends and outside of gaskets with pipe lubricant, cup grease or liquid vegetable soap to facilitate installation.

2. Prior to proceeding with critical tie-ins, submit sequence of work based on findings from "critical location" effort.

3. Use adequate surveying methods and equipment; employ personnel competent in use of this equipment. Horizontal and vertical deviations from alignment as indicated on Drawings shall not exceed 0.10 feet. Measure and record "as-built" horizontal alignment and vertical grade at maximum of every 100 feet on record drawings.

C. Protection of Pipeline: Securely place stoppers or bulkheads in openings and in end of line when construction is stopped temporarily and at end of each day's work.

D. Perform Critical Location as shown on Drawings. Refer to Section 02317 - Excavation and Backfill for Utilities for additional requirements at critical locations.

E. Assessment of deflection may be measured by Project Manager at location along pipe. Arithmetical averages of deflection or similar average measurements will not be deemed as meeting intent of standard. Refer to pipe material specifications for maximum allowable pipe deflection.

F. Perform following additional procedures when working on plant sites.

1. Seventy-two hours prior to each plant shutdown or connection, schedule coordination meeting with Project Manager and Water Production personnel. At this meeting, present proposed sequencing of Work and verification of readiness to complete Work as required and within time permitted. Do not proceed with Work until Project Manager agrees key personnel, equipment and materials are on hand to complete Work.

2. Prior to fully excavating around existing piping, excavate as minimal as possible to confirm type and condition of existing joints. Verify size, type, and condition of pipe prior to ordering materials or fully mobilizing for Work.

3. Do not proceed with connections to existing piping and identified critical stages of work unless approved by Project Manager and City's Utility Maintenance Division operator is present to observe.

4. Coordinate with City Drinking Water Operations to obtain reduction in operating pressures prior to performing connections to existing piping.

5. Make connections to existing piping only when two valves are closed off between connection and source of water pressure. Do not make connection relying solely on one valve, unless otherwise approved by Project Manager.

6. Perform critical stages of Work identified on Drawings at night or during low water demand months as specified in Section 01110 - Summary of Work.

7. Excavation equipment used on plant sites to have smooth bucket; no teeth or side cutters.

8. Submit to Project Manager Lone Star Notification transmittal number prior to beginning excavation.

9. Before each "dig" with mechanical excavator, probe ground to determine potential obstructions. Repeat procedure until existing pipe is located or excavation reaches desired elevation. Perform excavations within one foot to existing piping by hand methods.

10. Provide adequate notice to Project Manager and pipe manufacturer's representative when connecting or modifying existing prestressed or pretension concrete cylinder pipe.

11. Provide field surveyed (horizontal and vertical elevations) "as-builts" of new construction and existing underground utilities encountered. Submit in accordance with Section 01330 - Submittal Procedures.

12. Prior to performing plant work to be done on weekend, provide list of sites and contact person with phone numbers to Project Manager by noon on Thursday of week. Contact person must be accessible during weekend, have Houston Metro Area phone number, and be authorized to make emergency decisions.

13. No night work or plant shutdown will be scheduled to begin two working days before or after designated City Holidays.

G. For tie-ins to existing water lines, provide necessary material on hand to facilitate connection prior to shutting down existing water line. Provide City a minimum of two weeks notice prior to shutting down existing water line.

3.06 JOINTS AND JOINTING

A. Rubber Gasketed Bell-and-Spigot Joints for Concrete Cylinder Pipe, Bar Wrapped Pipe PVC, Steel, and DIP:

1. After rubber gasket is placed in spigot groove of pipe, equalize rubber gasket cross section by inserting tool or bar recommended by manufacturer under rubber gasket and moving it around periphery of pipe spigot.

2. Lubricate gaskets with nontoxic water-soluble lubricant before pipe units are joined.

3. Fit pipe units together in manner to avoid twisting or otherwise displacing or damaging rubber gasket.

4. After pipe sections are joined, check each gasket to ensure that no displacement of gasket has occurred. If displacement has occurred, remove pipe section and remake joint as for new pipe. Remove old gasket, and replace before remaking joint.

5. Provide means to prevent full engagement of spigot into bell in accordance with Paragraph 2.01 D. For PVC pipe, means may consist of an approved bell insertion protection system.

B. Flanged Joints where required on Concrete Cylinder Pipe, Bar Wrapped Pipe, Ductile Iron Pipe, or Steel Pipe:

1. AWWA C 207. Prior to installation of bolts, accurately center and align flanged joints to prevent over stressing of flanges, pipe and equipment. Align bolt holes to straddle vertical, horizontal or north-south center line. Do not exceed 3/64 inch per foot inclination of flange face from true alignment.

2. Use ring type or full-face gaskets for flanged joints. Provide 1/8-inch-thick cloth inserted rubber gasket material in accordance with AWWA C207. Cut gaskets at factory to proper dimensions. In PPCA areas, provide gasket material in accordance with Section 02105 – Chemical Sampling and Analysis.

3. Provide ASTM A193 Grade B7 high strength steel stud bolts with ASTM A194 heavy hex nuts. Use cadmium-plated steel hardware underground. Tighten bolts progressively to prevent unbalanced stress. Maintain at all times approximately same distance between two flanges at points around flanges. Tighten bolts alternately (180˚ apart) until all are evenly tight. Draw bolts tight to ensure proper seating of gaskets. Provide Denso petrolatum-based tape or approved equal for all exposed portions of nuts, bolts and pipe hardware.

4. Isolation Joints:

   a. Provide full-face Type "E" gasket. For 30-inch diameter and greater, provide Pyrox G-10 material and EPDM sealing element. For 24-inch diameter and smaller, provide Phenolic material and EPDM sealing element. Provide full-length bolt isolating sleeves and washers. Provide matching steel washers on both sides of each insulating washer on every bolt. Furnish kits in accordance with Specification Section 15640 – Joint Bonding and Electrical Isolation.

C. Welded Joints (Concrete Cylinder Pipe, Bar Wrapped Pipe, Steel Pipe):

1. Prior to starting work, provide certification of qualification for welders employed on project for type of work procedures and positions involved.

2. Steel Pipe Joints: AWWA C 206. See Section 02502 – Steel Pipe and Fittings or Section 02518 – Steel Pipe and Fittings for Large Diameter Water Lines. Refer to Contract Drawings for joint details. For interior welded joints, complete backfilling before welding. For exterior field-welded joints, provide adequate working room under and beside pipe. Use exterior welds for 30-inch and smaller.

3. Concrete Pipe Joints: See Section 02507 – Prestressed Concrete Cylinder Pipe or Section 02613 – Bar-Wrapped Steel Cylinder Pipe. Refer to Contract Drawings for joint details. Align piping and equipment so that no part is offset more than 1/8 inch. Set fittings and joints square and true, and preserve alignment during welding operation. For butt-welded joints, align abutting ends to minimize offset between surfaces. For pipe of same nominal wall thickness, do not exceed 1/16 inch offset. Use line-up clamps for this purpose; however, take care to avoid damage to linings and coatings.

4. Welding Rods: Compatible with metal to be welded to obtain strongest bond, E-70XX.

5. Deposit metal in successive layers to provide 1 to 3 passes or beads as requiredto completed the structural weld or control heat in the weld after backfill joint

6. Deposit no more than 1/4 inch of metal on each pass. Thoroughly clean each individual pass with wire brush or hammer to remove dirt, slag or flux.

7. Do not weld under weather condition that would impair strength of weld, such as wet surface, rain or snow, dust or high winds, unless work is properly protected.

8. Make tack weld of same material and by same procedure as completed weld. Otherwise, remove tack welds during welding operation.

9. Remove dirt, scale, and other foreign matter from inside piping before tying in sections, fittings, or valves.

10. Welded Joints for Large Diameter Water Lines:

    a. Use exterior welds for 30-inch and smaller.

    b. Employ an independent certified testing laboratory, approved by Project Manager, to perform weld acceptance tests on welded joints. Include cost of such testing and associated work to accommodate testing in contract unit price bid for water line. Furnish copies of test reports to Project Manager for review. Project Manager has final decision as to suitability of welds tested.

        1) Weld acceptance criteria:

            a) Conduct in accordance with ASTM E165 - Standard Test Method for Liquid Penetrant Examination and ASTM E709 - Standard Guide for Magnetic Particle Examination. Use X-ray methods for butt welds, for 100 percent of joint welds.

            b) Examine welded surfaces for the following defects:

                i. Cracking.

                ii. Lack of fusion/penetration.

iii. Slag which exceeds one-third (t) where (t) equals material thickness.

iv. Porosity/Relevant rounded indications greater than 3/16 inch; rounded indication is one of circular or elliptical shape with length equal to or less than three times its width.

v. Relevant linear indications in which length of linear indication exceeds three times its width.

vi. Four or more relevant 1/16-inch rounded indications in line separated by 1/16 inch or less edge to edge.

11. After pipe is joined and prior to start of welding procedure, make spigot and bell essentially concentric by jacking, shimming or tacking to obtain clearance tolerance around periphery of joint except for deflected joints.

12. Furnish each welder employed steel stencil for marking welds, so work of each welder can be identified. Mark pipe with assigned stencil adjacent to weld. When welder leaves job, stencil must be voided and not duplicated. Welder making defective welds must discontinue work and leave project site. Welder may return to project site only after recertification.

13. Scaffolding: Do not drag scaffolding or other items along interior of pipe.

14. Provide cylindrical corrosion barriers for polyurethane or epoxy-lined steel pipe 24-inch diameter and smaller, unless minimum wall thickness is 0.5 inch or greater.

    a. In addition to welding requirements contained here in Paragraph 3.06, conform to protection fitting manufacturer's installation recommendations.

    b. Provide services of technical representative of manufacturer available on site at beginning of pipe laying operations. Representative to train welders and advise regarding installation and general construction methods. Welders must have 12 months prior experience All steel pipe is to have cutback 3/4 inch to no greater than 1 inch of internal diameter coating from weld bevel.

    c. Furnish steel fittings with cylindrical corrosion barriers with shop welded extensions to end of fittings. Extension length to measure no

less than diameter of pipe. Shop apply lining in accordance with AWWA C 210 or AWWA C 222.

d. All steel pipe receiving field adjustments are to be cold cut using standard practices and equipment. No cutting using torch is to be allowed.

D. Harnessed Joints (Concrete Cylinder Pipe, Bar Wrapped Pipe or Steel Pipe):

1. Use of snap-ring type restrained joints on pipe is limited to 20-inch through 48-inch diameters.

2. Position snap-ring joint bolt on top (12 o'clock portion). Provide minimum 1/2-inch joint recess. Use joint "diapers" minimum of 12 inches wide.

3. For field adjustments with deflections or joint offsets beyond manufacturer's recommendations:

a. Field trim spigot.

b. Do not engage ring.

4. Harnessed joints are not permitted in areas defined on Drawings as potentially petroleum contaminated material, in tunnels, or at bend greater than 5 degrees.

5. Install harness type joints including snap rings at straight sections of pipe.

E. Restrained Joints:

1. For existing water lines and water lines less than 16 inches in diameter, restrain pipe joints with concrete thrust blocks unless otherwise shown on Drawings.

2. Thrust restraint lengths shown on Drawings are minimum anticipated lengths. These lengths are based on deflections or joint offsets indicated and on use of prestressed concrete cylinder pipe for large diameter lines and ductile iron pipe for small diameter lines. Adjustments in deflections or joint offsets or use of other pipe material may result in reduction or increase of thrust lengths.

3. Pipe manufacturer or representative to perform thrust restraint calculations in accordance with latest revision of applicable standard for pipe material chosen. Submit calculations for all pipe materials sealed by a registered Professional Engineer in State of Texas for review by Project Manager. Make adjustments in thrust restraint lengths at no additional cost to City.

4. Include buoyancy conditions for soil unit weight when computing thrust restraint calculations

5. Passive resistance of soil will not be permitted in calculation of thrust restraint for some pipe materials.

6. For 16-inch lines and larger use minimum 16-foot length of pipe in and out of joints made up of beveled pipe where restraint joint lengths are not identified on Drawings. Otherwise, provide restraint joints for a minimum length of 16 feet on each side of beveled joints.

7. Installation.

   a. Install restrained joints mechanism in accordance with manufacturer=s recommendations.

   b. Examine and clean mechanism; remove dirt, debris and other foreign material.

   c. Apply gasket and joint NSF 61 FDA food grade approved lubricant.

   d. Verify gasket is evenly seated.

   e. Do not over stab pipe into mechanism.

8. Prevent any lateral movement of thrust restraints throughout pressure testing and operation.

9. Place 2500 psi concrete conforming to Section 03315 - Concrete for Utility Construction, for blocking at each change in direction of existing water lines, to brace pipe against undisturbed trench walls. Finish placement of concrete blocking, made from Type I cement, 4 days prior to hydrostatic testing of pipeline. Test may be made 2 days after completion of blocking if Type II cement is used.

F. Joint Grout (Concrete Cylinder Pipe, Bar Wrapped Pipe, Mortar Coated Steel Pipe):

1. Mix cement grout mixture by machine except when less than 1/2 cubic yard is required. When less than 1/2 cubic yard is required, grout may be hand mixed. Mix grout only in quantities for immediate use. Place grout within 20 minutes after mixing. Discard grout that has set. Retempering of grout by any means is not permitted.

2. Prepare grout in small batches to prevent stiffening before it is used. Do not use grout which has become so stiff that proper placement cannot be assured without retempering. Use grout for filling grooves of such consistency that it will adhere to ends of pipe.

3. Surface Preparation: Remove defective concrete, laitance, dirt, oil, grease and other foreign material from concrete surfaces with wire brush or hammer to sound, clean surface. Remove rust and foreign materials from metal surfaces in contact with grout.

4. Follow established procedures for hot and cold weather concrete placement.

5. Complete joint grout operations and backfilling of pipe trenches as closely as practical to pipe laying operations. Allow grouted exterior joints to cure at least 1 hour before compacting backfill.

6. Grouting Exterior Joint Space: Hold wrapper in place on both sides of joint with minimum 5/8-inch-wide steel straps or bands. Place no additional bedding or backfill material on either side of pipe until after grout band is filled and grout has mechanically stiffened. Pull ends of wrapper together at top of pipe to form access hole. Pour grout down one side of pipe until it rises on other side. Rod or puddle grout to ensure complete filling of joint recess. Agitate for 15 minutes to allow excess water to seep through joint band. When necessary, add more grout to fill joint completely. Protect gap at top of joint band from backfill by allowing grout to stiffen or by covering with structurally protective material. Do not remove band from joint. Proceed with placement of additional bedding and backfill material.

7. Interior Joints for Pipe 24 Inches and Smaller: Circumferentially butter bell with grout prior to insertion of spigot, strike off flush surplus grout inside pipe by pulling filled burlap bag or inflated ball through pipe with rope. After joint is engaged, finish off joint grout smooth and clean. Use swab approved by Project Manager for 20-inch pipe and smaller.

8. Protect exposed interior surfaces of steel joint bands by pointing with grout. Remove and replace improperly cured or otherwise defective grout.

9. Strike off grout on interior joints and make smooth with inside diameter of pipe.

10. When installed in tunnel or encasement pipe and clearance within casing does not permit outside grout to be placed in normal manner, apply flexible sealer, such as Flex Protex or equal, to outside joint prior to joint engagement. Clean and prime surfaces receiving sealer in accordance with manufacturer's recommendations. Apply sufficient quantities of sealer to assure complete protection of steel in joint area. Fill interior of joint with grout in normal manner after joint closure.

11. Interior Joints for Water Lines 30 Inches and Larger: Clean joint space, wet joint surfaces, fill with stiff grout and trowel smooth and flush with inside

surfaces of pipe using steel trowel so that surface is smooth. Accomplish grouting at end of each work day. Obtain written acceptance from Project Manager of inside joints before proceeding with next day's pipe laying operation. During inspection, insure no delamination of joint mortar has occurred by striking joint mortar lining with rubber mallet. Remove and replace delaminated mortar lining.

12. Work which requires heavy equipment to be over water line must be completed before mortar is applied to interior joints.

G. Large Diameter Water Main Joint Testing: In addition to testing individual joints with feeler gauge approximately 1/2 inch wide and 0.015-inch thick, use other joint testing procedure approved or recommended by pipe manufacturer which will help ensure watertight installation prior to backfilling. Perform tests at no additional cost to City.

H. Make curves and bends by deflecting or offsetting joints or other method as recommended by manufacturer and approved by Project Manager. Submit details of other methods of providing curves and bends which exceed manufacturer's recommended deflection or joint offset prior to installation.

1. Deflection of pipe joints shall not exceed maximum deflection recommended by pipe manufacturer, unless otherwise indicated on Drawings.

2. If deflection exceeds that specified but is less than 5 percent, repair entire deflected pipe section such that maximum deflection allowed is not exceeded.

3. If deflection is equal to or exceeds 5 percent from that specified, remove entire portion of deflected pipe section and install new pipe.

4. Replace, repair, or reapply coatings and linings as required.

5. Assessment of deflection may be measured by Project Manager at location along pipe. Arithmetical averages of deflection or similar average measurement methods will not be deemed as meeting intent of standard.

6. When rubber gasketed pipe is laid on curve, join pipe in straight alignment and then deflect or offset to curved alignment.

I. Closures Sections and Approved Field Modifications to Steel, Concrete Cylinder Pipe, Bar Wrapped Pipe and Fittings:

1. For large diameter water lines, provide minimum overlap of 4 inches on each side for butt-strap closures.

2. For pipe diameters 36 inches and greater, perform field welds on interior and exterior of pipe.

3. Apply welded-wire fabric reinforcement to interior and exterior of exposed interior and exterior surfaces greater than 6 inches in diameter. Welded-wire fabric: minimum W1; maximum spacing 2 inches by 4 inches; 3/8 inch from surface of steel plate or middle third of lining or coating thickness for mortar thickness less than 3/4 inch.

4. Fill exposed interior and exterior surfaces with nonshrink grout.

3.07 CATHODIC PROTECTION APPURTENANCES

A. Where identified on Drawings, modify pipe for cathodic protection as detailed on Drawings and specified. Unless otherwise noted, provide insulation kits including test stations at connections to existing water system or at locations to isolate one type of cathodic system from another type, between water line, access manhole piping and other major openings in water line, or as shown on Drawings.

B. Bond joints for pipe installed in tunnel or open cut, except where insulating flanges are provided. Weld strap, wire or clip between bell and spigot of each joint or as shown on Drawings. No additional bonding required where joints are welded for thrust restraint. Repair coatings as specified by appropriate AWWA standard, as recommended by manufacturer, and as approved by Project Manager.

C. Bonding Strap or Clip: Free of foreign material that may increase contact resistance between wire and strap or clip.

3.08 SECURING, SUPPORTING AND ANCHORING

A. Support piping, as shown on Drawings and as specified in this Section, to maintain line and grade and prevent transfer of stress to adjacent structures.

B. Where shown on Drawings, anchor pipe fittings and bends installed on water line by welding consecutive joints of pipe together to distance each side of fitting. Restrained length, as shown on Drawings, assumes that installation of pipe and subsequent hydrostatic testing begin upstream and proceed downstream, with respect to normal flow of water in pipe. If installation and testing differs from this assumption, submit for approval revised method of restraining pipe joints upstream and downstream of device used to test against (block valve, blind flange or dished head plug).

C. Use adequate temporary blocking of fittings when making connections to distribution system and during hydrostatic tests. Use sufficient anchorage and blocking to resist stresses and forces encountered while tapping existing water line.

3.09 POLYETHYLENE WRAP FOR DUCTILE IRON PIPE

A. Conform to requirements of Section 02528 - Polyethylene Wrap.

3.10 CLEANUP AND RESTORATION

A. Provide cleanup and restoration crews to work closely behind pipe laying crews and, where necessary, during disinfection and hydrostatic testing, service transfers, abandonment of old water lines, backfill and surface restoration.

B. Unless otherwise approved by Project Manager, comply with the following:

1. Once water line is installed to limits approved in layout submitted, immediately begin preparatory work for disinfection effort.

2. No later than three days after completing disinfection preparatory work, submit to City appropriate request for disinfection.

3. If City fails to perform initial disinfection of lines in accordance with Section 02514 - Disinfection of Water Lines, within seven days from submission of appropriate request, and if approved by Project Manager, pipe laying operations may continue beyond approved limits until the City responds.

4. Immediately after transfer of services, begin abandonment of old water lines and site restoration.

5. Do not exceed a total of 50% of total project linear feet of disturbed right-of-way and easement until site is restored in accordance with Section 01740 - Site Restoration.

6. Exceeding any of the above footage limitations shall be considered a material breach of the Contract and subject to termination in accordance with the General Conditions.

C. For large diameter water lines, do not install more than 2,000 linear feet of water line, without previous 2,000 linear feet being restored in accordance with Section 01740 - Site Restoration. Schedule paving crews so repaving work will not lag behind pipe laying work by more than 1,000 linear feet. Failure to comply with this requirement shall be considered a material breach of the Contract and subject to termination in accordance with the General Conditions.

3.11 CLEANING PIPING SYSTEMS

A. Remove construction debris or foreign material and thoroughly broom clean and flush piping systems. Provide temporary connections, equipment and labor for cleaning. City must inspect water line for cleanliness prior to filling.

3.12 DISINFECTION OF WATER LINES

A. Conform to requirements of Section 02514 - Disinfection of Water Lines.

3.13 FIELD HYDROSTATIC TESTS

A. Conform to requirements of Section 02515 - Hydrostatic Testing of Pipelines.

END OF SECTION

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Section 02514

DISINFECTION OF WATER LINES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Disinfection of potable water lines.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for disinfection of water lines under this Section. Include cost in unit price of water lines being disinfected.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Adjusting Payment for Retesting.

1. Subsequent disinfection operations which may be necessary due to nonconforming or incomplete construction will be charged to Contractor. Charges will be deducted from retainage amounts when construction estimates are processed for final payment.

2. Total charge will consist of base charge of $135.00 plus footage charge based on number of feet of specified diameter pipe in construction project. Footage charge is as follows:

Size of Pipe	Charge per Linear Foot
2 inch to 4 inch	$0.03
6 inch	$0.04
8 inch	$0.05
10 inch to 12 inch	$0.07
16 inch to 20 inch	$0.09
24 inch to 30 inch	$0.13
32 inch to 48 inch	$0.16
54 inch	$0.20
60 inch	$0.22
66 inch	$0.31
72 inch to 84 inch	$0.40
90 inch to 96 inch	$0.58
108 inch	$0.75
120 inch or larger	$1.00

C. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in

this Section is included in total Stipulated Price.

1.03 REFERENCES

A. AWWA C 651 - Standard for Disinfecting Water Mains.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N

3.01 CONDUCTING DISINFECTION

A. Promptly disinfect water lines constructed before tests are conducted on water lines and before water lines are connected to City water distribution system.

B. Water for disinfection and flushing will be furnished by City without charge.

C. Unless otherwise provided in Contract Documents, City will conduct disinfection operations assisted by Contractor.

D. Coordinate chlorination operations through Project Manager.

3.02 PREPARATION

A. Provide temporary blind flanges, cast-iron sleeves, plugs, necessary service taps, copper service leads, risers and jumpers of sizes, location and materials, and other items needed to facilitate disinfection of new water lines prior to connection to City water distribution system. Normally, each valved section of water line requires two each 3/4-inch taps. A 2-inch minimum blow-off is required for water lines up to and including 6-inch diameter.

B. Use fire hydrants as blow-offs to flush newly constructed water lines 8 inch diameters and above. Where fire hydrants are not available on water lines, install temporary blow-off valves as approved by Project Manager and remove promptly upon successful completion of disinfection and testing.

C. Slowly fill each section of pipe with water in manner approved by Project Manager. Average water velocity when filling pipeline should be less than one foot per second and shall not, under any circumstance, exceed 2 feet per second. Before beginning disinfection operations, expel air from pipeline.

D. Backfill excavations immediately after installation of risers or blow-offs.

E. Install blow-off valves at end of water line to facilitate flushing of dead-end water lines. Install permanent blow-off valves according to drawings.

3.03 DISINFECTION BY CITY PERSONNEL

A. Correct problems that may prevent disinfection operations prior to advising Project Manager to perform disinfection work. When disinfection work cannot be performed due to covered up valves, missing valve stacks, inoperative fire hydrants or other nonconforming construction, charge will be levied against Contractor for each trip made by City personnel.

B. Notify and coordinate with Project Manager minimum of 72 hours before disinfection work is to be performed. Assist City personnel during disinfection operations.

3.04 DISINFECTION BY CONTRACTOR

A. The following procedure will be used when disinfection by Contractor is required by Contract Documents:

1. Use not less than 100 parts of chlorine per million parts of water.

2. Introduce chlorinating material to water lines in accordance with AWWA C 651.

3. After contact period of not less than 24 hours, flush system with clean water until residual chlorine is no greater than 1.0 parts per million parts of water.

4. Open and close valves in lines being sterilized several times during contact period.

5. If chemical compound is used for sterilizing agent, place in pipes as directed by Project Manager.

3.03 BACTERIOLOGICAL TESTING

A. After disinfection and flushing of water lines, bacteriological tests will be performed by City or testing laboratory in accordance with Section 01454 - Testing Laboratory Services. When test results indicate need for additional disinfection of water lines based upon Texas Department of Health requirements, assist City with additional disinfection operations.

3.06 COMPLETION

A. Upon completion of disinfection and testing, remove risers except those approved for use in subsequent hydrostatic testing, and backfill excavation promptly.

END OF SECTION

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Section 02515

HYDROSTATIC TESTING OF PIPELINES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Field hydrostatic testing of newly installed water pipelines.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No payment will be made for hydrostatic testing of pipelines under this Section. Include cost in unit price of pipelines being tested.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Disinfect water system pipelines prior to hydrostatic testing.

B. Hydrostatically test newly installed water pipelines after disinfection, when required, and before connecting to City water distribution system.

C. Water for testing will be charged to Contractor in accordance with City Ordinances. Prior to hydrostatic testing, obtain a transient meter from the City Deposit is required for transient meter.

D. Test pipelines with maximum lengths between valves, or plugs, according to the following criteria.

1. 2,000 linear feet for small diameter pipelines (20-inches in diameters or smaller)

2. 4,000 linear feet for large diameter pipelines (24-inches in diameters or larger)

E. Conduct hydrostatic tests in presence of Project Manager.

3.02 TEST PROCEDURES

A. Furnish, install, and operate connections, pump, meter and gages necessary for hydrostatic testing.

B. Allow pipeline to sit minimum of 24 hours from time it is initially disinfected until testing begins, to allow pipe wall or lining material to absorb water. Periods of up to 7 days may be required for mortar lining to become saturated.

C. For small diameter pipelines, expel air and apply minimum test pressure of 125 psi. For large diameter water lines, expel air and apply minimum test pressure of 150 psi.

D. Begin test by 9:00 a.m. unless otherwise approved by Project Manager. Maintain test pressure for 8 hours. When large quantity of water is required to maintain pressure during test, discontinue testing until cause of water loss is identified and corrected.

E. Keep valves inside pressure reducing stations closed during hydrostatic pressure test.

3.03 ALLOWABLE LEAKAGE FOR WATERLINES

A. During hydrostatic tests, no leakage will be allowed for sections of water lines consisting of welded joints.

B. Maximum allowable leakage for water lines with rubber gasketed joints: 3.19 gallons per inch nominal diameter per mile of pipe per 24 hours while testing.

C. For meter run installation, when work cannot be isolated and line fails pressure test, visual inspection of work by Project Manager for leakage during pressure test may be used to fulfill requirements of this section.

3.04 CORRECTION FOR FAILED TESTS

A. Repair joints showing visible leaks on surface regardless of total leakage shown on test. Check valves and fittings to ensure that no leakage occurs that could affect or invalidate test. Remove cracked or defective pipes, fittings, and valves discovered during pressure test and replace with new items.

B. Project Manager may require failed lines to be disinfected after repair and prior to retesting. Conduct and pay for subsequent disinfection operations in accordance with requirements of Section 02514 - Disinfection of Water Lines. Pay for water required for additional disinfection and retesting.

C. Repeat test until satisfactory results are obtained.

3.05 COMPLETION

A. Upon satisfactory completion of testing, remove risers remaining from disinfection and hydrostatic testing, and backfill excavation promptly.

END OF SECTION

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Section 02516

CUT, PLUG AND ABANDONMENT OF WATER LINES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Cut, plug and abandonment of water lines.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for cut, plug, and abandonment of water lines is on a unit price basis for each cut, plug, and abandonment performed. Separate payment will be made for each size of water line.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit product data for proposed plugs and clamps for approval.

PART 2 P R O D U C T S

2.01 MATERIALS

A. Concrete for reaction blocks: Class B conforming to requirements of Section 03315 - Concrete for Utility Construction.

B. Plugs and clamps: Applicable for type of pipe to be plugged.

PART 3 E X E C U T I O N

3.01 APPLICATION

A. Do not begin cut, plug and abandonment operations until replacement water line has been constructed, disinfected, and tested, and service lines have been transferred to replacement water line.

B. Install plug, clamp, and concrete reaction block and make cut at location shown on Drawings.

C. Main to be abandoned shall not be valved off and shall not be cut or plugged other than at supply water line or as shown on Drawings.

D. After water line to be abandoned has been cut and plugged, check for other sources feeding abandoned water line. When sources are found, notify Project Manager immediately. Cut and plug abandoned water line at point of other feed as directed by Project Manager.

E. Plug or cap ends or openings in abandoned water line in manner approved by Project Manager.

F. Remove and dispose of surface identifications such as valve boxes and fire hydrants. Valve boxes in improved streets, other than shell, may be filled with concrete after removing cap.

G. Backfill excavations in accordance with Section 02317 - Excavation and Backfill for Utilities.

H. Repair street surfaces in accordance with Section 02951- Pavement Repair and Restoration.

END OF SECTION

Section 02521

GATE VALVES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Gate valves.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for gate valves 20 inches in diameter and smaller under this Section. Include payment in unit price for water lines.

2. Payment for gate valves 24 inches to 36 inches in diameter is on a unit price basis. Unit price includes cost of required box for gate valves.

3. Payment for 2-inch blow-off valve with box is on a unit price basis for each installation.

4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. ASTM A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.

B. ASTM B 62 - Standard Specification for Composition Bronze or Ounce Metal Casting.

C. ASTM D 429 - Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.

D. ASTM B 763 - Standard Specification for Copper Alloy Sand Casting for Valve Application.

E. AWWA C 500 - Standard for Metal-Seated Gate Valves for Water Supply Service.

F. AWWA C 509 - Standard for Resilient-Seated Gate Valves for Water Supply Service.

G. AWWA C 515- Standard for Reduced Wall, Resilient- Seated Gate Valves for Water Supply Service.

H. AWWA C 550 - Standard for Protective Epoxy Interior Coatings for Valves and Hydrants.

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit manufacturer's product data for proposed valves for approval.

C. Provide detailed drawings of gearing mechanism for 20-inch and larger gate valves.

1.05 QUALITY CONTROL

A. Submit manufacturer's affidavit that gate valves are manufactured in the United States and conform to stated requirements of AWWA C 500, AWWA C 509, AWWA C 515, and this Section, and that they have been satisfactorily tested in the United States in accordance with AWWA C 500, AWWA C 509, and AWWA C 515.

PART 2 P R O D U C T S

2.01 MATERIALS

A. Gate Valves: AWWA C 500, AWWA C 509, AWWA C 515 and additional requirements of this Section. Direct bury valves and those in subsurface vaults open clockwise; aboveground and plant valves open counterclockwise.

B. If type of valve is not indicated on Drawings, use gate valves as line valves for sizes 20-inches and smaller. When type of valve is indicated, no substitute is allowed.

C. Gate Valves 1-1/2 inches in Diameter and Smaller: 125 psig; bronze; rising-stem; single-wedge; disc type; screwed ends

D. Coatings for Gate Valves 2 inches and larger: AWWA C 550 non-toxic, imparts no taste to water, functions as physical, chemical, and electrical barrier between base metal and surroundings, minimum 8-mil-thick, fusion-bonded epoxy. Prior to assembly of valve, apply protective coating to interior and exterior surfaces of body.

E. Gate Valves 2 inches in diameter: Iron body, double disc or resilient-seated, non-rising stem, 150-pound test, 2-inch square nut operating clockwise to open.

F. Gate Valves 3 inches to 12 inches in diameter: Non-directional, standard-wall resilient seated (AWWA C 509), parallel seat double disc (AWWA C 500), or reduced-wall resilient seated gate valves (AWWA C 515), 200 psig pressure rating, bronze mounting, push-on bell ends with rubber joint rings, and nut-operated unless otherwise specified. Provide approved standard-wall resilient seated valves. Provide approved reduced-wall resilient seated valves.

Provide approved double disc valves. Comply with following requirements unless otherwise specified in Drawings:

1. Design: Fully encapsulated rubber wedge or rubber seat ring mechanically attached with minimum 304 stainless-steel fasteners or screws; threaded connection isolated from water by compressed rubber around opening.

2. Body: Cast or ductile iron, flange bonnet and stuffing box together with ASTM A 307 Grade B bolts. Manufacturer's initials, pressure rating, and year manufactured shall be cast in body.

3. Bronze: Valve components in waterway to contain not more than 15 percent zinc and not more than 2 percent aluminum.

4. Stems: ASTM B 763 bronze, alloy number-995 minimum yield strength of 40,000 psi; minimum elongation in 2-inches of 12 percent, non-rising.

5. O-rings: For AWWA C 500, Section 3.12.2. For AWWA C 509, Sections 2.2.6 and 4.8.2. For AWWA C 515, Section 4.2.2.5.

6. Stem Seals Consist of three O-rings, two above and one below thrust collar with anti-friction washer located above thrust collar for operating torque.

7. Stem Nut: Independent or integrally cast of ASTM B 62 bronze.

8. Resilient Wedge: Molded, synthetic rubber, vulcanized and bonded to cast or ductile iron wedge or attached with 304 stainless steel screws tested to meet or exceed ASTM D 429 Method B; seat against epoxy-coated surface in valve body.

9. Bolts: AWWA C 500 Section 3.4, AWWA C 509 Section 4.4 or AWWA C 515 Section 4.4.4; stainless steel; cadmium plated, or zinc coated.

G. Gate valves 14 inch and larger in Diameter: AWWA C 500; parallel seat double disc gate valves; push-on bell ends with rubber rings and nut-operated unless otherwise specified. Provide approved double disc valves with 150 psig pressure rating. Comply with following requirements unless otherwise specified on Drawings:

1. Body: Cast iron or ductile iron; flange together bonnet and stuffing box with ASTM A 307 Grade B bolts. Cast following into valve body manufacturer's initials, pressure rating, and year manufactured. When horizontally mounted, equip valves greater in diameter than 12 inches with rollers, tracks, and scrapers.

2. O rings: For AWWA C 500, Section 3.12.2. For AWWA C 515, Section 4.2.2.5.

3. Stems: ASTM B 763 bronze, alloy number-995 minimum yield strength of 40,000 psi; minimum elongation in 2-inches of 12 percent, non-rising.

4. Stem Nut: Machined from ASTM B 62 bronze rod with integral forged thrust collar machined to size; non-rising.

5. Stem Seals: Consist of three O-rings, two above and one below thrust collar with anti-friction washer located above thrust collar for operating torque.

6. Bolts: AWWA C 500 Section 3.4 or AWWA C 515 Section 4.4.4; stainless steel; cadmium plated, or zinc coated.

7. Discs: Cast iron with bronze disc rings securely penned into machined dovetailed grooves.

8. Wedging Device: Solid bronze or cast-iron, bronze-mounted wedges. Thin plates or shapes integrally cast into cast-iron surfaces are acceptable. Other moving surfaces integral to wedging action shall be bronze monel or nickel alloy-to-iron.

9. Provide bypass for double-disc valves (AWWA C500).

10. Bronze Mounting: Built as integral unit mounted over, or supported on, cast-iron base and of sufficient dimensions to be structurally sound and adequate for imposed forces.

11. Gear Cases: Cast iron; furnished on 18-inch and larger valves and of extended type with steel side plates, lubricated, gear case enclosed with oil seal or O-rings at shaft openings.

12. Stuffing Boxes: Located on top of bonnet and outside gear case.

H. Gate valves 14 inches to 48 inches: Provide AWWA C 515; reduced-wall, resilient seated gate valves with 250 psig pressure rating. Furnish with spur or bevel gearing.

1. Mount valves horizontally if proper ground clearance cannot be achieved by normal vertical installation. For horizontally mounted gate valves, provide bevel operation gear mounted vertically for above ground operation.

2. Use valve body, bonnet, wedge, and operator nut constructed of ductile iron. Fully encapsulate exterior of ductile iron wedge with rubber.
3. Ensure wedge is symmetrical and seals equally well with flow in either direction.

4. Provide ductile iron operator nut with four flats at stem connection to apply even input torque to the stem.

5. Bolts: AWWA C515, Section 4.4.4, Stainless Steel; cadmium plated or zinc coated.

6. Provide high strength bronze stem and nut.

7. O-rings: AWWA C515, Section 4.2.2.5, pressure O-rings as gaskets.

8. Provide stem sealed by three O-rings. Top two O-rings are to be replaceable with valve fully open at full rated working pressure.

9. Provide thrust washers to the thrust collar for easy valve operation.

I. Gate Valves Extension Stem: When shown on Drawings, provide non-rising, extension stem having coupling sufficient to attach securely to operating nut of valve. Upper end of extension stem shall terminate in square wrench nut no deeper than 4 feet from finished grade or as shown on Drawings. Support extension stem with an arm attached to wall of manhole or structure that loosely holds extension stem and allows rotation in the axial direction only.

J. Gate Valves in Factory Mutual (Fire Service) Type Meter Installations: Conform to provisions of this specification; outside screw and yoke valves; carry label of Underwriters' Laboratories, Inc.; flanged, Class 125; clockwise to close.

K. Gate Valves for Tapping Steel Pipe: Provide double disc gate valve. Resilient wedge gate valve shall only be installed in a vertical position.

L. Provide flanged joints when valve is connected to steel or PCCP.

M. Key valve stem into the operator nut.

N. Do not exceed 600 ft-lbs of torque on operator nut on gate valve.

PART 3 E X E C U T I O N

3.01 INSTALLATION

A. Earthwork. Conform to applicable provisions of Section 02317 - Excavation and Backfilling for Utilities.

B. Operation. Do not use valves for throttling without prior approval of manufacturer.

3.02 SETTING VALVES AND VALVE BOXES

A. Remove foreign matter from within valves prior to installation. Inspect valves in open and closed positions to verify that parts are in satisfactory working condition.

B. Install valves and valve boxes where shown on Drawings. Set valves plumb and as detailed. Center valve boxes on valves. Carefully tamp earth around each valve box for minimum radius of 4 feet, or to undisturbed trench face when less than 4 feet. Install valves completely closed when placed in water line.

C. For pipe section of each riser, use only 6 inch, ductile iron Class 51, or DR18 PVC pipe cut to proper length. Riser must be installed to allow complete access for operation of valve. Assemble and brace box in vertical position as indicated on Drawings.

3.03 DISINFECTION AND TESTING

A. Assist Project Manager with disinfection of valves and appurtenances as required by Section 02514 - Disinfection of Water Lines and test as required by Section 02515 - Hydrostatic Testing of Pipelines.

B. Double-Disc Gate Valves: Apply hydrostatic test pressure equal to twice rated working pressure of valve between discs. Valve shall show no leakage through metal, flanged joints, or stem seals. Test at rated working pressure, applied between discs. Valve shall show no leakage through metal, flanged joints, or stem seals. Do not exceed leakage rate of 1 oz/hr/inch of nominal valve size.

C. Solid-Wedge Gate Valves: Apply hydrostatic pressure equal to twice rated working pressure of valve with both ends bulkheaded and gate open. Valve shall show no leakage through metal, flanged joints, or stem seals. Test at rated working pressure, applied through bulkheads alternately to each side of closed gate with opposite side open for inspection. Valve shall show no leakage through metal, flanged joints, or stem-seals. Do not exceed leakage rate of 1 oz/hr/inch of nominal valve size.

D. Repair or replace valves which exceed leakage rate.

3.04 PAINTING OF VALVES

A. Paint valves in vaults, stations, and above ground with approved paint.

END OF SECTION

Section 02522

BUTTERFLY VALVES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Butterfly valves.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for butterfly valves with operator manhole or valve box is on a unit price basis for each. Payment includes actuator, valve box or manhole (where shown), foundation and appurtenances necessary for complete installation of valve.

2. For butterfly valves with vault, valve and vault will be paid separately. Butterfly Valve will be paid on a unit price basis for each and includes hardware, actuator, testing and installation. Vault will be paid on a lump sum basis, and includes all materials, equipment, and appurtenances necessary for complete vault structure, foundation and supports as shown on Drawings.

3. Refer to Section 01270 – Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings.

B. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

C. ASTM A 536 – Standard Specification for Ductile Iron Castings.

D. ASTM A 564 – Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.

E. AWWA C 504 - Standard for Rubber-Seated Butterfly Valves.

F. AWWA C 516 – Large-Diameter Rubber-Seated Butterfly Valves, Sizes 78 in. (2,000 mm) and Larger.

G. NSF/ANSI 61 – Drinking Water System Components – Health Effects.

H. AWWA C 550 - Standard for Protective Interior Coatings for Valves and Hydrants.

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit manufacturer's product data for proposed valves and actuators for approval.

C. Submit Proof-of-Design and hydrostatic testing procedures in accordance with AWWA C504 or C516.

D. As part of initial review, submit manufacturer's affidavits certifying the following:

1. Compliance with specifications for valves and actuators.

2. Butterfly valves were manufactured in the United States.

3. Butterfly valves conform to applicable requirements of AWWA C504 or C516.

E. Butterfly valves have been satisfactorily tested in the United States in accordance with AWWA C504 or AWWA C516 using test pressure of 150 psi in both directions.

F. At time of delivery, submit manufacturer's affidavits certifying the following:

1. Coatings for interior surfaces of valves conform to applicable requirements of AWWA C550. Submit results of holiday test and thickness measurements of coatings.

2. Valves were manufactured in accordance with AWWA C504 or C516.

G. At time of delivery, furnish certified drawings and material test records by manufacturer. Furnish certified copies of test reports for review.

H. Submit data indicating maximum torque required to open valve, maximum torsional strength of shaft and torque output of actuator.

I. Provide submittal information on CD-ROM in Adobe portable document format (*.PDF).

J. Include number of turns to operate valves to fully open/closed.

K. For 30-inch and larger diameters, submit procedures for complete seat replacement in the field.

1.05 QUALITY CONTROL

A. Perform valve leakage tests in both directions at 150 psi in factory and field. Hydrostatic field tests of 150 psi shall be made against dished head plug or similar arrangement.

B. When proof of design tests are performed on valve delivered to job site, replace disc, bushing, shaft and seals with new unused items, and test and certify as described above.

C. Hydrostatic Testing by Manufacturer:

1. Hydrostatic testing to be witnessed by Project Manager prior to shipment of valves. Provide minimum 4 weeks notice to Project Manager to schedule witness testing. When possible, maximize number of valves to be tested during a plant visit; no more than two visits will be allowed per project to witness test valves, unless otherwise approved by Project Manager. City will pay expenses for each visit up to total of two visits incurred by Project Manager to witness testing of each grouping of valve(s) per project. Expenses for subsequent or extended visits by Project Manager for defective valves, improper scheduling or valve failures are to be paid by Contractor. Witness of hydrostatic testing by Project Manager will only be in regard to compliance with this specification and will not constitute approval by Project Manager nor relieve Contractor of obligations to comply with contract documents.

2. Document serial number on valve at time of testing and reflect in certified test records furnished to Project Manager. Identification plate must be permanently affixed to valve and actuator prior to hydrostatic testing.

3. Hydrostatic testing to conform to AWWA C504 or C516 except as modified below:

a. Install actuator prior to hydrostatic testing. Test actuator to verify actual number of turns match manufacturer's published number of turns. Verify valve stops are in correct positions.

b. Fully open and close valve prior to performing shell test and prior to each leakage test.

c. Perform shell test first.

d. When tested with water, adequately dry seat and disc.

e. When tested with air, fill top of valve with water to aid in viewing possible leakage.

f. Pressure Gauges: Calibrated within past 12 months; 0-500 psi range in increments of 5 psi; present calibration certificates prior to hydrostatic testing.

g. If seat adjustment is required during hydrostatic testing, perform valve leakage test again in both directions. Once seat adjustment is made, fully open and fully close valve three (3) times, and repeat leakage test.

4. Field Testing:

a. When valve arrives at the job site, Contractor is to operate valve fully open and closed twice in presence of Project Manager. Document number of turns to open and close each time.

b. Install operator nut plum.

c. After valve is installed, repeat the operation test and document number of turns in presence of Project Manager.

d. Manufacturer's representative must be present to witness the operation test again at the substantial walk thru. Verify valve operate fully open/closed twice at the appropriate number of turns.

PART 2 P R O D U C T S

2.01 VALVES AND ACTUATORS

A. Butterfly Valves and Actuators: Provide approved butterfly valves and actuators. Conform to AWWA C504 for 72-inch and smaller diameters. Conform to AWWA C516 for 78-inch and larger diameters. Compliance with NSF 61 is required for all parts in contact with finished water.

B. If type of valve is not indicated on Drawings, use butterfly valves for line valve sizes 24-inch and larger. When type of valve is specified on Drawings, no substitute will be allowed, unless otherwise approved by Project Manager.

C. Butterfly valves shall be short-body, flanged design and installed at locations as shown on Drawings.

D. Direct-bury valves and valves in subsurface vaults shall open clockwise. Above-ground and plant valves shall open counterclockwise.

E. Provide flanged joints when valve is connected to steel or PCCP. Provide ASTM A193 Grade B7 high strength steel stud bolts with ASTM A194 heavy hex nuts. Refer to flange bolting requirements in Section 02511 – Water Lines.

F. Butterfly Valves and Actuators (Additional Requirements for Large Diameter Water Lines):

1. Provide valves from approved manufacturer[(1)]. Provide all valves for single project, from same manufacturer.
[(1)]as modified for seat replacement in field for City of Houston

2. Provide manual actuators for single project from same manufacturer.

3. Shaft connecting actuator to valve body must be fully enclosed. Bonnet and extension to be fully enclosed and watertight.

2.02 VALVE CONSTRUCTION

A. Valves:

1. 72-inches and smaller diameters: AWWA C504, Class 150B. Body: Cast Iron, ASTM A 126, Class B, or Ductile Iron. Flanges: ASME B16.1, Class 125.

2. 78-inches and larger diameters: AWWA C516, Class 150B. Body: ASTM A536 Grade 65-45-12. Flanges: ASME B16.1, Class 125 for up to 96-inch, AWWA C207, Class D with bolt holes ¼-inch larger than nominal bolt diameter for larger than 96-inch diameters.

B. Discs: ASTM A536 Grade 65-45-12 Ductile Iron.

C. Seats: Buna-N or neoprene, and may be applied to the disc or body. Mechanically secure seat to disc or body using stainless steel retainer ring and bolts. Do not rely solely on adhesive properties of epoxy or similar bonding agent to attach seat to body. When seat is on disc, retain seat in position by shoulders located on both disc and stainless steel retaining ring. Mating surfaces for seats: Type 304 or 316 stainless steel, and secured to disc by mechanical means. Sprayed-on or plated mating surfaces not allowed. Seat must be adjustable and replaceable in field with no special tools for valves greater than 30-inches in diameter.

D. Coat interior wetted ferrous surfaces of valve, including disc, with epoxy or fusion bonded epoxy suitable for potable water conditions. Epoxy, surface preparation, and epoxy application: In accordance with AWWA C550 and coating manufacturer's recommendations. Provide minimum dry film thickness of 8 mils for epoxy coating or

minimum DFT of 16 mils for fusion bonded epoxy. Coatings shall be holiday tested and measured for thickness.

E. Valve shaft and keys: 24-inches in diameter and greater require a minimum of two (2) taper pins used for attaching valve shaft to valve disc. Use of torque plug for purposes of attaching valve shaft is not permitted. Shaft bearings: stainless steel, bronze, nylon or Teflon (supported by fiberglass mat or backing material with proven record of preventing Teflon flow under load) in accordance with AWWA C504 or C516. Sinter stainless steel bearing material. Design valve shaft to withstand 3 times the amount of torque necessary to open valve. Shaft Material:

1. 72-inches and smaller: Type 304 stainless steel for treated (potable) water applications. Type 316 stainless steel for raw water applications.

2. 78-inches and larger: ASTM A564, Type 630 (17-4 PH), Stainless Steel, Condition 1150.

3. Design valve shaft to withstand 3 times the amount of torque necessary to open valve.

F. Taper pins: Stainless Steel. Valves 24-inches in diameter and greater require a minimum of two (2) taper pins used for attaching valve shaft to valve disc, use of torque plug for purposes of attaching valve shaft is not permitted. Shaft Bearings: sintered stainless steel, sintered bronze, nylon or Teflon (supported by fiberglass mat or backing material with proven record of preventing Teflon flow under load) in accordance with AWWA C504 or C516.

G. Packing: Self adjusting and wear compensating, full or split ring V-type, and replaceable without removing actuator assembly.

H. Retaining Hardware for Seats: Type 304 or 316 stainless steel. Nuts and screws used with clamps and discs for rubber seats shall be held securely with locktight, or other approved method, to prevent loosening by vibration or cavitational effects.

I. Valve disc shall seat in position at 90 degrees to pipe axis and shall rotate 90 degrees between full-open and tight-closed position. Install valves with valve shafts horizontal and convex side of disc facing anticipated direction of flow, except where shown otherwise on Drawings.

J. For valves utilizing retaining rings, tighten bolts to a uniform torque. Measure torque prior to testing valve.

2.03 VALVE ACTUATOR CONSTRUCTION

A. Provide actuators for valves with size based on line velocity of 16 feet per second and uni-directional service, and unless otherwise shown on Drawings, equip with geared manual actuators. Provide fully enclosed and traveling-nut type, rack-and-pinion type, or worm-gear type for valves 24-inches and smaller. For 30-inches and larger, provide worm-gear or traveling-nut type.

B. Provide actuator designed for installation with valve shaft horizontal unless otherwise indicated on Drawings.

C. Provide bonnet extensions, as required, between valve body and actuator. Space between actuator housing and valve body shall be completely enclosed so that no moving parts are exposed to soil or elements.

D. Provide oil-tight and watertight actuator housings for valves, specifically designed for submerged service, and factory packed with suitable grease.

E. Install valve position indicator on each actuator housing located above ground or in valve vaults. Valves shall be equipped with 2-inch actuator nut only.

F. Indicate direction of opening of valve on exposed visible part of assembly and cast direction of open on 2-inch nut on top of valve operator extension. Paint 2-inch actuator nut and extension shaft black when counterclockwise open and red when clockwise to open.

G. Design worm-gear or traveling-nut actuators to be self-locking and designed to transmit twice the required actuator torque without damage to faces of gear teeth or contact faces of screw or nut.

H. Actuators shall be capable of withstanding minimum 450 foot-pounds of torque against the stops without damage to any parts of the actuator or valve.

2.04 VALVE BOXES

A. Provide Standard Type "A" valve boxes conforming to requirements of Section 02085 - Valve Boxes, Meter Boxes, and Meter Vaults.

2.05 VALVE SERVICE MANHOLES

A. For large diameter water lines, provide manholes to dimensions shown on Drawings conforming to requirements of Section 02082 - Precast Concrete Manholes.

PART 3 E X E C U T I O N

3.01 EARTHWORK

A. Conform to applicable provisions of Section 02317 - Excavation and Backfill for Utilities.

3.02 SETTING VALVES AND VALVE BOXES

A. Prior to hydrostatic testing of water line and valve:

1. Test valve by opening and closing valve a minimum of two times to verify valve seats properly.

2. Verify number of turns from fully open to fully closed position is same as identified in manufacturer's submittal.

3. Adjust valve as required if number of turns do not match.

4. Remove foreign matter from within valves.

B. Install valves in accordance with manufacturer's recommendations. Install valves where shown on Drawings or as located by Project Manager.

C. Use valve boxes for 16-inch and 24-inch valves unless otherwise shown on Drawings. Set valves plumb and as detailed. Center valve boxes on valves. Carefully tamp earth around each valve box for minimum radius of 4 feet, or to undisturbed trench face when less than 4 feet.

D. Avoid disturbing or overstressing valve body when installing valves. Perform field adjustment of valves under pressure to ensure shutoff occurs in number of rotations as described in valves operation and maintenance manual.

E. Submit certification that large diameter valve was installed, adjusted, and exercised in accordance with manufacturer's instructions. Manufacturer's certification shall state that all performance characteristics of large diameter valves, as installed, have been met. Adjustments made to valve, for any reason, must be made by manufacturer's representative.

3.03 DISINFECTION AND TESTING

A. Assist City with disinfection of valves and appurtenances as required by Section 02514 - Disinfection of Water Lines and test as required by Section 02515 - Hydrostatic Testing of Pipelines. Do not use valves for throttling without prior approval of manufacturer.

3.04 COATING OF PIPING

A. Coat valves located in vaults, stations, and above ground using approved paint. Coating shall be 6-12 mils thick, but no more than 12 mils. Apply coating in accordance with manufacturer's recommendations.

END OF SECTION

Section 02524

AIR RELEASE AND VACUUM RELIEF VALVES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Air release and vacuum relief valves.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for air release and vacuum relief valves is on unit price basis for each valve installed.

2. Payment includes manhole or vault (when required), fittings, vent piping and bollard(s) and appurtenances necessary for complete installation of valve.

3. Payment for valve assembly on aerial crossing includes fittings, anti-vandalism protection, freeze protection, vent piping and appurtenances necessary for complete installation of valve.

4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. ASTM A 48 - Standard Specification for Gray Iron Castings.

B. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

C. ASTM A 240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.

D. ASTM A 276 - Standard Specification for Stainless Steel Bars and Shapes.

E. ASTM A 313 - Standard Specification for Stainless Steel Spring Wire.

F. ASTM B 584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit manufacturer's product data for proposed valves for approval.

PART 2 P R O D U C T S

2.01 DESCRIPTION

A. Provide combination air valves designed to fulfill functions of air release (permit escape of air accumulated in line at high point of elevation while line is under pressure) and vacuum relief.

B. Provide inlet and outlet connections, and orifice as shown on Drawings.

1. Valve exterior: Painted with shop-applied primer suitable for contact with potable water.

2.02 MATERIALS

A. Air Release Valves: Provide approved air release valves ASTM A 48, Class 30, cast iron; float and leverage mechanism with body and cover, ASTM A 240 or ASTM A 276 stainless steel; orifice and seat, stainless steel against Buna-N or Viton mechanically retained with hex head nut and bolt. Other valve internals shall be stainless steel or bronze.

B. Air Release and Vacuum Relief Valves: Provide single-body, standard combination valves or duplex-body custom combination valves as indicated on Drawings.

1. For 2 inch and 3 inch, single-body valves, provide inlet and outlet size as shown on Drawings and orifice sized for 100 psi working pressure.

a. Valve materials: body, cover, and baffle, ASTM A 48, Class 35, or ASTM A 126, Grade B cast iron; plug or poppet, ASTM A 276 stainless steel; float, ASTM A 240 stainless steel; seat, Buna-N; other valve internals, stainless steel.

2. For 3 inch and larger duplex body valves as shown on Drawings, provide approved air release valve.

a. Air and vacuum valve materials: body and cover, ASTM A 126, Class B, cast iron; float, ASTM A 240 stainless steel; seat, Type 304, stainless steel and Buna-N, for sanitary sewer, Garlock #3000 (non-asbestos),for water lines; other valve internals, stainless steel or bronze (for sanitary sewer).

b. Air release valve: Constructed as specified in paragraph above on Air Release Valves.

C. Vacuum Relief Valves: Provide approved air inlet vacuum relief valves with flanged inlet and outlet connections as shown on Drawings. Provide air release valves in combination with inlet and outlet, and orifice as shown on Drawings. Valve shall open under pressure differential not to exceed 0.25 psi.

1. Materials for vacuum relief valves: valve body, ASTM A 48, Class 35, cast iron; seat and plug, ASTM B 584 bronze, copper alloy 836; spring, ASTM A 313, Type 304, stainless steel; bushing, ASTM B 584 bronze, copper alloy 932; retaining screws, ASTM A 276, Type 304, stainless steel.

D. Additional Requirements for Wastewater Applications:

1. Air Release/Vacuum Relief Valves shall have a minimum seating pressure of 0 psi through a maximum operating pressure of 250psi

2. Valve bodies shall be constructed of 316Ti stainless steel.

3. The valves shall have an internal debris shield and debris screen or an alternative mechanism to prevent clogging of the orifice.

4. Rubber components used shall be suitable for wastewater application

D. Manholes: As shown on Drawings conforming to requirements of Section 02082 - Precast Concrete Manholes.

PART 3 E X E C U T I O N

3.01 EARTHWORK

A. Conform to applicable provisions of Section 02317 - Excavation and Backfill for Utilities.

3.02 SETTING VALVES IN MANHOLES AND VAULTS

A. If required by Project Manager, provide services of technical representative of valve manufacturer available on site during installation of valves.

B. Prior to installing valves, remove foreign matter from within valves. Inspect valves in open and closed position to verify that parts are in satisfactory working condition.

C. Install valves and valve manholes and vaults where indicated on Drawings or as located by Project Manager. Set manholes and vaults plumb and as detailed. Center manholes on valves. Compact cement-stabilized sand around each manhole and vault for minimum radius

of 4 feet, or to undisturbed trench face when less than 4 feet. Provide above-ground vents for manholes and vaults as indicated on Drawings.

3.03 DISINFECTION AND TESTING

A. Assist City with disinfection of valves and appurtenances as required by Section 02514 - Disinfection of Waterlines and test as required by Section 02515 - Hydrostatic Testing of Pipelines.

3.04 PAINTING OF PIPING AND VALVES

A. Paint piping and valves located in manholes, stations, and above ground using approved paint.

END OF SECTION

Section 02532

SANITARY SEWER FORCE MAINS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Sanitary sewer force mains.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for installation of force main pipe by open-cut, augered with or without casing, or within limits of Potentially Petroleum Contaminated Area (PPCA) is on linear foot basis. Measurement will be taken along center line of pipe from end to end. Payment will be made for each foot of force main installed, complete in place including pipe, excavation, bedding, backfill and special backfill, shoring, earthwork, connections to existing manholes, acceptance testing, and pipe and accessories.

2. Payment for installation of force main pipe at a bayou crossing is on a lump sum basis.

3. The Unit Price item identifies line segments between stations as shown on Drawings.

4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCE STANDARDS

A. ACI 318 - ACI Building Code and Commentary.

B. ASTM D 696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 C and 30 C with a Vitreous Silica Dilatometer.

C. ASTM D 2310 - Standard Classification for Machine-Made “Fiberglass” (Glass-Fiber-Reinforced- Thermosetting-Resin) Pipe.

D. ASTM D 2992 - Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for “Fiberglass” (Glass-Fiber Reinforced Thermosetting-Resin) Pipe and Fittings.

E. ASTM D 2996 - Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.

F. Uni-Bell UNI-B-3 Polyvinyl Chloride (PVC) Pressure Pipe (complying with AWWA C 900).

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit proposed methods, equipment, materials, and sequence of operations for force main construction. Plan operations to minimize disruption of utilities to occupied facilities or adjacent property.

C. Force mains 24 inches in diameter and larger: Submit shop drawings and design calculations for joint restraint systems using reinforced concrete encasement of pressure pipe and fittings.

D. Submit qualifications, proposed methods, equipment, materials, and sequence for acceptance testing of pipeline. Submit evidence of experience with pipeline proving by pigging for at least three projects of equal or greater scope; project list shall include dates, size and length of pipe, location, owner name, contact person, and telephone number. Provide certificate of training by manufacturer of pigging equipment being used.

E. Submit test reports as specified in Part 3 of this Section.

PART 2 P R O D U C T S

2.01 PIPE FITTING MATERIAL SCHEDULE

A. Unless otherwise shown on Drawings, use pipe materials that conform to requirements specified in one or more of the following Sections:

1. Section 02501 - Ductile-Iron Pipe and Fittings.

2. Section 02504 - Fiberglass Reinforced Pipe.

3. Section 02505 - High Density Polyethylene Solid and Profile Wall Pipe (HDPE).

4. Section 02506 - Polyvinyl Chloride Pipe. Provide Lined Ductile-Iron Fittings in Accordance with Section 02501 - Ductile-Iron Pipe and Fittings.

5. Section 02509 – Fiberglass Reinforced Pipe for Pressure Mains.

B. Pipe shall be color coded green.

2.02 THRUST RESTRAINT

A. Unless otherwise shown on Drawings, provide concrete thrust blocking for force mains up to 12-inches in diameter, to prevent movement of buried lines under pressure at bends, tees, caps, valves and hydrants. Blocking shall be Portland cement concrete, as specified in Section 03315 - Concrete for Utility Construction. Place concrete in accordance with details on Drawings. Place thrust blocks between undisturbed ground and fittings. Anchor fittings to thrust blocks so that pipe and fitting joints are accessible for repairs. Concrete shall extend from 6 inches below pipe or fitting to 12 inches above.

B. For force mains larger than 12 inches in diameter, and where indicated on Drawings, provide restrained joints conforming to requirements of force main pipe material specifications. Install restrained joints for length of pipe on both sides of each bend or fitting for full length shown on Drawings.

C. Horizontal and vertical bends between zero and 10 degrees deflection angle will not require thrust blocks or harnessed or restrained joints.

D. Horizontal and vertical bends between 10 degrees and 90 degrees deflection angle shall have thrust restraint as shown on Drawings.

E. Provide thrust restraint at tees, plugs, blowoff drains, valves, and caps, as indicated.

F. Reinforced concrete encasement of force main pipe and fittings may be used in lieu of manufactured joint restraint systems. Alternate joint restraint systems using reinforced concrete encasement shall conform to following design requirements.

1. Design calculations shall be performed and sealed by Professional Engineer licensed in State of Texas.

2. Base design calculations upon soil parameters quantified in geotechnical report for site where alternative thrust restraint system is to be installed. When data is not available for site, use parameters recommended by geotechnical engineer.

3. The design system pressure shall be specified test pressure.

4. The following safety factors shall be used in sizing restraint system:

   a. Apply factor of safety equal to 1.5 for passive soil resistance.

   b. Apply factor of safety equal to 2.0 for soil friction.

5. Contain encasement entirely within standard trench width and terminate on both ends at pipe bell or coupling.

6. Concrete encasement reinforcement steel shall be designed for all loads, including internal pressure and longitudinal forces. Concrete design shall be in accordance with ACI 318.

PART 3 E X E C U T I O N

3.01 PIPE INSTALLATION BY OPEN-CUT

A. Perform excavation, bedding, and backfill in accordance with Section 02317 - Excavation and Backfill for Utilities.

B. Wrap ductile-iron pipe and fittings with polyethylene wrap in accordance with requirements of Section 02528 - Polyethylene Wrap. Do not install polyethylene wrap on ductile iron pipe protected by cathodic protection system or fusion bonded or polyurethane coated fittings.

C. Install pipe in accordance with pipe manufacturer's recommendations and as specified in following paragraphs.

D. Install pipe only after excavation is completed, bottom of trench is fine graded, bedding material is installed, and trench has been approved by Project Manager.

E. Install pipe to line and grade indicated. Place pipe so that it has continuous bearing of barrel on bedding material and is laid in trench so interior surfaces of pipe follow grades and alignment indicated. Provide bell holes where necessary.

F. Install pipe with spigot ends toward direction of flow. Form concentric joint with each section of adjoining pipe so as to prevent offsets.

G. Keep interior of pipe clean as installation progresses. Where cleaning after laying pipe is difficult because of small pipe size, use suitable swab or drag in pipe and pull it forward past each joint immediately after joint has been completed. Remove foreign material and debris from pipe.

H. Provide lubricant, place and drive home newly-laid sections with come-a-long winches so as to eliminate damage to sections. Install pipe to “home” mark where provided. Use of back hoes or similar powered equipment will not be allowed unless protective measures are provided and approved in advance by Project Manager.

I. Keep excavations free of water during construction and until final inspection.

J. When work is not in progress, cover exposed ends of pipes with approved plug to prevent foreign material from entering pipe.

K. Where sanitary sewer force main is to be installed under existing water line with separation distance of less than 2 feet, install one full joint length of pipe, minimum 18 foot length, centered on water line and maintain minimum 6-inch separation distance.

3.02 PIPE INSTALLATION OTHER THAN OPEN-CUT

A. For installation of pipe by augering, jacking, or tunneling, conform to requirements of specification section of augering or tunneling work.

3.03 HYDROSTATIC TESTING

A. After pipe and appurtenance have been installed, test line and drain. Prevent damage to Work or adjacent areas. Use clean water to perform tests.

B. Project Manager may direct tests of relatively short sections of completed lines to minimize traffic problems or potential public hazards.

C. Test pipe in presence of Project Manager.

D. Test pipe at 150 psig or 1.5 times design pressure of pipe, whichever is greater. Design pressure of force main shall be rated total dynamic head of lift station pump.

E. Test pipe at required pressure for minimum of 4 hours.

F. Maximum allowable leakage shall be as calculated by following formula:

$$L = (S)\ (D)\ (P^{0.5})\ /\ 155{,}400$$

Where:	L	=	Leakage in gallons per hour per 1,000 feet of pipe.
	S	=	Length of pipe in feet.
	D	=	Inside diameter of pipe in inches.
	P	=	Test pressure in pounds per square inch.

G. Correct defects, cracks, or leakage by replacement of defective items or by repairs as approved by Project Manager.

H. Plug openings in force main after testing and flushing. Use cast iron plugs or blind flanges to prevent debris from entering tested pipeline.

3.04 PIGGING TEST

A. After completion of hydrostatic testing and prior to final acceptance, test force mains longer than 200 feet by pigging to ensure piping is free of obstructions.

B. Pigs: Provide proving pigs manufactured of open-cell polyurethane foam body, without coating or abrasives which would scratch or otherwise damage interior pipe wall surface or lining. Pigs shall be able to pass through reductions of up to 65 percent of nominal cross-sectional area of pipe. Pigs shall be able to pass through standard fittings such as 45-degree and 90-degree elbows, crosses, tees, wyes, gate valves, or plug valves, as applicable to force main being tested.

C. Test Execution: Conduct pigging test in presence of Project Manager. Provide at least 48-hours notice of scheduled pigging of force main prior to commencing test.

END OF SECTION

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Section 02533

ACCEPTANCE TESTING FOR SANITARY SEWERS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Acceptance testing of sanitary sewers including:

1. Visual inspection of sewer pipes
2. Mandrel testing for flexible sewer pipes.
3. Leakage testing of sewer pipes.
4. Leakage testing of manholes.
5. Smoke testing of point repairs.
6. Television and Video Inspection.

B. All tests listed in this Section are not necessarily required on this Project. Required tests are named in other Sections which refer to this Section for testing criteria and procedures.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No payment will be made for acceptance testing under this Section. Include payment in unit price for work requiring acceptance testing.
2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. ASTM C 828 - Standard Test Method for Low Pressure Air Test of Vitrified Clay Pipe Lines.

B. ASTM C 924 - Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method.

C. ASTM D 3034 - Standard Specification for Type PSM Polyethylene (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

D. ASTM F 794 - Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.

E. ASTM F 1417 - Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air.

F. ASTM C 1244 Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.

1.04 PERFORMANCE REQUIREMENTS

A. Gravity flow sanitary sewers are required to have straight alignment and uniform grade between manholes.

B. Flexible pipe, including "semi-rigid" pipe, is required to show no more than 5 percent deflection. Test pipe no sooner than 30 days after backfilling of line segment but prior to final acceptance using standard mandrel to verify that installed pipe is within specified deflection tolerances.

C. Must meet Texas Commission on Environmental Quality (TCEQ) Testing Requirements Chapter-217-57.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Test Plan: Before testing begins and in adequate time to obtain approval through submittal process, prepare and submit test plan for approval by Project Manager. Include testing procedures, methods, equipment, and tentative schedule. Obtain advance written approval for deviations from Drawings and Specifications.

C. Test Reports: Submit test reports for each test on each segment of sanitary sewer.

1.06 GRAVITY SANITARY SEWER QUALITY ASSURANCE

A. Repair, correct, and retest manholes or sections of pipe which fail to meet specified requirements when tested.

B. Provide testing reports and video tape of television inspection as directed by Project Manager.

C. Upon completion of tape reviews by Project Manager, Contractor will be notified regarding final acceptance of sewer segment.

1.07 SEQUENCING AND SCHEDULING

A. Perform testing as work progresses. Schedule testing so that no more than 1000 linear feet of installed sewer remains untested at one time.

B. Coordinate testing schedules with Project Manager. Perform testing under observation of Project Manager.

PART 2 P R O D U C T S

2.01 DEFLECTION MANDREL

A. Mandrel Sizing. Rigid mandrel shall have outside diameter (O.D.) equal to 95 percent of inside diameter (I.D.) of pipe. Inside diameter of pipe, for purpose of determining outside diameter of mandrel, shall be average outside diameter minus two minimum wall thicknesses for O.D. controlled pipe and average inside diameter for I.D. controlled pipe, dimensions shall be per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing.

B. Mandrel Design. Rigid mandrel shall be constructed of metal or rigid plastic material that can withstand 200 psi without being deformed. Mandrel shall have nine or more "runners" or "legs" as long as total number of legs is odd number. Barrel section of mandrel shall have length of at least 75 percent of inside diameter of pipe. Rigid mandrel shall not have adjustable or collapsible legs which would allow reduction in mandrel diameter during testing. Provide and use proving ring for modifying each size mandrel.

C. Proving Ring. Furnish "proving ring" with each mandrel. Fabricate ring of 1/2-inch-thick, 3-inch-wide bar steel to diameter 0.02 inches larger than approved mandrel diameter.

D. Mandrel Dimensions (5 percent allowance). Average inside diameter and minimum mandrel diameter are specified in Table 02533-5, Pipe vs. Mandrel Diameter, at end of this Section. Mandrels for higher strength, thicker wall pipe or other pipe not listed in table may be used when approved by Project Manager.

2.02 EXFILTRATION TEST

A. Water Meter: Obtain transient water meter from City for use when water for testing will be taken from City system. Conform to City requirements for water meter use.

B. Test Equipment:

1. Pipe plugs.

2. Pipe risers where manhole cone is less than 2 feet above highest point in pipe or service lead.

2.03 INFILTRATION TEST

A. Test Equipment:

1. Calibrated 90 degree V-notch weir.

2. Pipe plugs.

2.04 LOW PRESSURE AIR TEST

A. Minimum Requirement for Equipment:

1. Control panel

2. Low-pressure air supply connected to control panel.

3. Pneumatic plugs: Acceptable size for diameter of pipe to be tested; capable of withstanding internal test pressure without leaking or requiring external bracing.

4. Air hoses from control panel to:

a. Air supply.

b. Pneumatic plugs.

c. Sealed line for pressuring.

d. Sealed line for monitoring internal pressure.

B. Testing Pneumatic Plugs: Place pneumatic plug in each end of length of pipe on ground. Pressurize plugs to 25 psig; then pressurize sealed pipe to 5 psig. Plugs are acceptable when they remain in place against test pressure without external aids.

2.05 GROUND WATER DETERMINATION

A. Equipment: Pipe probe or small diameter casing for ground water elevation determination.

2.06 SMOKE TESTING

A. Equipment:

1. Pneumatic plugs.

2. Smoke generator as supplied by Superior Signal Company, or approved equal.

3. Blowers producing 2500 scfm minimum.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Provide labor, equipment, tools, test plugs, risers, air compressor, air hose, pressure meters, pipe probe, calibrated weirs, or any other device necessary for proper testing and inspection.

B. Determine selection of test methods and pressures for gravity sanitary sewers based on ground water elevation. Determine ground water elevation using equipment and procedures conforming to Section 01578 - Control of Ground Water and Surface Water.

3.02 VISUAL INSPECTION OF GRAVITY SANITARY SEWERS

A. Check pipe alignment visually by flashing light between structures. Verify if alignment is true and no pipes are misplaced. In case of misalignment or damaged pipe, remove and re-lay or replace pipe segment.

3.03 MANDREL TESTING FOR GRAVITY SANITARY SEWERS

A. Perform deflection testing on flexible and semi-rigid pipe to confirm pipe has no more than 5 percent deflection. Mandrel testing shall conform to ASTM D 3034. Perform testing no sooner than 30 days after backfilling of line segment, but prior to final acceptance testing of line segment.

B. Pull approved mandrel by hand through sewer sections. Replace any section of sewer not passing mandrel. Mandrel testing is not required for stubs.

C. Retest repaired or replaced sewer sections.

3.04 LEAKAGE TESTING FOR GRAVITY COLLECTION SYSTEM PIPES

A. For a collection system pipe that will transport wastewater by gravity flow, test gravity sanitary sewer pipes for leakage by either exfiltration or infiltration methods, as appropriate, or with low pressure air testing.

B. Compensating for Ground Water Pressure:

1. Where ground water exists, install pipe nipple at same time sewer line is placed. Use 1/2-inch capped pipe nipple approximately 10 inches long. Make installation through manhole wall on top of sewer line where line enters manhole.

2. Immediately before performing line acceptance test, remove cap, clear pipe nipple with air pressure, and connect clear plastic tube to nipple. Support tube vertically and allow water to rise in tube. After water stops rising, measure height in feet of water over invert of pipe. Divide this height by 2.3 feet/psi to determine ground water pressure to be used in line testing.

C. Exfiltration test:

1. Determine ground water elevation.

2. Plug sewer in downstream manhole.

3. Plug incoming pipes in upstream manhole.

4. Install riser pipe in outgoing pipe of upstream manhole when highest point in service lead (house service) is less than 2 feet below bottom of manhole cone.

5. Fill sewer pipe and manhole or pipe riser, when used, with water to point 2-1/2 feet above highest point in sewer pipe, house lead, or ground water table, whichever is highest.

6. Allow water to stabilize for one to two hours. Take water level reading to determine drop of water surface, in inches, over one-hour period, and calculate water loss (1 inch of water in 4 feet diameter manhole equals 8.22 gallons) or measure quantity of water required to keep water at same level. Loss shall not exceed that calculated from allowable leakage according to Table 02533-1 at end of this Section.

D. Infiltration test: Ground water elevation must be not less than 2.0 feet above highest point of sewer pipe or service lead (house service).

1. Determine ground water elevation.

2. Plug incoming pipes in upstream manhole.

3. Insert calibrated 90 degree V-notch weir in pipe on downstream manhole.

4. Allow water to rise and flow over weir until it stabilizes.

E. Low Air Pressure Test: When using this test conform to ASTM C 828, ASTM C 924, or ASTM F 1417, as applicable, with holding time not less than that listed in Table 02533-2.

1. Low Pressure Air testing for sections of pipe shall be limited to lines less than 36-inch average inside diameter. Refer to charts 02533-2 and 02533-3.

2. Lines 36-inch average inside diameter and larger shall be tested at each joint. Minimum time allowable for pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch during joint test shall be 10 seconds, regardless of pipe size.

F. Retest: Repair and retest any section of pipe which fails to meet requirements.

3.05 TEST CRITERIA TABLES

A. Exfiltration and Infiltration Water Tests: Refer to Table 02533-1, Water Test Allowable Leakage, at end of this Section.

B. Low Pressure Air Test:

1. Times in Table 02533-2, Time Allowed for Pressure Loss from 3.5 psig to 2.5 psig, at end of this Section, are based on equation from Texas Commission on Environmental Quality (TCEQ) Design Criteria 217.57

		$T = 0.0850(D)(K)/(Q)$
where:	T =	time for pressure to drop 1.0 pounds per square inch gauge in seconds
	K =	0.000419 DL, but not less than 1.0
	D =	average inside diameter in inches
	L =	length of line of same pipe size in feet
	Q =	rate of loss, 0.0015 ft^3/min./sq. ft. internal surface

2. Since K value of less than 1.0 shall not be used, there are minimum testing times for each pipe diameter as given in Table 02533-3, Minimum Testing Times for Low Pressure Air Test.

Notes:
1. when two sizes of pipe are involved, compute time by ratio of lengths involved.
2. Lines with 27-inch average inside diameter and larger may be air tested at each joint.
3. Lines with average inside diameter greater than 36 inches must be air tested for leakage at each joint.
4. If joint test is used, perform visual inspection of joint immediately after testing.
5. For joint test, pipe is to be pressurized to 3.5 psi greater than pressure exerted by groundwater above pipe. Once pressure has stabilized, minimum times allowable for pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge shall be 10 seconds.

3.06 LEAKAGE TESTING FOR MANHOLES

A. After completion of manhole construction, wall sealing, or rehabilitation, but prior to backfilling, test manholes for water tightness using hydrostatic or vacuum testing procedures.

B. Plug influent and effluent lines, including service lines, with suitably-sized pneumatic or mechanical plugs. Ensure plugs are properly rated for pressures required for test; follow manufacturer's safety and installation recommendations. Place plugs minimum of 6 inches outside of manhole walls. Brace inverts to prevent lines from being dislodged when lines entering manhole have not been backfilled.

C. Vacuum testing:

1. Install vacuum tester head assembly at top access point of manhole and adjust for proper seal on straight top section of manhole structure. Following manufacturer's instructions and safety precautions, inflate sealing element to recommended maximum inflation pressure; do not over-inflate.

2. Evacuate manhole with vacuum pump to 10 inches mercury (Hg), disconnect pump, and monitor vacuum for time period specified in Table 02533-4, Vacuum Test Time Table.

3. A manhole passes the test if after 2.0 minutes and with all valves closed, the vacuum is at least 9.0 inches of mercury (Hg).

D. Perform hydrostatic exfiltration testing as follows:

1. Seal wastewater lines coming into manhole with internal pipe plug. Then fill manhole with water and maintain it full for at least one hour.
2. The maximum leakage for hydrostatic testing shall be 0.025 gallons per foot diameter per foot of manhole depth per hour.

3. If water loss exceeds amount tabulated above, locate leaks, complete repairs necessary to seal manhole and repeat test procedure until satisfactory results are obtained.

3.07 SMOKE TEST PROCEDURES FOR POINT REPAIRS

A. Application: Perform smoke test to:

1. Locate points of line failure for point repair.

2. Determine when point repairs are properly made.

3. Determine when service connections have been reconnected to rehabilitated sewer.

4. Check integrity of connections to newly replaced service taps to liners and to existing private service connections.

B. Limitations: Do not backfill service taps until completion of this test. Test only those taps in single manhole section at one time. Keep number of open excavations to minimum.

C. Preparation: Prior to smoke testing, give written notices to area residents no fewer than 2 days, nor more than 7 days, prior to proposed testing. Also give notice to City of Houston Police and Fire Departments 24 hours prior to actual smoke testing.

D. Isolate Section: Isolate manhole section to be tested from adjacent manhole sections to keep smoke localized. Temporarily seal annular space at manhole for sliplined sections.

E. Smoke Introduction:

1. Operate equipment according to manufacturer's recommendation and as approved by Project Manager.

2. Conduct test by forcing smoke from smoke generators through sanitary sewer main and service connections. Operate smoke generators for minimum of 5 minutes.

3. Introduce smoke into upstream and downstream manhole as appropriate. Monitor tap/connection for smoke leaks. Note sources of leaks.

F. Repair and Retest: Repair and replace taps or connections noted as leaking and then retest. Taps and connections may be left exposed in only one manhole section at time. When repair or replacement, testing or retesting, and backfilling of excavation is not completed within one work day, properly barricade and cover each excavation as approved by Project Manager.

G. Service Connections: On houses where smoke does not issue from plumbing vent stacks to confirm reconnection of sewer service to newly installed liner pipe, perform dye test to confirm reconnection. Introduce dye into service line through plumbing fixture inside structure or sewer cleanout immediately outside structure and flush with water. Observe flow at service reconnection or downstream manhole. Detection of dye confirms reconnection.

3.08 TELEVISION AND VIDEO INSPECTION PROCEDURE

A. Refer to Document 02588- Cleaning and Television Inspection

Table 02533-1
WATER TEST ALLOWABLE LEAKAGE

DIAMETER OF RISER OR STACK IN INCHES	VOLUME PER INCH OF DEPTH		ALLOWANCE LEAKAGE*	
	INCH	GALLONS	PIPE SIZE IN INCHES	GALLONS/MINUTE PER 100 FT.
1	0.7854	.0034	6	0.0039
2	3.1416	.0136	8	0.0053
2.5	4.9087	.0212	13	0.0066
3	7.0686	.0306	12	0.0079
4	12.5664	.0306	15	0.0099
5	19.6350	.0544	18	0.0118
6	28.2743	.1224	21	0.0138
8	50.2655	.2176	24	0.0158
			27	0.0177
			30	0.0197
			36	0.0237
			42	0.0276
For other diameters, multiply square of diameters by value for 1" diameter.			Equivalent to 50 gallons per inch of inside diameter per mile per 24 hours.	

* Allowable leakage rate must not exceed 10 gallons per inch of inside diameter per mile per 24 hours, when sewer is identified as located within 25-year flood plain.

Table 02533-2
ACCEPTANCE TESTING FOR
SANITARY SEWERS

TIME ALLOWED FOR PRESSURE LOSS FROM 3.5 PSIG TO 2.5 PSIG														
Pipe Diam. (in)	**Min. Time (min: sec)**	**Length for Min. Time (ft)**	**Time for Longer Length (sec)**	**Specification Time for Length (L) Shown (min:sec)**										
				100 ft	**150 ft**	**200 ft**	**250 ft**	**300 ft**	**350 ft**	**400 ft**	**450 ft**	**500 ft**	**550 ft**	**600 ft**
6	**5:40**	**398**	**0.8548**	**5:40**	**5:40**	**5:40**	**5:40**	**5:40**	**5:40**	**5:42**	**6:25**	**7:07**	**7:50**	**8:33**
8	**7:33**	**298**	**1.5196**	**7:33**	**7:33**	**7:33**	**7:33**	**7:36**	**8:52**	**10:08**	**11:24**	**12:40**	**13:56**	**15:12**
10	**9:27**	**239**	**2.3743**	**9:27**	**9:27**	**9:27**	**9:54**	**11:52**	**13:51**	**15:50**	**17:48**	**19:47**	**21:46**	**23:45**
12	**11:20**	**199**	**3.4190**	**11:20**	**11:20**	**11:20**	**14:15**	**17:06**	**19:57**	**22:48**	**25:39**	**28:30**	**31:20**	**34:11**
15	**14:10**	**159**	**5.3423**	**14:10**	**14:10**	**17:48**	**22:16**	**26:43**	**31:10**	**35:37**	**40:04**	**44:31**	**48:58**	**53:25**
18	**17:00**	**133**	**7.6928**	**17:00**	**19:14**	**25:39**	**32:03**	**38:28**	**44:52**	**51:17**	**57:42**	**64:06**	**70:31**	**76:56**
21	**19:50**	**114**	**10.4708**	**19:50**	**26:11**	**34:54**	**43:38**	**52:21**	**61:05**	**69:48**	**78:32**	**87:15**	**95:59**	**104:42**
24	**22:40**	**99**	**13.6762**	**22:48**	**34:11**	**45:35**	**56:59**	**68:23**	**79:47**	**91;10**	**102:34**	**113:58**	**125:22**	**136:46**
27	**25:30**	**88**	**17.3089**	**28:51**	**43:16**	**57:42**	**72:07**	**86:33**	**100:58**	**115:24**	**129:49**	**144:14**	**158:40**	**173:05**
30	**28:20**	**80**	**21.3690**	**35:37**	**53:25**	**71:14**	**89:02**	**106:51**	**124:39**	**142:28**	**160:16**	**178:05**	**195:53**	**213:41**
33	**31:10**	**72**	**25.8565**	**43:06**	**64:38**	**86:11**	**107:44**	**129:17**	**150:50**	**172:23**	**193:55**	**215:28**	**237:01**	**258:34**

Table 02533-3
MINIMUM TESTING TIMES FOR LOW PRESSURE AIR TEST

PIPE DIAMETER *(INCHES)*	**MINIMUM TIME** *(SECONDS)*	**LENGTH FOR MINIMUM TIME** *(FEET)*	**TIME FOR LONGER LENGTH** *(SECONDS/FT*
6	340	398	0.855
8	454	298	1.520
10	567	239	2.374
12	680	199	3.419
15	850	159	5.342
18	1020	133	7.693
21	1190	114	10.471
24	1360	100	13.676
27	1530	88	17.309
30	1700	80	21.369
33	1870	72	25.856

Table 02533-4
VACUUM TEST TIME TABLE

DEPTH IN FEET	**TIME IN SECONDS BY PIPE DIAMETER**		
	48"	60"	72"
4	10	13	16
8	20	26	32
12	30	39	48
16	40	52	64
20	50	65	80
24	60	78	96
*	5.0	6.5	8.0

*Add T times for each additional 2-foot depth.
(The values listed above have been extrapolated from ASTM C 1244

Table 02533-5
PIPE VS. MANDREL DIAMETER

Material and Wall Construction	Nominal Size (Inches)	Average I.D. (Inches)	Minimum Mandrel Diameter (Inches)
PVC-Solid (SDR 26)	6	6	5.764
5.476			
	8	7.715	7.329
	10	9.646	9.162
PVC-Solid (SDR 35)	12	12	11.737
11.150			
	15	14.374	13.655
	18	17.629	16.748
	21	20.783	19.744
	24	23.381	22.120
	27	26.351	25.033
PVC-Truss		8	7.750
7.363			
	10	9.750	9.263
	12	11.790	11.201
	15	14.770	14.032
PVC-Profile (ASTM F 794)	12	11.740	11.153
	15	14.370	13.652
	18	17.650	16.768
	21	20.750	19.713
	24	23.500	22.325
	27	26.500	25.175
	30	29.500	28.025
	36	35.500	33.725
	42	41.500	39.425
	48	47.500	45.125
HDPE-Profile	18	18.000	17.100
	21	21.000	19.950
	24	24.000	22.800
	27	27.000	25.650
	30	30.000	28.500
	36	36.000	34.200
	42	42.000	39.900
	48	48.000	45.600
	54	54.000	51.300
	60	60.000	57.000
Fiberglass		12	12.85
11.822			
(Class SN 46)	18	18.66	17.727

20	20.68	19.646
24	24.72	23.484
30	30.68	29.146
36	36.74	34.903
42	42.70	40.565
48	48.76	46.322
54	54.82	52.079
60	60.38	57.361

END OF SECTION

Section 02611

REINFORCED CONCRETE PIPE

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Reinforced concrete pipe for sanitary sewers and storm sewers.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for reinforced concrete pipe under this Section. Include cost in unit price Work as specified in following Sections:

   a. Section 02426 - Sewer Line in Tunnels.

   b. Section 02531 - Gravity Sanitary Sewers.

   c. Section 02631 - Storm Sewers.

2. Refer to Section 01270- Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this section is included in total Stipulated Price.

1.03 REFERENCES

A. ASTM C 76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

B. ASTM C 443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe Using Rubber Gaskets.

C. ASTM C 497 - Standard Test Method for Concrete Pipe, Manhole Sections, or Tile.

D. ASTM C 506 - Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain and Sewer Pipe

E. ASTM C 507 – Standard Specification for Reinforced Concrete Elliptical Culverts, Storm Drains and Sewer Pipe

F. ASTM C 655 - Standard Specification for Reinforced Concrete D-load Culvert, Storm Drain and Sewer Pipe.

G. ASTM C 877 - Standard Specification for External Sealing Bands for Noncircular Concrete Sewer, Storm Drain, and Culvert Pipe.

H. ASTM C 990 – Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections using Preformed Flexible Joint Sealants.

I. ASTM C 1479 – Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit complete product data for pipe, fittings and gaskets for approval. Indicate conformance to appropriate reference standards.

C. Submit manufacturer's certificate that concrete pipes meet applicable standards.

D. For jacking pipe, submit drawings and data describing grouting port design and closure procedures when required by Section 02431 - Tunnel Grout, including liner repair, as applicable.

PART 2 P R O D U C T S

2.01 REINFORCED CONCRETE PIPE

A. Conform circular reinforced concrete pipe to requirements of ASTM C 76, Class III. Conform to rubber gasket joints for sanitary sewers and storm sewers per ASTM C443 and tongue and groove joints for roadside ditch culverts with joints per ASTM C 990.

B. Conform reinforced concrete arch pipe to requirements of ASTM C 506 for Class A-III. Joints shall conform to ASTM C 443 or tongue & groove joints shall conform to ASTM C 990 with external sealing bands conforming to ASTM C 877. For roadside ditch culverts only, external sealing bands are not required.

C. Reinforced concrete elliptical pipe, either vertical or horizontal, shall conform to requirements of ASTM C 507 for Class VE-III for vertical or Class HE-III for horizontal. Use rubber gasket joints conforming to ASTM C 877. Rubber gasket joints shall conform to ASTM C

443. Tongue & groove joints shall conform to ASTM C 990 with external sealing bands conforming to ASTM C 877. For roadside ditch culverts only, external sealing bands are not required.

D. Conform reinforced concrete D-load pipe requirements of ASTM C 655.

2.02 GASKETS

A. When no contaminant is identified, furnish joints per section 2.01

B. Use the following gasket materials for pipes to be installed in potentially contaminated areas, especially where free product is found near elevation of proposed sewer:

CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber
Other Contaminants	As recommended by pipe manufacturer, Engineer of the Record and approved by City Engineer prior to installation

2.03 LINERS FOR SANITARY SEWER PIPE

A. Reinforced concrete pipe for sanitary sewers shall be PVC lined and conform to Section 02427 - Plastic Liner for Large Diameter Concrete Sewers and Structures.

B. Reinforced concrete pipes to be installed in potentially contaminated areas shall have liners recommended by manufacturer as resistant to contaminants identified in Phase II Environmental Site Assessment Report.

2.04 SOURCE QUALITY CONTROL

A. Representatives of City Engineer will inspect manufacturer's plant and casting operations as deemed necessary.

PART 3 E X E C U T I O N

3.01 INSTALLATION

A. Conform to requirements of following Sections, as applicable:

1. Section 02448 - Pipe and Casing Augering for Sewers.

2. Section 02531 - Gravity Sanitary Sewers.

3. Section 02631 - Storm Sewers.

4. Section 02441 - Micro-tunneling and Pipe-Jacked Tunnels.

B. Install reinforced concrete pipe in accordance with ASTM C 1479 and manufacturer's recommendations.

END OF SECTION

Section 02712

CEMENT STABILIZED BASE COURSE

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Foundation course of cement stabilized crushed stone.

B. Foundation course of cement stabilized bank run gravel.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for cement stabilized base course is on square yard basis. Separate pay items are used for each different required thickness of base course.

2. Payment for asphaltic seal cure is by gallon.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

4. Refer to Paragraph 3.09, Unit Price Adjustment.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. ASTM C 131 - Standard Test Method for Resistance to Degradation of Small-Size Course Aggregate by Abrasion and Impact in Los Angeles Machine.

B. ASTM C 150 - Standard Specification for Portland Cement.

C. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft-lbf/ft^3 (600kN kN-m/m^3).

D. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

E. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

F. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

G. TxDOT Tex-101-E - Preparing Soil and Flexible Base Materials for Testing.

H. TxDOT Tex-110-E - Particle Size Analysis of Soils.

I. TxDOT Tex-120-E - Soil-Cement Testing.

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit samples of crushed stone, gravel, and soil binder for testing.

C. Submit manufacturer's description and characteristics for pug mill and associated equipment, spreading machine, and compaction equipment for approval.

1.05 TESTS

A. Perform testing under provisions of Section 01454 - Testing Laboratory Services.

B. Perform tests and analysis of aggregate and binder materials in accordance with ASTM D 1557 and ASTM D 4318.

1.06 DELIVERY, STORAGE AND HANDLING

A. Make stockpiles from layers of processed aggregate to eliminate segregation of materials. Load material by making successive vertical cuts through entire depth of stockpile.

B. Store cement in weatherproof enclosures. Protect from ground dampness.

PART 2 P R O D U C T S

2.01 CEMENT

A. ASTM C 150 Type I; bulk or sacked.

2.02 WATER

A. Clean, clear; and free from oil, acids, alkali, or vegetable matter.

2.03 AGGREGATE

A. Crushed Stone: Material retained on No. 40 Sieve meeting following requirements:

1. Durable particles of crusher-run broken limestone, sandstone, or granite obtained from approved source.

2. Los Angeles abrasion test percent of wear not to exceed 40 when tested in accordance with ASTM C 131.

B. Gravel: Durable particles of bank run gravel or processed material.

C. Soil Binder: Material passing No. 40 Sieve meeting following requirements when tested in accordance with ASTM D 4318:

1. Maximum Liquid limit: 35.

2. Maximum Plasticity index: 10.

D. Mixed aggregate and soil binder shall meet the following requirements:

1. Grading in accordance with TxDOT Tex-101-E and Tex-110-E within the following limits:

Sieve	Percent Retained			
	Crushed Stone	Processed G. 1	Gravel G. 2	Bank run Gravel
1 3/4 inch	0 to 10	0 to 5	-	0 to 5
1/2 inch	-	-	0	-
No. 4	45 to 75	30 to 75	15 to 35	30 to 75
No. 40	55 to 80	60 to 85	55 to 85	65 to 85

2. Obtain prior permission from Project Manager for use of additives to meet above requirements.

2.04 ASPHALT SEAL CURE

A. Cutback Asphalt: MC30 conforming to requirements of Section 02742 - Prime Coat.

B. Emulsified Petroleum Resin: EPR-1 Prime conforming to requirements of Section 02742 - Prime Coat.

2.05 MATERIAL MIX

A. Design mix for minimum average compressive strength of 200 psi at 48 hours using TxDOT Tex-120-E unconfined compressive strength testing procedures. Provide minimum cement content of 1 1/2 sacks, weighing 94 pounds each, per ton of mix.

B. Increase cement content when average compressive strength of tests on field samples fall below 200 psi. Refer to Part 3 concerning field samples and tests.

C. Mix in stationary pug mill equipped with feeding and metering devices for adding specified quantities of base material, cement, and water into mixer. Dry mix base material and cement sufficiently to prevent cement balls from forming when water is added.

D. Resulting mixture shall be homogeneous and uniform in appearance.

2.06 SOURCE QUALITY CONTROL

A. Perform testing under provisions of Section 01454 - Testing Laboratory Services.

B. Perform testing for unconfined compressive strength by TxDOT Test Method Tex-120-E as follows:

1. Mold three samples each day or for each 300 tons of production.

2. Compressive strength shall be average of three tests for each production lot.

PART 3 E X E C U T I O N

3.01 EXAMINATION

A. Verify compacted subgrade is ready to support imposed loads.

B. Verify lines and grades are correct.

3.02 PREPARATION

A. Complete backfill of new utilities below future grade.

B. Prepare subgrade in accordance with requirements of Section 02330 - Embankment and Section 02315 - Roadway Excavation.

C. Correct subgrade deviations in excess of plus or minus 1/4 inch in cross section or in 16 foot length by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling.

D. Prepare sufficient subgrade in advance of base course for efficient operations.

3.03 PLACEMENT

A. Do not mix and place cement stabilized base when temperature is below 40 degrees F and falling. Place base when temperature taken in shade and away from artificial heat is above 35 degrees F and rising.

B. Place material on prepared subgrade in uniform layers to produce thickness indicated on Drawings. Depth of layers shall not exceed 6 inches.

C. Spread with approved spreading machine. Conduct spreading so as to eliminate planes of weakness or pockets of non-uniformly graded material resulting from hauling and dumping operations.

D. Provide construction joints between new material and stabilized base that has been in place 4 hours or longer. Joints shall be approximately vertical. Form joint with temporary header or make vertical cut of previous base immediately before placing subsequent base.

E. Use only one longitudinal joint at center line under main lanes and shoulder unless shown otherwise on Drawings. Do not use longitudinal joints under frontage roads and ramps unless indicated on Drawings.

F. Place base so that projecting reinforcing steel from curbs remain at approximate center of base. Secure firm bond between reinforcement and base.

3.04 COMPACTION

A. Start compaction as soon as possible but not more than 60 minutes from start of moist mixing. Compact loose mixture with approved tamping rollers until entire depth is uniformly compacted. Do not allow stabilized base to mix with underlying material.

B. Correct irregularities or weak spots immediately by replacing material and recompacting.

C. Apply water to maintain moisture between optimum and 2 percent above optimum moisture as determined by ASTM D 698. Mix in with spiked tooth harrow or equal. Reshape surface and lightly scarify to loosen imprints made by equipment.

D. Remove and reconstruct sections where average moisture content exceeds ranges specified at time of final compaction.

E. Finish by blading surface to final grade after compacting final course. Seal with approved pneumatic tired rollers which are sufficiently light to prevent surface hair line cracking. Rework and recompact at areas where hair line cracking develops.

F. Compact to minimum density of 95 percent of maximum dry density at moisture content of treated material between optimum and 2 percent above optimum as determined by ASTM D 1557, unless otherwise indicated on Drawings.

G. Maintain surface to required lines and grades throughout operation.

3.05 CURING

A. Moist cure for minimum of 7 days before adding pavement courses. Restrict traffic on base to local property access. Keep subgrade surface damp by sprinkling.

B. If indicated on Drawings, cover base surface with curing membrane as soon as finishing operation is complete. Apply with approved self-propelled pressure distributor at following rates, or as indicated on Drawings:

1. MC30: 0.1 gallon per square yard.

2. EPR-1 Prime: 0.15 gallon per square yard.

C. Do not use cutback asphalt during period of April 16 to September 15.

3.06 TOLERANCES

A. Smooth and conform completed surface to typical section and established lines and grades.

B. Top surface of base course: Plus or minus 1 1/4 inch in cross section, or in 16 foot length.

3.07 FIELD QUALITY CONTROL

A. Perform testing under provisions of Section 01454 - Testing Laboratory Services.

B. Take minimum of one core at random locations per 1000 linear feet per lane of roadway or 500 square yards of base to determine in-place depth.

C. Request additional cores in vicinity of cores indicating nonconforming in-place depths at no extra cost to City. When average of tests fall below required depth, place additional material and compact at no additional cost to City.

D. Perform compaction testing in accordance with ASTM D 698 or ASTM D 2922 and ASTM D 3017 at randomly selected locations. Remove and replace areas that do not conform to compaction requirements at no additional cost to City.

E. Fill cores and density test sections with new compacted cement stabilized base.

3.08 NONCONFORMING BASE COURSE

A. Remove and replace areas of base course found deficient in thickness by more than 10 percent, or that fail compressive strength tests, with cement-stabilized base of thickness shown on Drawings.

B. Replace nonconforming base course sections at no additional cost to City.

3.09 UNIT PRICE ADJUSTMENT

A. Make unit price adjustments for in-place depth determined by cores as follows:

1. Adjusted unit price shall be ratio of average thickness as determined by cores to thickness bid upon, times unit price.

2. Apply adjustment to lower limit of 90 percent and upper limit of 100 percent of unit price.

3.10 PROTECTION

A. Maintain stabilized base in good condition until completion of Work. Repair defects immediately by replacing base to full depth.

B. Protect asphalt membrane, when used, from being picked up by traffic. Membrane may remain in place when proposed surface courses or other base courses are to be applied.

END OF SECTION

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Section 02921

HYDRO MULCH SEEDING

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Seeding, fertilizing, mulching, and maintenance of areas indicated on Drawings.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for hydro mulch seeding is on an acre basis, within limits of construction if shown on the drawings.

2. No payment will be made for hydro mulch seeding under this Section if limits of constructions are not shown on the drawings. Include payment in Section 01740 – Site Restoration.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit certification from supplier that each type of seed conforms to these specifications and requirements of Texas Seed Law. Certification shall accompany seed delivery.

C. Submit certificate stating that fertilizer complies with these specifications and requirements of Texas Fertilizer Law.

PART 2 P R O D U C T S

2.01 MATERIALS

A. Topsoil: Conform to material requirements of Section 02911 - Topsoil.

B. Seed: Conform to U.S. Department of Agriculture rules and regulations of Federal Seed Act and Texas Seed Law. Seed shall be certified 90 percent pure and furnish 80 percent germination and meet following requirements:

1. Rye: Fresh, clean, Italian rye grass seed (lollium multi-florum), mixed in labeled proportions. As tested, minimum percentages of impurities and germination must be labeled. Deliver in original unopened containers.

2. Bermuda: Extra-fancy, treated, lawn type common bermuda (Cynodon dactylon). Deliver in original, unopened container showing weight, analysis, name of vendor, and germination test results.

3. Wet, moldy, or otherwise damaged seed will not be accepted.

4. Seed requirements, application rates, and planting dates are:

TYPE	APPLICATION RATE POUNDS/A	PLANTING DATE
Hulled Common Bermuda Grass 98/88 Unhulled Common Bermuda Grass 98/88	40 40	Jan 1 to Mar 31
Hulled Common Bermuda Grass 98/88	40	Apr 1 to Sep 30
Hulled Common Bermuda Grass 98/88 Unhulled Common Bermuda Grass 98/88 Annual Rye Grass (Gulf)	40 40 30	Oct 1 to Dec 31

C. Fertilizer: Dry and free flowing, inorganic, water soluble commercial fertilizer, which is uniform in composition. Deliver in unopened containers which bear manufacturers guaranteed analysis. Caked, damaged, or otherwise unsuitable fertilizer will not be accepted. Fertilizer shall contain minimum percentages of following elements:

1. Nitrogen: 10 Percent

2. Phosphoric Acid: 20 Percent

3. Potash: 10 Percent

D. Mulch:

1. Virgin wood cellulose fibers from whole wood chips having minimum of 20 percent fibers 0.42 inches in length and 0.01 inches in diameter.

2. Cellulose fibers manufactured from recycled newspaper and meeting same fiber content and size as for cellulose fibers from wood chips.

3. Dye mulch green for coverage verification purposes.

E. Soil Stabilizer: "Terra Tack 1" or approved equal.

F. Weed control agent: Pre-emergent herbicide for grass areas, such as "Benefin," or approved equal.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Place and compact topsoil in accordance with requirements of Section 02911 - Topsoil.

B. Dispose of Objectionable and Waste Materials in accordance with Section 01576 - Waste Material Disposal.

3.02 APPLICATION

A. Seed: Apply uniformly at rates given in Paragraph 2.01 B for type of seed and planting date.

B. Fertilizer: Apply uniformly at rate of 500 pounds per acre.

C. Mulch: Apply uniformly at rate of 50 pounds per 1000 square feet.

D. Soil Stabilizer: Apply uniformly at rate of 40 pounds per acre.

E. Weed Control Agent: Apply at manufacturer's recommended rate prior to hydro mulching.

F. Sod: Lay single row of sod along perimeter where top soil and pavement intersect. Apply in conformance to Section 02922 - Sodding.

G. Suspend operations under conditions of drought, excessive moisture, high winds, or extreme or prolonged cold. Obtain Project Manager approval before resuming operations.

3.03 MAINTENANCE

A. Maintain grassed areas minimum of 90 days, or as required to establish an acceptable lawn. For areas seeded in fall, continue maintenance following spring until acceptable lawn is established.

B. Maintain grassed areas by watering, fertilizing, weeding, and trimming.

C. Repair areas damaged by erosion by regrading, rolling and replanting.

D. Reseed small, sparse grass areas. When sparse areas exceed 20 percent of planted area, reseed by hydro mulch.

E. Mow grass when height reaches 3 1/2 inches or greater on average before final acceptance. Mow to height of 2 1/2 inches.

END OF SECTION

Section 02922

SODDING

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Restoration of existing lawn areas disturbed by construction shall be by installation of new sod.

B. Planting of sod within areas designated on Drawings for purpose of surface stabilization, channel stabilization or vegetation buffer strips.

C. Sod is defined as blocks, squares, strips of turfgrass, and adhering soil used for vegetative planting. To be placed edge to edge for complete coverage.

D. Lawn is defined as ground covered with fine textured grass kept neatly mowed.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for sodding is on square yard basis.

2. For utility construction, no separate payment will be made for sodding. Include payment in section 01740 under site restoration.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

1.04 QUALITY ASSURANCE

A. Sod only when weather and soil conditions are deemed by Project Manager to be suitable for proper placement.

B Water and fertilize new sod.

C. Guarantee sod to be growing 30 days after substantial completion.

D. Maintenance Period:

1. Begin maintenance immediately after each section of grass sod is installed and continue for 30 day period from date of substantial completion.

2. Resod unacceptable areas.

3. Water, fertilize, control disease and insect pests, mow, edge, replace unacceptable materials, and perform other procedures consistent with good horticultural practice to ensure normal, vigorous and healthy growth. Install disease control within guidelines set forth by Structural Pest Control Board of the State of Texas.

E. Notify Project Manager 10 days before end of maintenance period for inspection.

PART 2 P R O D U C T S

2.01 SOD

A. Species: Bermuda (Cynodon Dactylon), Buffalo (Buchloe Dactyloides), or St. Augustine (Stenotaphrum Secundatum) Gulf Coast variety to match existing sod.

B. Contents: 95 percent permanent grass suitable to climate in which it is to be placed; not more than 5 percent weeds and undesirable grasses; good texture, free from obnoxious grasses, roots, stones and foreign materials.

C. Size: 12 inch wide strips, uniformly 2 inches thick with clean-cut edges.

D. Sod is to be supplied and maintained in healthy condition as evidenced by grass being normal green color.

2.02 FERTILIZER

A. Available nutrient percentage by weight: 12 percent nitrogen, 4 percent phosphoric acid, and 8 percent potash; or 15 percent nitrogen, 5 percent phosphoric acid, and 10 percent potash.

2.03 WEED AND INSECT TREATMENT

A. Provide acceptable treatment to protect sod from weed and insect infestation. Submit treatment method to Project Manager for approval. Install insect and disease control within guidelines set forth by Structural Pest Control Board of the State of Texas.

2.04 WATER

A. Potable, available on-site through Contractor's water trucks. Contractor may use City of Houston hydrants when water use is measured through Contractor's meter. Do not use private resident's water.

2.05 BANK SAND

A. Free of clay lumps, roots, grass, salt or other foreign material.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Verify that soil placement and compaction have been satisfactorily completed. Verify that soil is within allowable range of moisture content.

B. Top soil shall be free of weeds and foreign material immediately before sodding.

C. Do not start work until conditions are satisfactory. Do not start work during inclement or impending inclement weather.

D. Rake areas to be sodded smooth, free from unsightly variations, bumps, ridges or depressions.

E. Spread 2 inch layer of bank sand over areas to be sodded prior to planting of sod.

F. Apply fertilizer at rate of 25 pounds per 1000 square feet. Apply after raking soil surface and not more than 48 hours prior to laying sod. Mix thoroughly into upper 2 inches of soil. Lightly water to aid in dissipation of fertilizer.

3.02 APPLICATION

A. Full Sodding: Lay sod with closely fitted joints leaving no voids and with ends of sod strips staggered. Lay sod within 24 hours of harvesting.

B. On slopes 2:1 and steeper, lay sod perpendicular to slope and secure every row with wooden pegs at maximum 2 feet on center. Drive pegs flush with soil portion of sod.

C. Prior to placing sod, on slopes 3:1 or where indicated, place Hold/Gro or Roll Lite or equal over topsoil. Securely anchor in place with posts sunk firmly into ground at maximum 16 feet on center along pitch of slope and equal to width of wire mesh horizontally across slopes.

D. After sod is laid, irrigate thoroughly to secure 6-inch minimum penetration into soil below sod.

E. Tamp and roll sod with approved equipment to eliminate minor irregularities and to form close contact with soil bed immediately after planting and watering. Submit type of tamping and rolling equipment to be used to Project Manager for approval, prior to construction.

3.03 MAINTENANCE

A. Watering:

1. Water lawn areas once a day with minimum 1/2 inch water for first 3 weeks after area is sodded.

2. After 3 week period, water twice a week with 3/4 inch of water each time unless comparable amount has been provided by rain.

3. Make weekly inspections to determine moisture content of soil unless soil is in frozen condition.

4. Water in afternoon or at night to enable soil to absorb maximum amount of water with minimum evaporation.

B. Mowing:

1. Mow sod at intervals which will keep grass height from exceeding 3 1/2 inches.

2. Set mower blades at 2 1/2 inches.

3. Do not remove more than one-half of grass leaf surface.

4. Mow sodded areas requiring mowing within 1 month after installation with light-weight rotary type mower. Mow sod only when dry and not in saturated or soft condition.

5. Remove grass clippings during or immediately after mowing.

C. Fertilizer and Pest Control:

1. Evenly spread fertilizer composite at rate of 40 pounds per 5000 square feet or as recommended by manufacturer. Do not place fertilizer until 2 weeks after placement of sod.

2. Restore bare or thin areas by topdressing with mix of 50 percent sharp sand and 50 percent sphagnum peat moss.

3. Apply mixture 1/4 to 1/2 inch thick.

4. Treat areas of heavy weed and insect infestation as recommended by treatment manufacturer.

D. Restrict all traffic from sodded areas until sod is established or for minimum 10 days during growing season. Use wood lath and plastic tape to cordon sodded areas. Maintain tape and lath throughout for minimum 30 days during growing season.

3.04 CLEANUP

A. During course of planting, remove excess and waste materials; keep lawn areas clean and take precautions to avoid damage to existing structures, plants, grass, and streets.

B. Remove barriers, signs, and other Contractor material and equipment from project site at termination of establishment period.

C. Dispose of unused materials and rubbish in accordance with Section 01576 - Waste Material Disposal.

END OF SECTION

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Section 03315

CONCRETE FOR UTILITY CONSTRUCTION

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Cast-in-place concrete work for utility construction or rehabilitation, such as slabs on grade, small vaults, site-cast bases for precast units, and in-place liners for manhole rehabilitation.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No payment will be made for concrete for utility construction under this Section. Include cost in applicable utility structure.

2. Obtain services of and pay for certified testing laboratory to prepare design mixes.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. ACI 117 - Standard Tolerances for Concrete Construction and Materials.

B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.

C. ACI 302.1R - Guide for Concrete Floor and Slab Construction.

D. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.

E. ACI 308 - Standard Practice for Curing Concrete.

F. ACI 309R - Guide for Consolidation of Concrete.

G. ACI 311 - Guide for Concrete Plant Inspection and Field Testing of Ready-Mix Concrete.

H. ACI 315 - Details and Detailing of Concrete Reinforcement.

I. ACI 318 - Building Code Requirements for Reinforced Concrete and Commentary.

J. ACI 544 - Guide for Specifying, Mixing, Placing, and Finishing Steel Fiber Reinforced Concrete.

K. ASTM A 82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.

L. ASTM A 185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.

M. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

N. ASTM A 767 - Standard Specifications for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.

O. ASTM A 775 - Standard Specification for Epoxy-Coated Reinforcing Steel Bars.

P. ASTM A 820 - Standard Specification for Steel Fibers for Fiber-Reinforced Concrete.

Q. ASTM A 884 - Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.

R. ASTM C 31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.

S. ASTM C 33 - Standard Specification for Concrete Aggregates.

T. ASTM C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

U. ASTM C 42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

V. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.

W. ASTM C 138 - Standard Test Method for Unit Weight Yield and Air Content (Gravimetric) of Concrete.

X. ASTM C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.

Y. ASTM C 150 - Standard Specification for Portland Cement.

Z. ASTM C 172 - Standard Practice for Sampling Freshly Mixed Concrete.

AA. ASTM C 173 - Standard Test Method for Air Content of Freshly Mixed Concrete by Volumetric Method.

AB. ASTM C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

AC. ASTM C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.

AD. ASTM C 309 - Standard Specifications for Liquid Membrane-Forming Compounds for Curing Concrete.

AE. ASTM C 494 - Standard Specification for Chemical Admixtures for Concrete.

AF. ASTM C 595 - Standard Specification for Blended Hydraulic Cements.

AG. ASTM C 685 - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing.

AH. ASTM C 1064 - Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete.

AI. ASTM C 1077 - Standard Practice for Laboratory Testing of Concrete and Concrete Aggregate for Use in Construction and Criteria for Laboratory Evaluation.

AJ. CRSI MSP-1 - Manual of Standard Practice.

AK. CRSI - Placing Reinforcing Bars.

AL. Federal Specification SS-S-210A - Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints

AM. NRMCA - Concrete Plant Standards.

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit proposed mix design and test data for each type and strength of concrete in Work.

C. Submit laboratory reports prepared by independent testing laboratory stating that materials used comply with requirements of this Section.

D. Submit manufacturer's mill certificates for reinforcing steel. Provide specimens for testing when required by Project Manager.

E. Submit certification from concrete supplier that materials and equipment used to produce and deliver concrete comply with this Specification.

F. When required on Drawings, submit shop drawings showing reinforcement type, quantity, size, length, location, spacing, bending, splicing, support, fabrication details, and other pertinent information.

G. For waterstops, submit product information sufficient to indicate compliance with this Section, including manufacturer's descriptive literature and specifications.

1.05 HANDLING AND STORAGE

A. Cement: Store cement off of ground in well-ventilated, weatherproof building.

B. Aggregate: Prevent mixture of foreign materials with aggregate and preserve gradation of aggregate.

C. Reinforcing Steel: Store reinforcing steel to protect it from mechanical injury and formation of rust. Protect epoxy-coated steel from damage to coating.

PART 2 P R O D U C T S

2.01 CONCRETE MATERIALS

A. Cementitious Material:

1. Portland Cement: ASTM C 150, Type II, unless use of Type III is authorized by Project Manager; or ASTM C 595, Type IP. For concrete in contact with sewage use Type II cement.

2. When aggregates are potentially reactive with alkalis in cement, use cement not exceeding 0.6 percent alkali content in form of $Na_2O + 0.658K_20$.

B. Water: Clean, free from harmful amounts of oils, acids, alkalis, or other deleterious substances, and meeting requirements of ASTM C 94.

C. Aggregate:

1. Coarse Aggregate: ASTM C 33. Unless otherwise indicated, use following ASTM standard sizes: No. 357 or No. 467; No. 57 or No. 67, No. 7. Maximum size: Not larger than 1/5 of narrowest dimension between sides of forms, nor larger than 3/4 of minimum clear spacing between reinforcing bars.

2. Fine Aggregate: ASTM C 33.

3. Determine potential reactivity of fine and coarse aggregate in accordance with Appendix to ASTM C 33.

D. Air Entraining Admixtures: ASTM C 260.

E. Chemical Admixtures:

1. Water Reducers: ASTM C 494, Type A.

2. Water Reducing Retarders: ASTM 494, Type D.

3. High Range Water Reducers (Superplasticizers): ASTM C 494, Types F and G.

F. Prohibited Admixtures: Admixtures containing calcium chloride, thiocyanate, or materials that contribute free chloride ions in excess of 0.1 percent by weight of cement.

G. Reinforcing Steel:

1. Use new billet steel bars conforming to ASTM A 615, ASTM A 767, or ASTM A 775, grade 40 or grade 60, as shown on Drawings. Use deformed bars except where smooth bars are specified. When placed in work, keep steel free of dirt, scale, loose or flaky rust, paint, oil or other harmful materials.

2. Where shown, use welded wire fabric with wire conforming to ASTM A 185 or ASTM A 884. Supply gauge and spacing shown, with longitudinal and transverse wires electrically welded together at points of intersection with welds strong enough not to be broken during handling or placing.

3. Wire: ASTM A 82. Use 16 1/2 gauge minimum for tie wire, unless otherwise indicated.

H. Fiber:

1. Fibrillated Polypropylene Fiber:

a. Addition Rate: 1.5 pounds of fiber per cubic yard of concrete.

b. Physical Properties:

1. Material: Polypropylene

2. Length: 1/2 inch or graded

3. Specific Gravity: 0.9l

c. Acceptable Manufacturer: W. R. Grace Company, Fibermesh, or approved equal.

2. Steel Fiber: Comply with applicable provisions of ACI 544 and ASTM A 820.

   a. Ratio: 50 to 200 pounds of fiber per cubic yard of concrete.

   b. Physical Properties

      1. Material: Steel

      2. Aspect Ratio (for fiber lengths of 0.5 to 2.5 inch, length divided by diameter or equivalent diameter): 30:1 to 100:1

      3. Specific Gravity: 7.8

      4. Tensile Strength: 40-400 ksi.

      5. Young's Modulus: 29,000 ksi

      6. Minimum Average Tensile Strength: 50,000 psi

      7. Bending Requirements: Withstand bending around 0.125-inch diameter mandrel to angle of 90 degrees, at temperatures not less than 60 degrees F, without breaking

I. Curing Compounds: Type 2 white-pigmented liquid membrane-forming compounds conforming to ASTM C 309.

2.02 FORM WORK MATERIALS

A. Lumber and Plywood: Seasoned and of good quality, free from loose or unsound knots, knot holes, twists, shakes, decay and other imperfections which would affect strength or impair finished surface of concrete. Use S4S lumber for facing or sheathing. Forms for bottoms of caps: At least 2 inch (nominal) lumber or 3/4 inch form plywood backed adequately to prevent misalignment. For general use, provide lumber of 1-inch nominal thickness or form plywood of approved thickness.

B. Form work for Exposed Concrete Indicated to Receive Rubbed Finish: Form or form-lining surfaces free of irregularities; plywood of 1/4 inch minimum thickness, preferably oiled at mill.

C. Chamfer Strips and Similar Moldings: Redwood, cypress, or pine that will not split when nailed and which can be maintained to true line. Use mill-cut molding dressed on all faces.

D. Form Ties: Metal or fiberglass of approved type with tie holes not larger than 7/8 inch in diameter. Do not use wire ties or snap ties.

E. Metal Forms: Clean and in good condition, free from dents and rust, grease, or other foreign materials that tend to disfigure or discolor concrete in gauge and condition capable of supporting concrete and construction loads without significant distortion. Countersink bolt and rivet heads on facing sides. Use only metal forms which present smooth surface and which line up properly.

2.03 PRODUCTION METHODS

A. Use either ready-mixed concrete conforming to requirements of ASTM C 94, or concrete produced by volumetric batching and continuous mixing in accordance with ASTM C 685.

2.04 MEASUREMENT OF MATERIALS

A. Measure dry materials by weight, except volumetric proportioning may be used when concrete is batched and mixed in accordance with ASTM C 685.

B. Measure water and liquid admixtures by volume.

2.05 DESIGN MIX

A. Use design mixes prepared by certified testing laboratory in accordance with ASTM C 1077 and conforming to requirements of this section.

B. Proportion concrete materials based on ACI 211.1 to comply with durability and strength requirements of ACI 318, Chapters 4 and 5, and this specification. Prepare mix design of Class A concrete so minimum cementitious content is 564 pounds per cubic yard. Submit concrete mix designs to Project Manager for review.

C. Proportioning on basis of field experience or trial mixtures in accordance with requirements at Section 5.3 of ACI 318 may be used, when approved by Project Manager.

D. Classification:

CLASS	TYPE	MINIMUM COMPRESSIVE STRENGTH (LBS/SQ. IN.)		MAXIMUM W/C RATIO	AIR CONTENT (PERCENT)	CONSISTENCY RANGE IN SLUMP (INCHES)
		7-DAY	28-DAY			
A	Structural	3200	4000	0.45	4± 1	2 to 4*
B	Pipe Block Fill, Thrust Block	----	1500	----	4± 1	5 to 7
*When ASTM C 494, Type F or Type G admixture is used to increase workability, this range may be 6 to 9.						

E. Add steel or polypropylene fibers only when called for on Drawings or in another section of these Specifications.

F. Determine air content in accordance with ASTM C 138, ASTM C 173 or ASTM C 231.

G. Use of Concrete Classes: Use classes of concrete as indicated on Drawings and other Specifications. Use Class B for unreinforced concrete used for plugging pipes, seal slabs, thrust blocks, trench dams, tunnel inverts and concrete fill unless indicated otherwise. Use Class A for all other applications.

2.06 PVC WATERSTOPS

A. Extrude from virgin polyvinyl chloride elastomer. Use no reclaimed or scrap material. Submit waterstop manufacturer's current test reports and manufacturer's written certification that material furnished meets or exceeds Corps of Engineers Specification CRD-C572 and other specified requirements.

B. Flat Strip and Center-Bulb Waterstops:

1. Thickness: not less than 3/8 inch

2. Acceptable Manufacturers:

a. Kirkhill Rubber Co., Brea, California

b. Water Seals, Inc., Chicago, Illinois

c. Progress Unlimited, Inc., New York, New York

d. Greenstreak Plastic Products Co., St. Louis, Missouri

e. Approved equal.

2.07 RESILIENT WATERSTOP

A. Resilient Waterstop: Where shown on Drawings; either bentonite- or adhesive-type material.

B. Bentonite Waterstop:

1. Material: 75 percent bentonite, mixed with butyl rubber-hydrocarbon containing less than 1.0 percent volatile matter, and free of asbestos fibers or asphaltics.

2. Manufacturer's rated temperature ranges: For application, 5 to 125 degrees F; in service, -40 to 212 degrees F.
3. Cross-sectional dimensions, unexpanded waterstop: 1 inch by 3/4 inch

4. Provide with adhesive backing capable of producing excellent adhesion to concrete surfaces.

C. Adhesive Waterstop:

1. Preformed plastic adhesive waterstop at least 2 inches in diameter.

2. Meets or exceeds requirements of Federal Specification SS-S-210A.

3. Supplied wrapped completely by 2 part protective paper.

4. Submit independent laboratory tests verifying that material seals joints in concrete against leakage when subjected to minimum of 30 psi water pressure for at least 72 hours.

5. Provide primer, to be used on hardened concrete surfaces, from same manufacturer who supplies waterstop material.

6. Acceptable Manufacturer: Synko-Flex Preformed Plastic Adhesive Waterstop, Synko-Flex Products, Inc.; or approved equal.

PART 3 E X E C U T I O N

3.01 FORMS AND SHORING

A. Provide mortar-tight forms sufficient in strength to prevent bulging between supports. Set and maintain forms to lines designated such that finished dimensions of structures are within tolerances specified in ACI 117. Construct forms to permit removal without damage to concrete. Forms may be given slight draft to permit ease of removal. Provide adequate clean out openings. Before placing concrete, remove extraneous matter from within forms.

B. Install rigid shoring having no excessive settlement or deformation. Use sound timber in shoring centering. Shim to adjust and tighten shoring with hardwood timber wedges.

C. Design Loads for Horizontal Surfaces of Forms and Shoring: Minimum fluid pressure, 175 pounds per cubic foot; live load, 50 pounds per square foot. Maximum unit stresses: 125 percent of allowable stresses used for form materials and for design of support structures.

D. Back form work with sufficient number of studs and wales to prevent deflection.

E. Re-oil or lacquer liner on job before using. Facing may be constructed of 3/4 inch plywood made with waterproof adhesive backed by adequate studs and wales. In such cases, form lining will not be required.

F. Unless otherwise indicated, form outside corners and edges with triangular 3/4 inch chamfer strips (measured on sides).

G. Remove metal form ties to depth of at least 3/4 inch from surface of concrete. Do not burn off ties. Do not use pipe spreaders. Remove spreaders which are separate from forms as concrete is being placed.

H. Treat facing of forms with approved form coating before concrete is placed. When directed by Project Manager, treat both sides of face forms with coating. Apply coating before reinforcement is placed. Immediately before concrete is placed, wet surface of forms which will come in contact with concrete.

3.02 PLACING REINFORCEMENT

A. Place reinforcing steel accurately in accordance with approved Drawings. Secure steel adequately in position in forms to prevent misalignment. Maintain reinforcing steel in place using approved concrete and hot-dip galvanized metal chairs and spacers. Place reinforcing steel in accordance with CRSI Publication "Placing Reinforcing Bars." Request inspection of reinforcing steel by Project Manager and obtain acceptance before concrete is placed.

B. Minimum spacing center-to-center of parallel bars: 2 1/2 times nominal bar diameter. Minimum cover measured from surface of concrete to face of reinforcing bar unless shown otherwise on Drawings: 3 inches for surfaces cast against soil or subgrade, 2 inches for other surfaces.

C. Detail bars in accordance with ACI 315. Fabricate reinforcing steel in accordance with CRSI Publication MSP-1, "Manual of Standard Practice." Bend reinforcing steel to required shape while steel is cold. Excessive irregularities in bending will be cause for rejection.

D. Do not splice bars without written approval of Project Manager. Approved bar bending schedules or placing drawings constitute written approval. Splice and development length of bars shall conform to ACI 318, Chapters 7 and 12, and as shown on Drawings. Stagger splices or locate at points of low tensile stress.

3.03 EMBEDDED ITEMS

A. Install conduit and piping as shown on Drawings. Accurately locate and securely fasten conduit, piping, and other embedded items in forms.

B. Install waterstops as specified in other sections and according to manufacturer's instructions. Securely position waterstops at joints as indicated on Drawings. Protect waterstops from damage or displacement during concrete placing operations.

3.04 BATCHING, MIXING AND DELIVERY OF CONCRETE

A. Measure, batch, mix, and deliver ready-mixed concrete in accordance with ASTM C 94, Sections 8 through 11. Produce ready-mixed concrete using automatic batching system as described in NRMCA Concrete Plant Standards, Part 2 - Plant Control Systems.

B. Measure, mix and deliver concrete produced by volumetric batching and continuous mixing in accordance with ASTM C 685, Sections 6 though 8.

C. Maintain concrete workability without segregation of material and excessive bleeding. Obtain approval of Project Manager before adjustment and change of mix proportions.

D. Ready-mixed concrete delivered to site shall be accompanied by batch tickets providing information required by ASTM C 94, Section 16. Concrete produced by continuous mixing shall be accompanied by batch tickets providing information required by ASTM C 685, Section 14.

E. When adverse weather conditions affect quality of concrete, postpone concrete placement. Do not mix concrete when air temperature is at or below 40 degrees F and falling. Concrete may be mixed when temperature is 35 degrees F and rising. Take temperature readings in shade, away from artificial heat. Protect concrete from temperatures below 32 degrees F until concrete has cured for minimum of 3 days at 70 degrees F or 5 days at 50 degrees F.

F. Clean, maintain and operate equipment so that it thoroughly mixes material as required.

G. Hand-mix only when approved by Project Manager.

3.05 PLACING CONCRETE

A. Give sufficient advance notice to Project Manager (at least 24 hours prior to commencement of operations) to permit inspection of forms, reinforcing steel, embedded items and other preparations for placing concrete. Place no concrete prior to Project Manager's approval.

B. Schedule concrete placing to permit completion of finishing operations in daylight hours. However, when necessary to continue after daylight hours, light site as required. When rainfall occurs after placing operations are started, provide covering to protect work.

C. Use troughs, pipes and chutes lined with approved metal or synthetic material in placing concrete so that concrete ingredients are not separated. Keep chutes, troughs and pipes clean and free from coatings of hardened concrete. Allow no aluminum material to be in contact with concrete.

D. Limit free fall of concrete to 4 feet. Do not deposit large quantities of concrete at one location so that running or working concrete along forms is required. Do not jar forms after concrete has taken initial set; do not place strain on projecting reinforcement or anchor bolts.

E. Use tremies for placing concrete in walls and similar narrow or restricted locations. Use tremies made in sections, or provide in several lengths, so that outlet may be adjusted to proper height during placing operations.

F. Place concrete in continuous horizontal layers approximately 12 inches thick. Place each layer while layer below is still plastic.

G. Compact each layer of concrete with concrete spading implements and mechanical vibrators of approved type and adequate number for size of placement. When immersion vibrators cannot be used, use form vibrators. Apply vibrators to concrete immediately after depositing. Move vibrator vertically through layer of concrete just placed and several inches into plastic layer below. Do not penetrate or disturb layers previously placed which have partially set. Do not use vibrators to aid lateral flow concrete. Closely supervise consolidation to ensure uniform insertion and duration of immersion.

H. Handling and Placing Concrete: Conform to ACI 302.1R, ACI 304R and ACI 309R.

3.06 WATERSTOPS

A. Embed waterstops in concrete across joints as shown. Waterstops shall be continuous for extent of joint; make splices necessary to provide continuity in accordance with manufacturer's instructions. Support and protect waterstops during construction operations; repair or replace waterstops damaged during construction.

B. Install waterstops in concrete on one side of joints, leaving other side exposed until next pour. When waterstop will remain exposed for 2 days or more, shade and protect exposed waterstop from direct rays of sun during entire exposure and until exposed portion of waterstop is embedded in concrete.

C. Splicing PVC Waterstops:

1. Splice waterstops by heat-sealing adjacent waterstop sections in accordance with manufacturer’s printed instructions.

2. Butt end-to-end joints of two identical waterstop sections may be made in forms during placement of waterstop material.

3. Prior to placement in form work, prefabricate waterstop joints involving more than two ends to be joined together, angle cut, alignment change, or joining of two dissimilar waterstop sections, allowing not less than 24 inch long strips of waterstop material beyond joint. Upon inspection and approval by Project Manager, install prefabricated waterstop joint assemblies in form work, and butt-weld ends of 24 inch strips to straight-run portions of waterstop in forms.

D. Setting PVC Waterstops:

1. Correctly position waterstops during installation. Support and anchor waterstops during progress of work to ensure proper embedment in concrete and to prevent folding over of waterstop by concrete placement. Locate symmetrical halves of waterstops equally between concrete pours at joints, with center axis coincident with joint openings. Thoroughly work concrete in joint vicinity for maximum density and imperviousness.

2. Where waterstop in a vertical wall joint does not connect with any other waterstop, and is not intended to be connected to waterstop in future concrete placement, terminate waterstop 6 inches below top of wall.

E. Replacement of Defective Field Joints: Replace waterstop field joints showing evidence of misalignment, offset, porosity, cracks, bubbles, inadequate bond or other defects with products and joints complying with Specifications.

F. Resilient Waterstop:

1. Install resilient waterstop in accordance with manufacturer's instructions and recommendations.

2. When requested by Project Manager, provide technical assistance by manufacturer's representative in field at no additional cost to City.

3. Use resilient waterstop only where complete confinement by concrete is provided; do not use in expansion or contraction joints.

4. Where resilient waterstop is used in combination with PVC waterstop, lap resilient waterstop over PVC waterstop minimum of 6 inches and place in contact with PVC waterstop. Where crossing PVC at right angles, melt PVC ribs to form smooth joining surface.

5. At free top of walls without connecting slabs, stop resilient waterstop and grooves (where used) 6 inches from top in vertical wall joints.

6. Bentonite Waterstop:

   a. Locate bentonite waterstop as near as possible to center of joint and extend continuous around entire joint. Minimum distance from edge of waterstop to face of member: 5 inches.

   b. Where thickness of concrete member to be placed on bentonite waterstop is less than 12 inches, place waterstop in grooves at least 3/4 inch deep and 1 1/4 inches wide formed or ground into concrete. Minimum distance from edge of waterstop placed in groove to face of member: 2.5 inches.

   c. Do not place bentonite waterstop when waterstop material temperature is below 40 degrees F. Waterstop material may be warmed so that it remains above 40 degrees F during placement but means used to warm it shall in no way harm material or its properties. Do not install waterstop where air temperature falls outside manufacturer's recommended range.

   d. Place bentonite waterstop only on smooth and uniform surfaces; grind concrete smooth when necessary to produce satisfactory substrate, or bond waterstop to irregular surfaces using epoxy grout which completely fills voids and irregularities beneath waterstop material. Prior to installation, wire brush concrete surface to remove laitance and other substances that may interfere with bonding of epoxy.

   e. In addition to adhesive backing provided with waterstop, secure bentonite waterstop in place with concrete nails and washers at 12 inch maximum spacing.

7. Adhesive Waterstop:

   a. With wire brush thoroughly clean concrete surface on which waterstop is to be placed and then coat with primer.

   b. If surface is too rough to allow waterstop to form complete contact, grind to form adequately smooth surface.

   c. Install waterstop with top protective paper left in place. Overlap joints between strips minimum of 1 inch and cover back over with protective paper.

   d. Do not remove protective paper until just before final form work completion. Place concrete immediately. time that waterstop material is uncovered prior to concrete placement shall be minimized and shall not exceed 24 hours.

3.07 CONSTRUCTION JOINTS

A. Definitions:

1. Construction joint: Contact surface between plastic (fresh) concrete and concrete that has attained initial set.

2. Monolithic: Manner of concrete placement to reduce or eliminate construction joints; joints other than those indicated on Drawings will not be permitted without written approval of Project Manager. Where so approved, make additional construction joints with details equivalent to those indicated for joints in similar locations.

3. Preparation for Construction Joints: Roughen surface of concrete previously placed, leaving some aggregate particles exposed. Remove laitance and loose materials by sandblasting or high-pressure water blasting. Keep surface wet for several hours prior to placing of plastic concrete.

3.08 CURING

A. Comply with ACI 308. Cure by preventing loss of moisture, rapid temperature change and mechanical injury for period of 7 curing days when Type II or IP cement has been used and for 3 curing days when Type III cement has been used. Start curing as soon as free water has disappeared from concrete surface after placing and finishing. A curing day is any calendar day in which temperature is above 50 degrees F for at least 19 hours. Colder days may be counted when air temperature adjacent to concrete is maintained above 50 degrees F. In continued cold weather, when artificial heat is not provided, removal of forms and shoring may be permitted at end of calendar days equal to twice required number of curing days. However, leave soffit forms and shores in place until concrete has reached specified 28 day strength, unless directed otherwise by Project Manager.

B. Cure formed surfaces not requiring rubbed-finished surface by leaving forms in place for full curing period. Keep wood forms wet during curing period. Add water as needed for other types of forms. Or, at Contractor's option, forms may be removed after 2 days and curing compound applied.

C. Rubbed Finish:

1. At formed surfaces requiring rubbed finish, remove forms as soon as practicable without damaging surface.

2. After rubbed-finish operations are complete, continue curing formed surfaces by using either approved curing/sealing compounds or moist cotton mats until normal curing period is complete.

D. Unformed Surfaces: Cure by membrane curing compound method.

1. After concrete has received final finish and surplus water sheen has disappeared, immediately seal surface with uniform coating of approved curing compound, applied at rate of coverage recommended by manufacturer or as directed by Project Manager. Do not apply less than 1 gallon per 180 square feet of area. Provide satisfactory means to properly control and check rate of application of compound.

2. Thoroughly agitate compound during use and apply by means of approved mechanical power pressure sprayers equipped with atomizing nozzles. For application on small miscellaneous items, hand-powered spray equipment may be used. Prevent loss of compound between nozzle and concrete surface during spraying operations.

3. Do not apply compound to dry surface. When concrete surface has become dry, thoroughly moisten surface immediately prior to application. At locations where coating shows discontinuities, pinholes or other defects, or when rain falls on newly coated surface before film has dried sufficiently to resist damage, apply additional coat of compound at specified rate of coverage.

3.09 REMOVAL OF FORMS AND SHORING

A. Remove forms from surfaces requiring rubbing only as rapidly as rubbing operation progresses. Remove forms from vertical surfaces not requiring rubbed-finish when concrete has aged for required number of curing days. When curing compound is used, do not remove forms before 2 days after concrete placement.

B. Leave soffit forms and shores in place until concrete has reached specified 28-day strength, unless directed otherwise by Project Manager.

3.10 DEFECTIVE WORK

A. Immediately repair defective work discovered after forms have been removed. When concrete surface is bulged, uneven, or shows excess honeycombing or form marks which cannot be repaired satisfactorily through patching, remove and replace entire section.

3.11 FINISHING

A. Patch honeycomb, minor defects and form tie holes in concrete surfaces with cement mortar mixed one part cement to two parts fine aggregate. Repair defects by cutting out unsatisfactory material and replacing with new concrete, securely keyed and bonded to existing concrete. Finish to make junctures between patches and existing concrete as inconspicuous as possible. Use stiff mixture and thoroughly tamp into place. After each patch has stiffened sufficiently to allow for greatest portion of shrinkage, strike off mortar flush with surface.

B. Apply rubbed finish to exposed surfaces of formed concrete structures as noted on Drawings. After pointing has set sufficiently, wet surface with brush and perform first surface rubbing with No. 16 carborundum stone, or approved equal. Rub sufficiently to bring surface to paste, to remove form marks and projections, and to produce smooth, dense surface. Add cement to form surface paste as necessary. Spread or brush material, which has been ground to paste, uniformly over surface and allow to reset. In preparation for final acceptance, clean surfaces and perform final finish rubbing with No. 30 carborundum stone or approved equal. After rubbing, allow paste on surface to reset; then wash surface with clean water. Leave structure with clean, neat and uniform-appearing finish.

C. Apply wood float finish to concrete slabs.

3.12 FIELD QUALITY CONTROL

A. Testing shall be performed under provisions of Section 01454 - Testing Laboratory Services.

B. Unless otherwise directed by Project Manager, following minimum testing of concrete is required. Testing shall be performed by qualified individuals employed by approved independent testing agency, and conform to requirements of ASTM C 1077.

1. Take concrete samples in accordance with ASTM C 172.

2. Make one set of four compression test specimens for each mix design at least once per day and for each 150 cubic yards or fraction thereof. Make, cure and test specimens in accordance with ASTM C 31 and ASTM C 39.

3. When taking compression test specimens, test each sample for slump according to ASTM C 143, for temperature according to ASTM C 1064, for air content according to ASTM C 231, and for unit weight according to ASTM C 138.

4. Inspect, sample and test concrete in accordance with ASTM C 94, Section 13, 14, and 15, and ACI 311-5R.

C. Test Cores: Conform to ASTM C 42.

D. Testing High Early Strength Concrete: When Type III cement is used in concrete, specified 7 day and 28 day compressive strengths shall be applicable at 3 and 7 days, respectively.

E. If 7-day or 3-day test strengths (as applicable for type of cement being used) fail to meet established strength requirements, extended curing or resumed curing on those portions of structure represented by test specimens may be required. When additional curing fails to produce required strength, strengthening or replacement of portions of structure which fail to develop required strength may be required by Project Manager, at no additional cost to City.

3.13 PROTECTION

A. Protect concrete against damage until final acceptance by City.

B. Protect fresh concrete from damage due to rain, hail, sleet, or snow. Provide protection while concrete is still plastic, and whenever precipitation is imminent or occurring.

C. Do not backfill around concrete structures or subject them to design loadings until components of structure needed to resist loading are complete and have reached specified 28 day compressive strength, except as authorized otherwise by Project Manager.

END OF SECTION

Section 04061

MORTAR

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Mortar and grout for masonry.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for mortar under this Section. Include payment in Lump Sum for building or structure with price breakdown included in Schedule of Values.

2. Refer to Section 01270 - Measurement and Payment and Section 01292- Schedule of Values.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. ASTM C 143 - Standard Testing Method for Slump of Hydraulic Cement Concrete

B. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar.

C. ASTM C 150 - Standard Specification for Portland Cement.

D. ASTM C 207 - Standard Specification for Hydrated Lime for Masonry Purposes.

E. ASTM C 270 - Standard Specification for Mortar for Unit Masonry.

F. ASTM C 404 - Standard Specification for Aggregates for Masonry Grout.

G. ASTM C 476 - Standard Specification for Grout for Masonry.

H. ASTM C 780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.

I. ASTM C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars.

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Include design mix, indicate Property Method used, required environmental conditions, and admixture limitations.

C. Samples: Submit two ribbons of each mortar color, illustrating color and color range.

D. Submit test reports under provisions of Section 01450 - Contractor's Quality Control.

E. Submit test reports on mortar indicating conformance to ASTM C 270.

F. Submit test reports on grout indicating conformance to ASTM C 476.

G. Submit manufacturer's certificate under provisions of Section 01450 - Contractor's Quality Control, that products meet or exceed specified requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site and store and protect products under provisions of Section 01610 - Basic Product Requirements.

B. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Maintain materials and surrounding air temperatures to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry work.

1.07 MIX TESTS

A. Test mortar and grout in accordance with Section 01454 - Testing Laboratory Services.

B. Testing of Mortar Mix: Test in accordance with ASTM C 780. Test mortar mix for compressive strength, consistency, mortar aggregate ratio, water content, air content, and splitting tensile strength.

C. Testing of Grout Mix: Test in accordance with ASTM C 109. Test grout mix for compressive strength and slump.

PART 2 P R O D U C T S

2.01 MATERIALS

A. Portland Cement: ASTM C 150, Type I, white color.

B. Masonry Cement: Not permitted.

C. Mortar Aggregate: ASTM C 144, standard masonry type. Grading and color suitable for type of masonry, one source for entire project. (Not less than 5 percent shall pass No. 100 sieve).

D. Hydrated Lime: ASTM C 207, Type S.

E. Grout Aggregate: ASTM C 404.

F. Water: Clean and potable.

2.02 MORTAR COLOR

A. Mortar Color: Mineral oxide pigment; color; to be selected by Project Manager from manufacturer's samples.

2.03 ADMIXTURES

A. Antifreeze: Antifreeze admixtures will not be permitted.

B. Accelerator: Accelerator may be used only with approval of Project Manager.

2.04 MORTAR

A. Mortar for Load Bearing Walls and Partitions: ASTM C 270, Type S utilizing Property Method to achieve 1800 psi strength.

B. Mortar for Non-load Bearing Walls and Partitions: ASTM C 270, Type S utilizing the Property Method to achieve 1800 psi strength.

C. Mortar for Masonry Below Grade or in Contact with Earth: ASTM C 270, Type M utilizing the Property Method to achieve 2500 psi strength.

D. Pointing Mortar: ASTM C 270, Type N, using the Property Method to achieve 750 psi strength.

2.05 MORTAR MIXING

A. Thoroughly mix mortar ingredients in quantities needed for immediate use in accordance with ASTM C 270 to achieve strengths noted in Paragraph 2.04.

B. Add mortar color and admixtures in accordance with manufacturer's instructions. Provide uniformity of mix and coloration.

C. Do not use anti-freeze compounds to lower freezing point of mortar.

D. If water is lost by evaporation, retemper only within 2 hours of mixing.

E. Use mortar within 2 hours after mixing at temperatures of 80 degrees F, or 2 1/2 hours at temperatures under 50 degrees F.

2.06 GROUT

A. Bond Beams, Lintels, and Other Areas to be Grouted Solid: 3000 psi strength at 28 days; 7 to 8 inches slump per ASTM C 143; mixed in accordance with ASTM C 476, Fine Grout.

2.07 GROUT MIXING

A. Thoroughly mix mortar ingredients in quantities needed for immediate use in accordance with ASTM C 476, Fine Grout.

B. Add admixtures in accordance with manufacturer's instructions. Provide uniformity of mix.

C. Do not use anti-freeze compounds to lower freezing point of grout.

PART 3 E X E C U T I O N

3.01 EXAMINATION

A. Request inspection of spaces to be grouted.

3.02 PREPARATION

A. Apply bonding agent to existing concrete surfaces.

B. Plug clean out holes with masonry units to prevent leakage of grout materials. Brace masonry for wet grout pressure.

3.03 INSTALLATION

A. Install mortar and grout in accordance with manufacturer's instructions.

B. Work grout into masonry cores and cavities to eliminate voids.

C. Do not displace reinforcement while placing grout.

D. Remove grout spaces of excess mortar.

END OF SECTION

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Section 04210

BRICK MASONRY FOR UTILITY CONSTRUCTION

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Brick masonry work in utility construction for permanent or temporary installation of below ground structures.

B. Brick masonry in repair and rehabilitation of utility lines and associated structures.

1.02 UNIT PRICES

A. No payment will be made for brick masonry under this Section unless specifically noted in bid documents. Include payment in unit price for applicable utility structure section.

1.03 REFERENCES

A. ASTM C 32 - Specification for Sewer and Manhole Brick (Made from Clay or Shale).

B. ASTM C 55 - Standard Specification for Concrete Building Brick.

C. ASTM C 62 - Specification for Building Brick (Solid Masonry Units Made from Clay or Shale).

D. ASTM C 67 - Methods of Sampling and Testing Brick and Structural Clay Tile.

E. ASTM C 91 - Specification for Masonry Cement.

F. ASTM C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens).

G. ASTM C 140 - Standard Method of Sampling and Testing Concrete Masonry Units.

H. ASTM C 270 - Standard Specification for Mortar for Unit Masonry.

1.04 SUBMITTALS

A. Submittals shall conform to requirements of Section 01330 - Submittal Procedures.

B. Submit certification from the manufacturer that brick units meet applicable requirements of reference standards.

C. As an alternate to providing certification, submit test results that show brick units meet applicable requirements of reference standards, when tested by an approved independent testing laboratory. Test result submittals shall be at no cost to the City.

1.05 HANDLING AND STORAGE

A. Handle and store brick to prevent damage.

B. Store brick and mortar mix off the ground and in a dry place. Cover mortar mix to protect from weather.

PART 2 P R O D U C T S

2.01 CLAY AND SHALE BRICK MASONRY UNITS

A. Manholes and Structures: Use brick units made from clay or shale conforming to requirements of ASTM C 32, Grade MM, either cored or solid. Units shall have the following physical properties:

1. Compressive Strength: 2200 psi minimum for individual brick; 2500 psi average for five bricks.

2. Size: 2-1/4" by 7-5/8" by 3-5/8".

3. Test Procedure: ASTM C 67.

B. Sewer Brick: Use brick units made from clay or shale conforming to requirements of ASTM C 32, Grade SM, either cored or solid. Units shall have the following physical properties:

1. Compressive Strength: 3750 psi minimum for individual brick; 5000 psi average for 5 bricks.

2. Size: 2-1/4" by 7-5/8" by 3-5/8".

3. Test Procedure: ASTM C 67.

2.02 CONCRETE BRICK MASONRY UNITS

A. Manholes and Structures: Conform to requirements of ASTM C 55, grade S-1.

B. Dimensions: 2-1/4" by 7-5/8" by 3-5/8".

2.03 MORTAR

A. Provided mortar conforming to the requirements of Section 4061 - Mortar.

PART 3 E X E C U T I O N

3.01 EXAMINATION

A. Ensure that foundations and other surfaces to support brickwork are at proper grades and elevations. Correct improperly prepared surfaces. Work surfaces and masonry shall be free of dirt, grease, oil, or other harmful materials before starting brick masonry work.

3.02 WEATHER REQUIREMENTS

A. Lay no masonry when temperature of outside air is below 50 F, unless satisfactory means are provided to heat materials and protect work from cold and frost.

B. Maintain mortar at 50 F or above and ensure that mortar will harden without freezing.

3.03 BRICK PLACEMENT

A. Use sewer brick where exposed to flow. Where not exposed to flow, use manhole brick.

B. Lay sewer brick with the 2-1/4" by 7-5/8" side exposed to flow.

C. Lay manhole bricks so that in every fifth course the long axis of bricks are perpendicular to the long axis of the four preceding courses.

D. Lay curved courses, and courses in different planes, using bonded and keyed construction.

E. Lay brick plumb and true with courses level and uniformly spaced. Adjust the bond of face brick so that no course will terminate with a piece less than one-half length of brick.

F. Dampen brick prior to placement.

G. Where fresh masonry joins partially set or totally set masonry, clean surfaces of set masonry. Remove loose mortar and brick. Wet brick to obtain the best possible bond.

H. Immediately remove mortar droppings and splashing as work progresses to facilitate final cleaning.

3.04 JOINTS

A. Completely fill joints in brick and other materials with mortar as each course is laid.

B. Make joints in exposed brickwork a uniform 3/8-inch wide, unless otherwise shown on Drawings.

C. When mortar is "thumbprint" hard, tool exposed joints with a round or other suitable jointer that is slightly larger than width of the mortar joint. In tooling, make sure that cracks and crevices are closed.

D. Point holes in exposed masonry. Cut out defective joints and repoint.

3.05 FIELD QUALITY CONTROL

A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.

B. A minimum of one set of mortar samples shall be molded for each day's placement as directed by Project Manager. Mold three 2-inch cube specimens. One cube will be tested for compressive strength at 7 days and 2 cubes will be tested for compressive strength at 28 days in accordance with ASTM C 109.

C. Each load of bricks delivered to the jobsite shall be tested.

1. Test clay bricks in accordance with ASTM C 167.

2. Test concrete bricks in accordance with ASTM C 140.

END OF SECTION

THE FOLLOWING ITEMS SHOULD BE CHECKED FOR COORDINATION DURING DESIGN:

****

A. Coordinate this specification with other related specifications including the following related Sections.

****

RELATED SECTIONS

1. Section 02087 - Brick Manholes for Storm Sewers.
2. Section 02632 - Cast-in-Place Inlets, Headwalls, and Wingwalls.
3. Section 02085 - Valve Boxes, Meter Boxes, and Meter Vaults.
4. Section 02086 - Adjusting Manholes, Inlets, and Valve Boxes to Grade.
5. Section 02555 - Manhole Rehabilitation.

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Section 05501

METAL FABRICATIONS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Bolts, anchors, nuts, sleeves, concrete anchors, scheduled items, and other miscellaneous metal items not specifically included under other sections of these specifications.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices

1. No separate payment will be made for metal fabrications under this section. Include payment as part of the Work in appropriate sections.

2. Refer to Section 01270 - Measurement and Payment.

B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.03 REFERENCES

A. ASTM A 36 - Structural Steel.

B. ASTM A 53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

C. ASTM A 123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

D. ASTM A 153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

E. ASTM A 276 - Stainless and Heat-Resisting Steel Bars and Shapes.

F. ASTM A 307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

G. ASTM A 500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.

H. ASTM A 501 - Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

I. ASTM F 593 - Stainless Steel Bolts, Hex Cap Screws, and Studs.

J. ASTM F 594 - Stainless Steel Nuts.

K. AWS A 2.0 - Standard Welding Symbols.

L. AWS D 1.1 - Structural Welding Code.

M. SSPC - Steel Structures Painting Council.

1.04 SUBMITTALS

A. Submit following Section 01330 - Submittal Procedures.

B. Shop Drawings: Indicate profiles, sizes, thickness, grade class, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.

C. Indicate welded connections using standard AWS A 2.0 welding symbols. Indicate net weld lengths.

D. Submit manufacturer's technical literature and test reports showing certified capacities for concrete anchors.

E. When foreign manufactured material is proposed for use, test material for conformance to ASTM Standards by a certified independent testing laboratory located in the United States. Certification from any other source outside the United States is unacceptable. Furnish copies of test reports to Project Manager for review. Do not begin fabrication until material has been approved. No additional payment will be made for this testing.

1.05 QUALIFICATIONS

A. Prepare shop drawings under direct supervision of a professional Structural Engineer experienced in design of this work and licensed in the State of Texas.

B. Welders' Certificates: Submit following Section 01330 - Submittal Procedures, certifying welders employed on the Work, verifying AWS D1.1, Structural Welding Code, using procedures, materials and equipment of type required for this work. Welder must have been qualified or re-certified within the previous 12 months of date welding is being performed.

1.06 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on Drawings.

1.07 DELIVERY AND STORAGE

A. Materials stored at project site: Store above ground on platforms, skids, or other supports. Keep free of dirt, mud, grease, or oil. Protect from corrosion.

PART 2 P R O D U C T S

2.01 MATERIALS

A. Steel Shapes and Plate: ASTM A 36.

B. Stainless Steel Sections: ASTM A 276, Type 316 for non-welded items and Type 316L for welded items.

C. Steel Tubing: ASTM A 500 or ASTM A 501, Grade B.

D. Pipe: ASTM A 53, Grade B Schedule 40.

E. Bolts, Nuts, and Washers: ASTM A 307 galvanized to ASTM A 153 for galvanized components. Provide anchor bolts for all equipment and machinery when anchor bolts are not furnished by manufacturer. Conform anchor size, length, projection, etc., to requirements of equipment and machinery manufacturer. Provide templates to accurately position anchor bolts in forms.

F. Stainless Steel Bolts and Nuts: Bolts in accordance with ASTM F 593, Type 316; nuts in accordance with ASTM F 594, Type 316; UNC coarse threads.

G. Concrete Anchors: Concrete anchors are inserted into holes drilled in hardened concrete. Use one of the following types:

1. Adhesive Anchors: For concrete anchors which are submerged, in splash zones, in enclosed spaces over liquids, or anchoring vibrating equipment, use epoxy adhesive anchors. Adhesive anchors may be used at all locations where concrete anchors are required. Epoxy systems shall be Sika/FI System with Sikadur Injection Gel Epoxy, Master Builders Concresive Epoxy Cartridge Dispensing System and Concresive Paste LPL, or equal. Threaded rods shall be ASTM F 593, Type 316 studs. Where adhesive anchors, or connected metal, are exposed to direct sunlight, the anchors shall be certified to maintain at least 90 percent of their rated strength (tested at 73 F) when tested at 160 F.

2. Expansion Anchors: Where concrete anchors are indicated and adhesive anchors are not required, wedge type anchors made with ASTM A 276, Type 316 Stainless Steel shall be used. Anchors shall be KWIK Bolt II By Hilti, Inc., or equal.

H. Welding Materials: AWS D 1.1; type required for materials being welded.

I. Shop and Touch-Up Primer: Same manufacturer as protective coating; compatible with protective coating; applied in accordance with manufacturer's recommendation.

2.02 FABRICATION

A. Fit and shop-assemble in largest practical sections for delivery to site.

B. Fabricate items with joints tightly fitted and secured. Weld all shop connections except where welding is not practical, or unless otherwise shown on Drawings. Where screw bolts cannot be avoided, conceal fasteners where possible or countersink heads, screw up tight and nick threads to prevent loosening. Weld joints continuously except as shown on Drawings.

C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

D. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

E. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

F. Welding shall conform to requirements of AWS D1.1, Structural Welding Code – Steel. Perform welding not governed by above in accordance with best modern practice for strength and durability.

2.03 FINISHES

A. Prepare surfaces to be primed in accordance with SSPC SP 2.

B. Do not prime surfaces in direct contact with concrete or where field welding is required.

C. Galvanize, after completion of welded fabrication, in accordance with ASTM A 123, structural steel members. Provide minimum 1.25 ounces per square foot galvanized coating.

PART 3 E X E C U T I O N

3.01 EXAMINATION

A. Verify that field conditions are acceptable and ready to receive work.

B. Beginning of installation means erector accepts existing conditions.

3.02 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

B. Supply items required to be cast into concrete or embedded in masonry with setting templates, to appropriate sections.

C. Coat stainless steel threads with an anti-seizing compound prior to installing nuts.

3.03 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects.

B. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. Field weld components indicated on shop drawings.

D. Perform field welding in accordance with AWS D 1.1.

E. Obtain Project Manager approval prior to cutting or making adjustments in the field.

F. After erection, prime welds, abrasions, and surfaces not shop primed except surfaces to be in contact with concrete.

3.04 ERECTION TOLERANCES

A. Maximum Variation from Plumb: 1/4 inch per story, non-cumulative.

B. Maximum Offset from True Alignment: 1/4 inch.

3.05 COATING REPAIRS

A. Thoroughly clean field welds, abrasions, and damaged or defective areas of galvanized surfaces to remove all loose, cracked or bruised splatter coating. After surface is prepared, for galvanized surfaces apply two coats of galvanizing repair coating, as approved by Project Manager. Repair other coated surfaces in accordance with manufacturer's recommendations, unless otherwise specified.

END OF SECTION

SECTION 06530

FIBERGLASS GRATING SYSTEMS

PART 1 G E N E R A L

1.01 DESCRIPTION

A. Furnish molded fiberglass grating in the locations shown in the Drawings.

B. All fiberglass gratings shall be manufactured using the open molding manufacturing process. Pultruded fiberglass gratings and “compression molded” fiberglass gratings are not acceptable.

C. Design panel sizes and dimensions adequate to support anticipated live loads of 150 lb per square foot plus dead loads. Design panels to fit equipment layouts, providing smaller removable panel sections in location where access may be required.

1.02 SUBMITTALS

A. Submit information to establish compliance with the specifications in accordance with the procedures set forth in Section 01300. This material shall include a detailed layout of all proposed fiberglass grating and the manufacturer's literature on all system components.

1.03 QUALITY CONTROL

A. All molded fiberglass gratings shall be manufactured in an ISO 9002 Certified manufacturing facility, thus ensuring that every panel is subjected to the following:

1. Full “wet-out” of the glass rovings.
2. Consistent resin-to-glass ratios.
3. Consistent non-skid characteristics.
4. Traceability of resins and glass used in the gratings.
5. Consistent load-carrying capability.
6. Continuing ultraviolet and chemical resistance testing.
7. Elimination of voids.

1.04 MINIMUM STIFFNESS REQUIREMENTS.

A. On a 36” span, a 12” wide strip of the 1½” thick grating must not deflect more than 0.18” when subjected to a uniform loading of 100 psf, and the same 12” wide strip of 1½” grating must not deflect more than 0.25” when subjected to a concentrated line load of 200 pounds on the same 36” span.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. Delta Composites, L.L.C. (DeltaGrate HS), Houston, Texas

B. McNichols Co ISO 9002 Certified, www.mcnichols.com

C. Other suppliers acceptable to Engineer

2.02 MATERIALS

A. Resin Type

1. All molded fiberglass grating shall be manufactured using the Dow Chemical USA vinyl ester resin known as Derakane Momentum™ 411-350. Orthophthalic polyester resins, isophthalic polyester resins, and phenolic resins are not acceptable. The Derakane Momentum™ 411-350 resin is designed to meet the corrosion requirements in the toughest of environments and resists chemical attack from both acids and caustics.

2. ASTM E84-98, Standard Method of Test for Surface Burning Characteristics of Building Materials Surface Burning Characteristics of Building Materials, a test to determine the flame spread and the smoke developed density of any material, must have been performed on a sample of the grating panel within the last 3 years. The molded fiberglass grating must possess, at a minimum, an ASTM E84-98 Flame Spread Rating (FSR) of 20 or less.

3. UV inhibitors shall be used in the resin matrix to enhance the gratings resistance to ultraviolet attack.

B. GLASS CONTENT

1. The molded grating shall be manufactured by strategically interweaving high strength, continuous glass rovings within a grating mold to produce an

integral laminate with load bars in both the longitudinal and transverse directions. The molded grating panel shall contain a minimum of thirty-eight (38%) percent glass content by weight.

C. SKID RESISTANCE

1. The walking surface of the grating shall be skid resistant, or slip resistant, and this skid resistance shall be achieved by the creation of a concave contour on topside of the bearing bars, more commonly called “memiscus top” grating.

2. Stair tread panels shall be gritted and shall possess a gritted nosing to provide a skid resistant walking surface.

D. COLOR

1. All molded fiberglass grating shall be orange in color.

2.02 BEARING BAR WIDTH, THICKNESS AND MESH CONFIGURATION

A. All grating panels and stair tread panels shall possess bearing bars that are a minimum of ¼” wide at the top of the bearing bar. No molded grating with a bearing bar that measures less than ¼” on top will be accepted regardless of published tolerances.

B. All bearing bars shall be 1 ½” deep.

C. All grating panels shall be manufactured with a mesh configuration of 1 ½” x 1 ½”square mesh as measured from centerline to centerline of bearing bars.

D. Stair tread panels shall have a mesh configuration of 1” x 6” rectangular mesh as measured from centerline to centerline of bearing bars.

2.03 ATTACHMENT OF MOLDED FIBERGLASS GRATING

A. The molded fiberglass grating used in all horizontal framing plans shall be secured by the use of the G-Clip manufactured by Grating Fasteners, Inc., Bellechase, Louisiana.

B. Stair treads are to be secured with Type M Clips.

C. Attachment of molded fiberglass grating panels in all horizontal framing plans shall be achieved by the use of one G-Clip for every 5-6 square feet of grating, but no less than four (4) clips per panel for square and rectangular pieces, or three clips for

any triangular pieces. All stair treads should be attached with the use of four Type M Clips per stair tread.

D. The longitudinal edges of adjacent fiberglass grating panels are to attached by the use of Type C-Clips. Use of the C-Clip is to reduce the differential deflection of adjacent panels when concentrated loads are applied close to the longitudinal edges of the panes. The C-Clips cause the panels to deflect as “one”, thereby reducing the possibility of a tripping hazard. Use of the C-Clip to tie adjacent panels should be used when the clear span of grating panels exceed 36”, and the clip should be installed in the center of the clear span.

E. All grating attachment clips described above shall be manufactured from 316 stainless steel.

PART 3 E X E C U T I O N

3.01 SAWING, CUTTING, DRILLING, SEALING, ETC.

A. All cutting, drilling or sanding of fiberglass grating shall be performed according to the manufacturer's instruction and safety precautions.

END OF SECTION

Section 09901
PROTECTIVE COATINGS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Preparing surfaces, providing adequate conditions for proper workmanship, and furnishing and applying the protective coating materials required for metallic, concrete, masonry and plastic surfaces.

B. Color code painting of piping and piping identification signs and markers.

1.02 UNIT PRICES

A. No separate payment will be made for protective coatings unless specifically listed in Document 00410 – Bid Form. Include payment for protective coatings in unit prices for items to which coatings are applied.

B. Measurement for protective coatings, when included as a separate pay item, is on a square-foot basis for completed protective coating systems.

C. Refer to Section 01270 – Measurement and Payment for unit price procedures.

1.03 REFERENCES

A. ANSI A13.1 – Color Schedule

B. ANSI/AWWA C213 – Fusion-bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.

C. Federal specification TT-P-28 – Paint, Aluminum, Heat Resisting 1200 degrees F).

D. Federal Standard 595A – Federal Standard Colors.

E. Military Specification DOD-P-23236 – Paint Coating Systems, Steel Ship Tank, Fuel and Salt Water Ballast, Class 2.

F. NSF Standard 61 – Drinking Water System Components – Health Effects.

G. SSPC-PA 1 – Paint Application Specification No. 1 - Shop, Field and Maintenance Painting.

H. SSPC-PA 2 – Paint Application Specification No. 2 – Measurement of Dry Paint Thickness with Magnetic Gages.

I. SSPC-Paint 16 – Coal Tar Epoxy-Polyamide Black (or Dark Red) Paint.

J. SSPC-SP 1 – Solvent Cleaning.

K. SSPC-SP 2 – Hand Tool Cleaning.

L. SSPC-SP 3 – Power Tool Cleaning.

M. SSPC-SP 5/NACE 1 – White Metal Blast Cleaning.

N. SSPC-SP 6/ NACE 3 – Commercial Blast Cleaning.

O. SSPC-SP 7/NACE 4 - Brush-Off Blast Cleaning.

P. SSPC-SP 10/NACE 2 – Near White Metal Blast Cleaning.

Q. SSPC-SP 11 – Power Tool Cleaning to Bare Metal.

R. SSPC-VIS 1-89 – Visual Standard for Abrasive Blast Cleaned Steel.

S. SSPC-VIS 3 – Visual Standard for Power-and Hand-Tool Cleaned Steel.

T. SSPC-QP 1 – Standard Procedure for Evaluating Qualifications of Painting Contractors

U. SSPC-QP 2 - Standard Procedure for Evaluating Qualifications of Painting Contractors to Remove Hazardous Paint.

V. SSPC-SP12/NACE 5 – Surface Preparation and Cleaning of Steel and Other Hard Materials by High- and Ultrahigh-Pressure Water Jetting Prior to Recoating.

1.04 DEFINITIONS

A. Paint, coatings, or finishes as used in this Section include surface treatments, emulsions, enamels, paints, epoxies, polyurethanes, acrylics, zincs, and other protective coatings with the exceptions of galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.

B. DFT means minimum dry film thickness.

C. VOC means Volatile Organic Components

1.05 PERFORMANCE REQUIREMENTS

A. See the Drawings and other Specifications to determine how coatings under this Section will be applied. Paint or coat new and modified surfaces in conformance with this Section.

B. Coating system schedules summarize surfaces to be coated, required surface preparation, and coating systems to be applied. Coating notes on Drawings are used to show exceptions to schedules, to show or extend limits of coating systems, or to clarify or show details for application of coating systems.

C. Do not apply protective coatings to the following surfaces unless specifically named or shown to be coated;

1. Concrete.

2. Stainless steel, bronze, or brass.

3. Machined surfaces.

4. Grease fittings.

5. Glass.

6. Equipment nameplates.

7. Platform gratings, stair treads, door thresholds, and other walk surfaces.

8. Galvanized steel electrical conduit and associated galvanized and factory-coated junction boxes and electrical panels.

9. Galvanized surfaces inside buildings and not exposed to view.

10. Manhole and valve covers and rings, storm water inlet gratings, covers, and frames.

D. Provide decorative and protective coatings for interior architectural surfaces such as wood, gypsum board, and masonry in accordance with Section 09900 – Painting.

1.06 SUBMITTALS

A. Make submittals in accordance with Section 01330 – Submittal Procedures.

B. Submit the following information at least 10 days prior to protective coating work.

1. Coating Materials List: Eight copies of a coating materials list naming the manufacturer and the coating number, keyed to the coating systems described in this Section. Submit the list prior to or at the time of sample submittal.

2. Paint Manufacturer's Information: For each coating system to be used, submit the following data:

   a) Paint manufacturer's Product Data Sheet for each product proposed, including statements on the suitability of the material for the intended use.

   b) Technical and performance information that demonstrates compliance with the system performance and material requirements.

   c) Paint manufacturer's instructions and recommendations on surface preparation, application and curing.

   d) Colors available for each product, where applicable.

   e) Compatibility of shop and field applied coatings, where applicable.

   f) Material Safety Data Sheets for each product used.

   g) VOC of each paint or coating proposed, stated in grams per litre.

3. Samples

   a) Submit color samples of paint, finishes, and other coating materials on 8-1/2 inch by 11-inch sheet metal or heavy cardstock. Have each sheet completely coated over its entire surface with one protective coating material, type, and color.

   b) Provide two sets of color samples to match each color selected by the City Engineer from the manufacturer's standard color sheets. If custom-mixed colors are indicated, prepare color samples using color formulations prepared to match the color samples furnished by the City Engineer.

   c) Submit one 15-pound sample of each abrasive proposed to be used for surface preparation for submerged and severe service coating systems.

1.07 QUALIFICATIONS

A. Where protective coatings are to be applied by a Contractor, employ a Contractor who possesses a valid state license as required for performance of painting and coating work called for in this Specification.

B. Submit 5 references, which show that the painting Contractor has previous successful experience with the indicated or comparable coating systems. Include the name, address, and the telephone number for the owner of each installation for which the painting Contractor provided the protective coating. As an alternative, submit proof of certification in accordance with SSPC-QP 1.

C. For any project which involves removal or repair of lead based paints, submit proof of certification in accordance with SSPC-QP 2.

1.08 ENVIRONMENTAL RESTRICTIONS

A. Ventilate area where coating is being applied. Post and enforce NO SMOKING OR OPEN FLAME signs until coating has cured.

B. Provide lighting level of 80-foot candles (860 1x) measured mid-height at substrate surface.

C. Restrict worker access and construction traffic from area where coating is being applied or is cured.

D. Comply with City of Houston and all applicable OSHA confined space entry regulations including but not limited to OSHA Permit-Required Confined Space Standard 1910.146.

1.09 WARRANTY INSPECTION AND MAINTENANCE

A. Warranty Inspection:

1. A warranty inspection may be conducted during the eleventh month following completion of coating and painting. The Contractor and a representative of the coating material manufacturer along with a NACE Certified Coating Inspector acting as the representative of the City Engineer, shall attend this inspection.

2. The City Engineer may, by written notice to the Contractor, reschedule the warranty inspection to another date within the one-year correction period, or may cancel the warranty inspection altogether. Cancellation of the warranty inspection does not relieve the Contractor of his responsibilities under the Contract Documents.

3. Repair defective work discovered during the warranty inspection in accordance with these Specifications.

B. Extended Maintenance of Chemical Tank Lining Systems: Promptly repair defects in the chemical resistant sheet lining system for a period of 2 years after the lining has been placed into service. Such maintenance includes repair of the chemical tank and any equipment or facilities damaged by the corrosive action of the chemicals.

PART 2 P R O D U C T S

2.01 COATINGS CRITERIA

A. Suitability: Use suitable coating materials as recommended by the manufacturer. Recommendations must be accompanied by test methods used to determine suitability and results of these tests.

B. Compatibility: In any coating system, use only compatible materials from a single manufacturer. Give particular attention to compatibility of primers, intermediate coats and finish coats. If necessary, apply a barrier coat or tie coat between existing prime coat and subsequent field coats to ensure compatibility.

C. Containers: Supply coating materials in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, and name of manufacturer, all plainly legible at the time of use.

D. Colors: Use colors and shades of colors of all coats of paint as indicated on the coating schedules or as selected by the City Engineer. Make each coat a contrasting shade to the previous and following coats to facilitate inspection of surface coverage of each coat. The City Engineer will select finish colors from the manufacturer's standard color samples.

E. Substitute or Equal Products:

1. To establish equality under Section 01630 – Product Substitution Procedures, furnish satisfactory documentation from the manufacturer of the proposed substitute product that the material meets the indicated requirements and is equivalent or better in the following properties:

a) Resistance to abrasion and physical damage.

b) Resistance to chemical attack.

c) Life expectancy.

d) Ability to recoat in the future.

e) Solids content by volume.

f) Dry film thickness per coat.

g) Compatibility with other coatings.

h) Suitability for the intended service.

i) Temperature limitations in service and during application.

j) Type and quality of recommended undercoats and topcoats.

k) Ease of application.

l) Ease of repairing damaged areas.

m) Stability of colors.

n) VOC content expressed in grams per litre.

2. For substitutions, submit protective-coating materials which are standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. Where requested, provide the City Engineer with the names of not less than 10 successful applications of the proposed manufacturer's products, which comply with these requirements. Applications must be in similar service environments to the job being contracted.

2.02 INDUSTRIAL COATING SYSTEMS

A. Material Sources: Each of the following manufacturers is capable of supplying many of the specified industrial coating materials. Where manufacturers and paint numbers are listed, it is to show the type and quality of coatings that are required. Proposed substitute materials will be considered as indicated under paragraph 2.01.5. Provide industrial coating materials that have a record of satisfactory performance in industrial plants, manufacturing facilities, and water and wastewater treatment plants.

1. Ameron International

2. Carboline Coatings Company

3. ICI/Devoe Coatings

4. Sigma Coatings USA, Inc.

5. Hempel Coatings USA, Inc.

6. AKZO/International Coatings

7. Tnemec Company

B. System 1 – Aliphatic Polyurethane Finish Coat: Use a two-component aliphatic acrylic polyurethane coating. Provide superior color and gloss retention, resistance to splash from acid and alkaline chemicals, resistance to chemical fumes and severe weathering, and have a minimum solids content of 58 percent by volume. As primer, use a rust inhibitive 2-component epoxy coating with minimum solids content of 66 percent by volume.

1. Prime Coat:

a) DFT = 4-6 mils (100-150 microns).

b) Products: Ameron 385, Carboline 893, Tnemec 69, VyGuard V75, or equal.

2. Finish Coats (one or more):

a) DFT = 2-4 mils (50-100 microns).

b) Products: Ameron 450 GL, Carboline 134 HG, Tnemec 74, VyGuard V54, or equal.

3. Total System = 6-10 mils (150-250 microns).

4. Apply more than one finish coat as necessary to produce a finish with uniform color and texture.

C. System 2 – Inorganic Zinc/Epoxy Polyurethane: For prime coat, use a 2-component water or solvent-based inorganic zinc silicate which contains at least 85 percent of metallic zinc by weight in the dried film, and is recommended by the coating manufacturer as a primer for this system. As intermediate coat, use a high-build, 2-component epoxy with a solids content of at least 70 percent by volume. For finish coats, use a 2-component aliphatic acrylic or polyester polyurethane coating material that provides superior color and gloss retention, resistance to chemical fumes and severe weathering, and a minimum solids content of 58 percent by volume.

1. Prime Coat:

   a) DFT = 2.5-4.0 mils (65-100 microns).

   b) Products: Ameron Dimetcote 21-5 or 21-9, Carbozinc 11 or D7WB, VyGuard 13F6 or 13F7, or equal.

2. Intermediate Coat:

   a) DFT = 4-6 mils (100-150 microns).

   b) Ameron 385, Carboline 893, VyGuard V75, or equal.

3. Finish Coats (one or more):

   a) DFT = 2.5 to 4.0 mils (65-100 microns).

   b) Ameron 450 GL, Carboline 134 HG, VyGuard V54, or equal.

4. Total System DFT = 9-14 mils (225-600 microns).

5. Apply intermediate coat in excess of 4 mils (100 microns) DFT using the mist coat/full coat technique to completely cover the inorganic zinc primer and prevent bubbling of the epoxy or polyurethane finish coat.

6. Apply more than one finish coat as necessary to produce a finish with uniform color and texture.

7. If inorganic zinc primer is used as a pre-construction or shop-applied primer, and there are damaged or uncoated areas, spot blast the damaged area with abrasive to an SSPC-SP 10 Near White Metal Standard and then coat with the specified material.

D. System 3 – Inorganic Zinc: Use a 2-component water-based inorganic zinc silicate which contains at least 85 percent of metallic zinc by weight in the dried film.

1. Prime Coat and Finish Coat (one).

   a) DFT = 2.5 to 4.0 mils (65-100 microns).

   b) Products: Ameron Dimetcote 21-5, Carbozinc D7WB, VyGuard 13F6 or 13F7, or equal.

2. Total System DFT = 2.5 to 4.0 mils (65-100 microns).

E. System 4 – Acrylic Latex: Use a single component, water-based acrylic latex with a fungicide additive having a minimum solids content of 35 percent by volume. Apply a prime coat as recommended by manufacturer. Select coating material, which is available in ANSI safety colors.

1. Prime Coat:

a) DFT = 2-3 mils (50-75 microns).

b) Products: Carboline D3358, Ameron 148, Hemucryl 1803.

2. Finish Coats (2 or more):

a) DFT = 6-8 mils (150-200 microns).

b) Products: Carboline D3359, Ameron 220, Hemucryl 4803, or equal.

3. Total System DFT = 8-11 mils (200-275 microns).

F. System 5 – Epoxy: Use a two-component, rust inhibitive, polyamide-cured epoxy coating material with a recoatable finish that is available in a wide selection of colors. Coating shall have a minimum solids content of 66 percent by volume and shall be resistant to service conditions of condensing moisture, splash and spillage of lubricating oils, and frequent washdown and cleaning.

1. Prime Coat:

a) DFT = 3-5 mils (75-125 microns).

b) Products: Ameron 385PA, Carboline 193, Tnemec 69, VyGuard V75, or equal.

2. Prime Coat (where shop applied):

a) DFT = 3-5 mils (75-125 microns).

b) Products: Ameron 370, Carboline 193, Tnemec 161, VyGuard V75, or equal.

3. Finish Coats (2 or more):

a) DFT = 5- 7 mils (125-175 microns).

b) Products: Ameron 385, Carboline 893, Tnemec 69, VyGuard V75, or equal.

4. Total System DFT = 8-12 mils (200-300 microns).

G. System 6 – Aliphatic Polyurethane, Fiberglass: Use a two-component aliphatic polyurethane coating material with superior color and gloss retention, resistance to splash from acid and alkaline chemicals, and resistance to chemical fumes and severe weathering. Use a primer, tie coat, or mist coat as recommended by the manufacturer.

1. Prime Coat (Tie Coat): Ameron 385, Carboline 893, Tnemec P66, VyGuard V75, or equal.

2. Finish Coats (2 or more):

a) DFT = 2-4 mils (50-75 microns).

b) Products: Ameron Amershield, Carbothane 134 HG, Tnemec 74, VyGuard V54, or equal.

H. Section 7 – Alkyd Enamel: Use a high quality, gloss, or semi-gloss, medium long oil alkyd finish with a minimum solids content of 49 percent by volume. Apply primer as recommended by manufacturer.

1. Prime Coat:

a) DFT = 2-3 mils (50 to 75 microns).

b) Products: Ameron 5105, Carboline AD29, Tnemec P4-55, VyGuard 13R29, or equal.

2. Finish Coats (2 or more):

a) DFT = 2-4 mils (50-75 microns).

b) Products: Ameron 5401HAS, Carboline GP62, Tnemec 2H, VyGuard V20, or equal.

3. Total System DFT = 4-7 mils (100-175 microns).

I. System 8 – Aluminum Metal Isolation: Use one coat of a high-build polyamide epoxy paint.

1. Products: Tnemec P66, Ameron 385, Carboline 893, Tnemec P66, VyGuard V75, or equal.]

2. Total System DFT = 6-8 mils (150-200 microns).

J. System 9 – Aluminum Silicone Resin: Use an aluminum silicone resin material suitable for a service temperature of up to 1000 degrees F (538 degrees C). Coating shall comply with Federal Specification DOD-P-28.

1. Prime Coat and Finish Coat (2 or more):

a) DFT = 2-4 mils (50-100 microns).

b) Products: Tnemec 39-1061, Ameron 878, Carboline 4631, VyGuard V437A1, or equal.

c) Total System DFT = 2-4 mils (50-100 microns).

K. System 10 – Zinc Rich Epoxy: Use a polyamide Epoxy resin material which contains at least 76 percent zinc in the dried film.

1. Prime Coat and Finish Coat (2 or more):

a) DFT = 3-5 mils (75-125 microns).

b) Products: Ameron 68HS, Carboline 858, VyGuard 13F4, or equal.

c) Total System DFT = 3-5 mils (75-125 microns).

2.03 SUBMERGED AND SEVERE SERVICE COATING SYSTEMS

A. Material Sources: The manufacturers listed in this paragraph are materials, which satisfy the material descriptions of this paragraph and have a documented successful record for long-term submerged or sever service conditions. Proposed substitute products will be considered as indicated under paragraphs 2.01.5.

B. System 100 – Amine-Cured Epoxy: Use a high-build amine-cured epoxy with a solids content of at least 80 percent by volume. Coating shall be suitable for long-term immersion in potable water. For potable water service, select a coating material listed in the NSF 61 Standard.

1. Prime Coat and Finish Coats (3 or more):

a) DFT = 16-19 mils (400 to 475 microns).

b) Products: Ameron Amercoat 395, Carboline 891, Tnemec 139, or equal.

2. For coating of valves and non-submerged equipment, DFT = 12-14 mils (300-350 microns).

C. System 101 – Polyamide Cured Epoxy: Use a high-build, polyamide epoxy resin with a solids content of at least 56 percent by volume. Coating shall be suitable for long-term immersion in potable water. For potable water service, select a coating material listed under NSF 61 Standard.

1. Prime Coat and Finish Coats (3 or more):

a) DFT = 12-14 mils (300-350 microns).

b) Products: Tnemec 20, VyGuard 78PR, or equal.

D. System 102 – Coal Tar Epoxy: Use a high-build 2-component amine or polyamide-cured coal tar epoxy with a solids content of at least 68 percent by volume. Coating shall be suitable for long-term immersion in wastewater and for coating of buried surfaces. Coating shall conform to Mil Spec DOD-P-23236, or to SSPC Paint 16. Prime coats are for use as a shop primer only. Omit prime coat when both surface preparation and coating are performed in the field.

1. Prime Coat: DFT = 1.5-2.5 mils (38-65 microns).

a) Products: Ameron Amercoat 83HS, Tnemec P66, VyGuard V75, or equal.

2. Finish Coats (2 or more):

a) DFT = 14-18 mils (350-450 microns).

b) Products: Ameron 78HB, Carbomastic 14, Tnemec 46H413, VyGuard 64, or equal.

c) Total System DFT = 15.5-20.5 mils (387-513 microns).

E. System 103 – Fusion Bonded Epoxy: Use a 100 percent powder epoxy applied in accordance with ANSI/AWWA C213, except that surface preparation shall be as specified in the coating system schedule of this Section. Apply the coating using the fluidized bed process.

1. Liquid Epoxy: For field repairs, use a 100 percent solids liquid epoxy as recommended by the powder epoxy manufacturer to provide a DFT of 15-17 mils (375-425 microns).

2. Powder Coating:

   a) DFT = 15-17 mils (375-425 microns).

   b) Products: Scotchkote 134 or 206N, Napgard 7-0008 or 7-2500, or equal.

   c) Total System DFT = 15-17 mils (375-425 microns).

   d) For coating of valves, DFT =11-12 mils (275-300 microns).

F. System 104 – Chemical Resistant Sheet Lining:

1. Materials: Use natural rubber, chlorobutyl rubber, ethylene propylene diene monomer (EPDM) rubber, chloroprene polymer (neoprene) rubber, or chlorosulfonated polyethylene (Hypalon) rubber sheet lining material. Submit shop drawings containing technical information that confirms the suitability of the lining material system for long-term immersion in each chemical to be stored. Service temperatures are expected to be up to 150 degrees F (65 degrees C).

   a) Neoprene Sheet Lining Material: Use a synthetic rubber formulated for steam curing at atmospheric pressure. Provide a minimum lining thickness of 3/16 inch. Supply B.F. Goodrich compound 59688, or equal.

   b) Chlorobutyl Sheet Lining Material: Use a synthetic rubber formulated for steam curing at atmospheric pressure. Supply B.F. Goodrich compound 60924, or equal.

   c) Natural Rubber (soft) Sheet Lining Material: Use a soft natural rubber formulated for steam curing at thickness at atmospheric pressure. Provide a minimum lining thickness of 3/16 inch. Supply B.F. Goodrich compound 83160, or equal.

   d) Natural Rubber (hard) Sheet Lining Material: Use a hard, natural rubber resistant to oxidizing agents and formulated for autoclave curing. Provide a minimum lining thickness of 3/16 inch. Supply B.F. Goodrich compound 8631, or equal.

   e) EPDM Sheet Lining Material: Use synthetic rubber suitable for use as a lining for 50 percent sulphuric acid solution and formulated for autoclave or steam curing under pressure.

   f) Hypalon Sheet Lining Material: Use synthetic rubber suitable for use as a lining for 50 percent sulfuric acid solution.

2. Primers: Use primers, adhesives, activators, accelerators, and other necessary materials as recommended by the sheet material manufacturer.

3. Metal Surface Preparation: Prior to abrasive blast cleaning, prepare the base metal as required by the sheet lining material manufacturer's installation instructions. If the instructions differ from these specifications, provide the highest degree of cleaning and surface preparation required by either instructions or specifications. Perform abrasive blast cleaning in accordance with this section.

4. Installation: Install lining materials in accordance with the material manufacturer's written installation instructions. Line interior surfaces including piping, vents, fittings, flange faces, manhole covers, and blind flanges.

5. Testing: Test the lining system for holidays in accordance with this Section before and after curing.

6. Curing: Cure the lining system by steam using the time and temperature as required by the material manufacturer.

G. System 105 – Vinyl Ester: Use vinyl ester resin coating material with an inert flake pigment. Coating shall be suitable for immersion service in 30 percent hydrochloric acid and 30 percent sulfuric acid solutions.

1. Coating (2 or more coats):

a) DFT = 40-45 mils (1000-1125 microns).

b) Products: Plasite 4100, or equal.

c) Prime Coat: As recommended by the material manufacturer.

H. System 106 – 100% Solids Epoxy: Use a solventless epoxy resin coating suitable for severe service areas subject to splash, spillage or intermittent immersion in wide range of industrial chemicals, and wastewater run-off. Coating shall be able to resist normal abrasion from rolling vehicles.

1. Coating (2 or more coats):

a) DFT = 15-20 mils (325-500 microns).

b) Products: Ameron, Carboline.

c) Prime Coat: As recommended by manufacturer.

I. System 107 – 100% solids Epoxy Sealer: Use a clear, unpigmented solventless epoxy suitable for application over marginal surfaces including damp surfaces, tight rust and tight old coatings. Coating shall be able to serve as primer for alkyd, acrylic, epoxy, and polyurethane finish coats.

1. Coating (1 coat only):

a) DFT = 1-2 mils (25-50 microns).

b) Products: ICI/Devoe 167 PrePrime, Carboline Rust Bond, or equal.

J. System 108 - 100% Solids, Isocyanate-Free, Solvent-Free, High Build Epoxy Coating for Wastewater applications only, to be spray applied in one or more coats to all interior surfaces of exposed concrete above the spring line or as otherwise detailed.

1. Product Characteristics:

a. Product: 100% solids, solvent-free high-build epoxy system

b. Product Type: amine cured epoxy

c. VOC Content (ASTM D3960): 0%

d. Compressive Strength, psi (ASTM D695): 10,500 (minimum)

e. Tensile Strength, psi (ASTM D638): 4,500 (minimum)

f. Flexural Strength, psi (ASTM D790): 7,500 (minimum)

g. Adhesion to Concrete, psi/mode of failure (ASTM D7234): 350 psi (minimum)/with substrate (concrete) failure

h. Chemical Resistance, pH$\geq$0.5 (ASTM G20): 60% Sulfuric Acid

2. In all cases the coating product(s) shall be applied to a minimum dry film thickness of 80 mils to surface profiles of CSP-4 to CSP-5 or 125 mils minimum DFT to surface profiles of CSP-6 or greater.

3. When the wall of the liner is to be structurally designed to withstand the hydraulic load generated by the groundwater table the long term (50yr) value of the flexural modulus of elasticity will be utilized to calculate the thickness of the structural line. The initial flexural modulus of elasticity (short term) of the submitted resin material will be utilized with the long term deformation percentage as determined by ASTM D2990 in the design equation outlined in ASTM 1216-09, Appendix XI. The value of the long term flexural modulus of the proposed product will be certified by an independent, certified, third party testing lab, independent of the

Manufacturer. [The definition of long term value will be identified as initial flexural modulus of elasticity less the reduction in value caused by Creep over a fifty (50) year minimum period and verified by third party testing (ASTM D2990).]

4. Subsequent top-coating or additional coats of the coating product(s) shall occur within the product recoat window or 24 hours whichever is less. Additional surface preparation procedures will be required if this recoat window is exceeded.

K. System 109 - 100% Solids, Solvent-Free, Multi-Layered Polymer Lining System (Polyurea and Polyurethane) for Wastewater applications only, to be spray applied in three layers to all interior surfaces of exposed concrete above the spring line or as otherwise detailed.

1. Product Characteristics:

a. Product: 100% solids, solvent-free, polyuria (two layers) and polyurethane (one layer) system

b. Product Type: Self-curing polymer lining

c. VOC Content (ASTM D3960): 0%

d. Tensile Strength, psi (ASTM D412): 2,400 (minimum)

e. . Elongation % (ASTM D412): 200 (minimum)

f. Tear Strength, pli (ASTM D624): 300 (minimum)

g. Shore D Hardness, (ASTM 2240): 45 (minimum)

h. Adhesion to Concrete, psi/mode of failure (ASTM D7234): 350 psi (minimum)/with substrate (concrete) failure

i. Chemical Resistance, pH$\geq$0.5 (ASTM G20): 30% Sulfuric Acid

2. In all cases the coating product(s) shall be applied to a minimum thickness of 500 mils total.

3. For resistance to ground water head pressure the coating shall be a minimum of 500 mils thick for depths up to 32 feet. For depths greater than 32 feet consult the coating manufacturer for recommendations.

4. Subsequent top-coating or additional coats of the coating product(s) shall occur within the product recoat window or 24 hours whichever is less. Additional surface preparation procedures will be required if this recoat window is exceeded.

L. System 110 – 100% Solids, High Build Polyurethane Coating for Wastewater applications, to be spray applied in one or more coats to all interior surfaces of exposed concrete above the spring line or as otherwise detailed.

1. Product Characteristics:

a. Product: 100% solids, high-build polyurethane system

b. Product Type: Catalyzed, two component, polyurethane

c. VOC Content (ASTM D3960): 0%

d. Compressive Strength, psi (ASTM D695): 18,000 (minimum)

e. Tensile Strength, psi (ASTM D638): 7,450 (minimum)

f. Flexural Strength, psi (ASTM D790): 14,000 (minimum)

g. Flexural Modulus, psi (ASTM D790): 735,000 (minimum)

i. Adhesion to Concrete, psi/mode of failure (ASTM D7234): 200 psi (minimum) with substrate (concrete) failure

j. Chemical Resistance, pH 0.5 (ASTM G20): 20% Sulfuric Acid

2. In all cases the coating product(s) shall be applied to a minimum dry film thickness of 80 mils to surface profiles of CSP-4 to CSP-5 or 125 mils minimum DFT or surface profiles of CSP-6 or greater.

3. When the wall of the resin based liner is to be structurally designed to withstand the hydraulic load generated by the groundwater table the long term (50yr) value of the flexural modulus of elasticity will be utilized to calculate the thickness of the structural line. The initial flexural modulus of elasticity (short term) of the submitted resin material will be utilized with the long term deformation percentage as determined by ASTM D2990 in the design equation outlined in ASTM 1216-09, Appendix XI. The value of the long term flexural modulus of the proposed product will be certified by an independent, certified, third party testing lab, independent of the Manufacturer. [The definition of long term value will be identified as initial flexural modulus of elasticity less the reduction in value caused by *Creep over a fifty (50) year minimum period and verified by third party testing (ASTM D2990).*]

4. Polyurethane product characteristics allow high build thicknesses to be achieved in one application without additional surface preparation. However, if installation requires applications outside of the recoat window, additional surface preparation may be necessary by using a primer or abrading the previously coating surface area.

PART 3 E X E C U T I O N

3.01 MANUFACTURER'S SERVICES

A. Require the protective coating manufacturer to furnish a qualified technical representative to visit the project site for technical support as may be necessary to resolve field problems attributable to or associated with manufacturer's products.

B. For submerged and severe service coating systems, require the paint manufacturer to furnish the following services:

1. At least 6 hours of on-site instruction on the proper surface preparation, use, mixing, application, and curing of the coating systems.

2. Observe the start of surface preparation, mixing, and application and curing of the coating systems.

3. Require the services of a NACE Certified Coating Inspector at all times during the surface preparation, mixing, application, curing and testing of all coatings applied in submerged or acid spill areas.

3.02 WORKMANSHIP

A. Use skilled craftsmen and experienced supervision. For all jobs involving lead based paint removal or repair, require the presence of a certified Competent Person, Lead per OSHA requirements.

B. Apply coating to produce an even film of uniform thickness. Give special attention to edges, corners, crevices, and joints. Ensure thorough cleaning and an adequate thickness of coating material. Apply coatings to produce finished surfaces free from runs, drips, ridges, waves, laps, brush marks, and variations in color, texture and finish. Effect complete hiding so that the addition of another coat would not increase the hiding. Give special attention to ensure that edges, corners, crevices, welds, and similar areas receive a film thickness equivalent to adjacent areas. Apply a brushed stripe coat to all edges and welds after priming submerged or severe service areas.

C. Remove, mask or otherwise protect hardware, lighting fixtures, switch plates, machined surfaces, couplings, shafts, bearings, name plates on machinery, and other surfaces not to be painted. Provide drop cloths to prevent coating materials from falling on or marring adjacent surfaces. Protect the working parts of mechanical and electrical equipment from damage during surface preparation and coating operations. Mask openings in motors to prevent entry of coating or other materials.

D. Do not damage adjacent work during blast cleaning operations. Conduct spray painting under carefully controlled conditions. Promptly repair any damage to adjacent work or adjoining property occurring from blast cleaning or coating operations.

E. Coordinate cleaning and coating so that dust and other contaminants from the cleaning process will not fall on wet, newly-coated surfaces.

3.03 SURFACE PREPARATION STANDARDS

A. The following referenced surface preparation standards of the Society for Protective Coatings (SSPC) form a part of this Specification:

1. Solvent Cleaning (SSPC-SP1): Removal of oil, grease, soil, drawing and cutting compounds, and other soluble contaminants from steel surfaces by cleaning with solvent, vapor degreasing, emulsion or alkaline cleaners, or steam.

2. Hand Tool Cleaning (SSPC-SP2): Removal of all loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter by hand chipping, scraping, sanding, and wire brushing.

3. Power Tool Cleaning (SSPC-SP3): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by rotary or impact power tools, power wire brushing, or power abrading.

4. White Metal Blast Cleaning (SSPC-SP5/NACE 1): Removal of all visible oil, grease, soil, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter by blast cleaning.

5. Commercial Blast Cleaning (SSPC-SP6/NACE 3): Removal of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter, except that random staining shall be limited to no more than 33 percent of each unit area of surface.

6. Brush-Off Blast Cleaning (SSPC-SP7/NACE 4): Removal of all visible oil, grease, dirt, dust, loose mill scale, loose rust, and loose coating, all of which shall be considered tightly adherent if they cannot be removed by lifting with a dull putty knife.

7. Near-white Blast Cleaning (SSPC-SP10/NACE 1): Removal of all visible oil, grease, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter, except that random staining shall be limited to no more than 5 percent of each unit area of surface.

3.04 METAL SURFACE PREPARATION (UNGALVANIZED)

A. Provide the minimum abrasive-blasted surface preparation as indicated in the coating system schedules at the end of this Section. Where there is a conflict between these specifications and the coatings manufacturer's printed recommendations for the intended service, the higher degree of cleaning applies.

B. Perform metal surface preparation in conformance with the current SSPC/NACE Standards and this Section. Blast cleaned surfaces must match standard samples in SSPC-VIZ 1.

C. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning using solving cleaning as per SSPC-SP1.

D. Have sharp edges rounded or chamfered and burrs, surface defects, and welded splatter ground smooth prior to blast cleaning.

E. Select the type and size of abrasive to produce a surface profile that meets the coating manufacturer's recommendation for the particular coating and service conditions. As abrasives for submerged and severe service coating systems use clean, hard, sharp cutting crushed slag. Do not use automated blasting systems and metal shot or grit for surfaces that will be in submerged service, even if subsequent abrasive blasting is planned with hard, sharp-cutting slag.

F. Do not reuse abrasive except when an automated blasting system is used for surfaces that will be in non-submerged service. For automated blasting systems, use clean, oil-free abrasives. In the abrasive mix use at least 50 percent steel grit. Replenish abrasive mix with new shot/grit combination as necessary to maintain the anchor profile within ½ mil (13 microns) of the specified profile.

G. Comply with the applicable federal, state, and local air pollution control regulations for blast cleaning.

H. For air-blast cleaning, supply compressed air at adequate pressure from well-maintained compressors equipped with oil and moisture separators which delivers oil and water-free air as checked with white blotter, white cloth, or plastic sheets at the beginning of each blasting sequence.

I. Clean surfaces of dust and residual particles of the cleaning operation using dry air-blast cleaning, vacuuming, or another approved method prior to painting. Vacuuming must be the

final cleaning method immediately prior to painting areas that will go into submerged service.

J. In enclosed areas and other areas where dust may settle, vacuum the surface clean and wipe it with a tack cloth.

K. Remove damaged or defective coating by the specified blast or power tool cleaning to meet the clean surface requirements before recoating.

L. If the specified abrasive blast cleaning will damage adjacent work, the area to be cleaned is less than 100 square feet, and the coated surface will not be in submerged service, then SSPC-SP2 – Hand Tool Cleaning or SSPC-SP3 – Power Tool Cleaning, may be used. If the coated area to be cleaned is less than 100 square feet, and will be in submerged service, then SSPC-SP11 Power Tool Cleaning to Bare Metal may be used.

M. Completely remove shop-applied coatings of unknown composition before the specified coatings are applied. Examine valves, castings, ductile or cast iron pipe, and fabricated pipe or equipment for the presence of shop-applied temporary coatings. Completely remove temporary coatings by solvent cleaning per SSPC-SP1 method before starting abrasive blast cleaning. Alternate cleaning methods such as Baking Soda Blasting or Sponge Jet Blasting may be used as appropriate.

N. Use the solvent cleaning method (SSPC-SP1) to clean shop-primed equipment in the field before finish coats are applied.

3.05 SURFACE PREPARATION FOR GALVANIZED FERROUS METAL

A. For galvanized ferrous metal use the alkaline cleaning method per SSPC-SP1 to remove oil, grease, and other contaminants detrimental to adhesion of protective coatings. Alternate methods with biodegradable surfactant type cleaners followed by fresh water washing may be used as appropriate.

B. Apply pretreatment coatings of surfaces in accordance with the printed recommendations of the coating manufacturer.

3.06 SURFACE PREPARATION OF FERROUS SURFACES WITH EXISTING COATINGS

A. Preparatory Cleaning: Remove grease, oil, heavy chalk, dirt, or other contaminants by solvent or detergent cleaning prior to abrasive blast cleaning. Determine the generic type of the existing coatings by laboratory testing.

B. Abrasive Blast Cleaning: Provide the degree of cleaning specified in the coating system schedule for the entire surface to be coated. If the degree of cleaning is not indicated in the schedule, remove deteriorated coatings by abrasive blast cleaning to meet the requirements of SSPC-SP6 Commercial Blast Cleaning. Clean areas of tightly adhering coatings to meet the requirements of SSPC-SP7 Brush-Off Blast Cleaning, with the remaining thickness of pre-existing coating not to exceed 3 mils.

C. Incompatible Coatings: If coatings to be applied are not compatible with existing coatings, apply intermediate coatings conforming to the paint manufacturer's recommendation for the indicated coating system or completely remove the existing coating prior to abrasive blast cleaning. Make a small trial application for compatibility prior to painting large areas. Allow the trial application to cure for 7 days at 50 degrees F (10 degrees C) or higher before determining compatibility.

D. Unknown Coatings: Completely remove coatings of unknown composition prior to application of new coatings.

E. Water Jetting or Wet-abrasive Blast Cleaning: Where specified or where job site conditions do not permit dry-abrasive blasting for industrial coating systems due to dust or air pollution considerations, water jetting or wet-abrasive blasting may be used. In both methods, use inhibitors approved by the manufacturer of the coating system, which will be applied over the cleaned area. Begin the coating application as soon as the surface has dried, and before the formation of any flash rusting. Perform water jetting with or without abrasive injection, as appropriate to achieve the specified degree of surface cleanliness. Do not use water-jetting methods for submerged or severe-service coating systems, unless specified for that area.

3.07 PLASTIC, FIBERGLASS, AND NONFERROUS METALS SURFACE PREPARATION

A. Unless otherwise indicated, for equipment, or parts of equipment which are not submerged in service, shop-prime them, and then finish-coat them in the field after installation. For methods, materials, application equipment, and other details of shop painting, comply with this Section. If the shop primer requires topcoating within a specified period of time, apply the finish coating in the shop and then touch-up the paint after installation.

B. Perform surface preparation and coating work in the field for equipment, or parts and surfaces of equipment which are submerged or inside an enclosed hydraulic structure when in service, with the exception of pumps and valves.

C. For certain pieces of equipment, it may be undesirable or impractical to apply finish coatings in the field. Such equipment may include engine generator sets, equipment such as electrical control panels, switch gear or main control boards, submerged parts of pumps, ferrous metal passages in valves, or other items where it is not possible to obtain the required quality in the field. For such equipment, prime and finish-coat in the shop and touch-up in the field after installation. Use the identical material for touch-up that was used for shop painting. Require the manufacturer of each such piece of equipment to certify as part of its shop drawings that the surface preparation is in accordance with these specifications. Submit the coating material product data sheet with the shop drawings for the equipment.

D. For certain small pieces of equipment, the manufacturer may have a standard coating system, which is suitable for the intended service conditions. In such cases, the final determination of suitability will be made during review of the shop drawing submittals. Equipment of this type generally includes only indoor equipment such as instruments, small compressors, and chemical metering pumps.

E. Protect shop-painted surface during shipment and handling. Protect surfaces with padding or blocking. Lift equipment with canvas or nylon slings. Do not expose primed surface to the weather for more than 2 months before being topcoated, or less time if recommended by the coating manufacturer.

F. Repair damage to shop-applied coatings in accordance with this Section and the coating manufacturer's printed instructions.

G. Make certain that the shop primers and field topcoats are compatible and meet the requirements of this Section. Submit copies of applicable coating manufacturer's product data sheets with equipment shop drawings.

3.08 APPLICATION OF COATINGS

A. Apply protective coatings to steel substrates in accordance with SSPC-PA1 – Paint Application Specification No. 1. Shop, Field and Maintenance Painting.

B. Inspect cleaned surfaces and each coat prior to succeeding coats. Schedule inspections with the Project Manager in advance.

C. Paint blast-cleaned ferrous metal surfaces before rusting or other deterioration of the surface occurs. Limit blast cleaning to only those surfaces that can be coated in the same working day unless the area to be coated is protected by humidity control equipment set to maintain humidity below 50 percent at all times.

D. Apply coatings in accordance with the manufacturer's instructions and this Section, whichever has the most stringent requirements.

E. Give special attention to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thickness is likely to occur. Use stripe painting by brush, after application of the primer, for these areas.

F. Give special attention to materials, which will be joined so closely that proper surface preparation and application are not possible. Coat such contact surface prior to assembly or installation. Only inorganic zinc primers may be used on faying surfaces.

G. Apply finish coats, including touch-up and damage repair coats, in a manner, which will present uniform texture and color-matched appearance.

H. Do not apply coatings under the following conditions:

1. Temperature outside of the manufacturer's recommended minimum and maximum range.

2. Dust or smoke laden atmosphere.

3. When the substrate or air temperature is less than 5 degrees F (3 degrees C) above the due point.

4. When air temperature is expected to drop below 40 degrees F (14 degrees C) or less than 5 degrees F (3 degrees C) above the dew point within 8 hours after application of the coating.

5. When wind conditions are in excess of 15 MPH or dust laden.

I. Determine the dew point by use of a sling psychrometer in conjunction with the U.S. Department of Commerce, Weather Bureau psychometric tables.

J. For steel piping which will not be buried, have the surface abrasive blast cleaned and primed before installation.

K. Apply finish coats after concrete, masonry, and equipment installation is complete and the work areas are clean and dust free. Concrete must have cured for a minimum of 28 days @ 75 degrees F (24 degrees C) unless an approved epoxy sealer has been applied to green concrete within 12 hours of finishing the concrete.

3.09 CURING OF COATINGS

A. Maintain curing conditions in accordance with the recommendations of the coating material manufacturer and this Section, whichever is the most stringent. Complete curing before placing the coating systems into service.

B. In the case of enclosed areas, forced air ventilation using heated air may be required until the coatings have fully cured.

C. Forced Air Ventilation of Enclosed Hydraulic Structures: Forced air ventilation is required for the application and curing of coatings on the interior surfaces of enclosed hydraulic structures. During application and curing periods, continuously exhaust air from the lowest level of the structure using portable ducting to force air into all compartments or around baffles of the structure. After interior coating operations have been completed, provide a final curing period that meets the minimum temperature and time requirements of the manufacturer of the coating system being applied, while operating the forced air ventilation system continuously.

3.10 SHOP AND FIELD INSPECTION AND TESTING

A. Give the City Engineer a minimum of 3 days advance notice of the start of any field surface preparation work or coating application work, and a minimum of 7 days advance notice of the start of any shop surface preparation work.

B. Perform surface preparation and coating applications in the presence of the Project Manager, or his appointed NACE certified coating inspector, unless the City Engineer has granted prior approval to perform the work in their absence.

C. Inspection by the Project Manager or the NACE certified inspector, or the waiver of inspection of any particular portion of the work, does not relieve the Contractor of his responsibility to perform the Work in accordance with these Specifications.

D. Erect and move scaffolding where requested by the Project Manager to facilitate inspection. Provide additional illumination to light areas to be inspected. Remove or grind smooth all scaffolding clips welded to the structure prior to surface preparation of the structure.

E. Until final acceptance of the coatings, furnish inspection devices in good working condition for the detection of holidays and measurement of dry-film thickness (DFT) of protective coatings. Make DFT gauges available for the Project Manager’s use while coating is being done, until final acceptance of such coatings. Provide the services of a NACE certified coating inspector for all holiday detection work until the final acceptance of such coatings. Operate holiday inspection devices in the presence of the Project Manager.

F. Perform holiday tests on coated ferrous surfaces inside a steel reservoir, other surfaces that will be submerged in water or other liquids, or surfaces which are enclosed in a vapor space in such structures. Holiday tests shall be performed on surfaces coated with any of the submerged and severe service coating systems. Mark and repair or recoat areas which contain holidays in accordance with the coating manufacturer’s printed instructions and then retest. DO NOT PERFORM HOLIDAY TESTING AFTER STRUCTURE HAS BEEN SUBMERGED.

1. Coatings with Thickness Exceeding 20 mils (500 microns): For surfaces having a total DFT exceeding 20 mils (500 microns); use a pulse-type holiday Detector such as Elcometer 136, or equal. Adjust and operate in accordance with NACE RPO 188.

2. Coatings with Thickness of 20 mils (500 microns) or Less: For surfaces having a total DFT of 20 mils or less, use Elcometer 269 non-destructive type holiday detector, or equal. Instrument must operate at less than 75 volts. For thicknesses between 10 and 20 mils (250 and 500 microns) and a non-sudsing type wetting agent such as Kodak Photo-Flo, or equal may be added to the water prior to wetting the detector sponge. For submerges or severe service areas, the residue of the wetting agent must be removed with clean, fresh water prior to application of any additional coats of coating.

G. Film Thickness Testing: On ferrous metals, measure the DFT in accordance with SSPC-PA2 Measurement of Dry Film Thickness with magnetic gauges using either a pull-off type gauge (Elcometer 211) or constant pressure gauge (Elcometer 345F), or equal. Test each coat for the correct thickness. Calibrate the DFT gauge at the beginning of each workday or shift in accordance with the directions of the manufacturer of the gauge. Do not take measurements until at least 8 hours after coating application. On non-ferrous metals, measure the DFT with positive pressure eddy current gages (Elcometer 345N) or equal.

I. Surface Preparation: Evaluation of blast-cleaned surface preparation work will be based upon comparison with photographic samples contained in SSPC-VIZ 1. Evaluation of surface profile will be based upon the use of TesTex pressure sensitive tapes.

3.11 PAINTING AND IDENTIFICATION OF PIPING

A. Painting and Color Coding:

1. Use colors and signs to identify all piping which is exposed to view in buildings or tunnels, above suspended ceilings or exposed above grade, and all outdoor piping. Identify each pipe by a color complying with the following schedule of colors and by applied markers.

2. Coat pipes in the number of coats and type of material specified. Base coats for pipeline painting may be a neutral color. Make each succeeding base coat a contrasting color. For the final coat, comply with the pipe identifying color schedule.

3. Apply pipe identification markers to exposed piping, except for the following pipe at wastewater lift stations:

   a. Discharge piping for wastewater pumps.

   b. Vent piping.

c. Any piping inside wet wells.

B. Pipe Identification Markers:

1. Identify all pipes with applied signs or markers at 15-foot centers, at both sides of penetrated walls or floors, adjacent to valves, at connected equipment, at branch fittings, and in congested pipe layouts.

a. Apply markers consisting of signs with legends as follows:

OUTSIDE DIAMETER OF PIPE OR COVERING (INCHES)	LENGTH OF COLOR FIELD (INCHES)	SIZE OF LETTERS (INCHES)
3/4 to 1- 1/4	8	1/2
1- 1/2 to 2- 3/8	8	3/4
2- 1/2 to 5- 7/8	12	1- 1/4
6 to 7- 7/8	12	1- 1/4
8 to 10	24	2- 1/2
Over 10	32	3- 1/2

b. As pipe markers use semi-rigid outdoor grade acrylic plastic, Seton Name Plate Corp. SetMark, or equal. Use Type SNA for outside diameters 3/4 through 5- 7/8 inches and Type STR for 6-inch outside diameter or larger. For pipes or pipe covering less than 3/4-inch in diameter, use applied marker of brass identification tags 1-1/2 inches square with depressed letters 1/4-inch high, black-filled. Apply tightly to pipeline with metal or plastic straps.

C. Pipe Identification Color Schedule:

1. For pipe coatings, use the colors listed in the following pipe identification color schedule for facilities:

PIPE IDENTIFICATION COLOR SCHEDULE

PIPING SYSTEM	COLOR	FED. STD. NO.
Fire Mains	Red	11105
Oxygen	Orange	12246
Sodium Hypochlorite	Yellow	13655
Raw Polymer	Pink	11156
Diluted Polymer	Purple	17142
Natural Gas	Yellow	13655
Heating Water	Pink	11158
Domestic Hot	Lt. Pink	11668
Potable Water	Blue	15102

Non-Potable Water	White	17875
Instrument Air	Green	14187
Plant Air	Dk. Green	14110
Raw Sewage	Gray	16473
Grit	Dk. Gray	16187
Cyclone Return	Gray	16473
Classifier Return	Gray	16473
PIPING SYSTEM	**COLOR**	**FED. STD. NO.**
Heavy Solids	Dk. Brown	10080
Return Sludge	Brown	10091
Waste Sludge	Yellow-Brown	10266
Scum	Lt. Brown	10334
Chilled Water Supply (CWS)	Blue-Green	14329
Chilled Water Return (CWR)	Blue-Green	14325
Condensing Water Supply (Cond-WS)	Lt. Green	14533
Condensing Water Return (Cond-WR)	Lt. Green	14533
Deionized Water (DW)	Lt. Blue	15526
Vacuum (Vac)	White	17875
Vent	Lt. Gray	16492

2. Use colors for the applied signs and markers in accordance with the color schedule, except for brass identification tags, which are colored as indicated in paragraph 3.14.2.2.
3. For final colors used for pipe identification conforming to Federal Std.595A.

    a. For pipe identification colors not listed above, follow American National Standard (ANSI A13.1-81) Color Schedule:

        1. Materials inherently hazardous, flammable or explosive; chemically active or toxic; extreme temperature or pressure; radioactive: Yellow Field with Black Letters.

        2. Material of inherently low hazard – liquid or liquid admixture: Green Field with White Letters; gas or gaseous admixture: Blue Field with White Letters.

        3. Fire quenching materials, water, foam, carbon dioxide, Halon, etc.: Red Field with White Letters.

3.12 COATING SYSTEM SCHEDULES – FERROUS METALS

A. Coating System Scheduled, Ferrous Metal – Not Galvanized

SCHEDULE NO. AND APPLICATION	SURFACE PREPARATION	SYSTEM NO./ DESCRIPTION
FM-1: Surfaces indoors and outdoors, exposed or covered, except those listed below.	Near White Metal blast cleaning SSPC-SP10/NACE 2	(2) Inorganic zinc/epoxy/ polyurethane
FM-2: Surfaces in chlorination room, chlorine storage room, sodium hypochlorite storage room	Near White Metal blast cleaning SSPC-SP10/NACE 2	(100) Amine-cured epoxy
FM-3: Surfaces of pumps and equipment & other ferrous surfaces submerged or intermittently submerged in potable water, utility water, and wastewater, including surfaces lower than 2 feet above high-water level in hydraulic structures, and surfaces inside enclosed hydraulic structures, pump state wet wells, and vents (excluding shop-coated valves, couplings, and pumps).	White Metal Blast Cleaning SSPC-SP5/ NACE 1	(100) Amine-cured epoxy
FM-4: Surfaces exposed to high temperature between 150 and 600 degrees F (65 and 315 degrees C).	Near White Metal blast cleaning SSPC-SP10/NACE 2	(3) Inorganic Zinc, water-based
FM-5: Surfaces exposed to high temperature between 600 and 1000 degrees F.	Near White Metal blast cleaning SSPC-SP10/NACE 2	(9) Aluminum silicon resin
FM-6: Where indicated, ferrous surfaces in water passages of valves 4-inch size and larger, exterior surfaces of submerged valves.	White Metal Blast Cleaning SSPC-SP5/ NACE 1	(101) Polyamide-cured epoxy
FM-7: Where indicated, ferrous surfaces in water passages of pumps which have discharge size of 4 inches or larger; exterior, submerged surfaces of pumps.	White Metal Blast Cleaning SSPC-SP5/ NACE 1	(101) Polyamide-cured epoxy
FM-8: Ferrous surfaces of sleeve couplings.	White Metal Blast Cleaning SSPC-SP5/ NACE 1	(103) Fusion-bonded epoxy
FM-9: Ferrous surfaces of sluice gates, flap gates, and shear gates, including wall thimbles.	White Metal Blast Cleaning SSPC-SP5/ NACE 1	(101) Polyamide-cured epoxy
FM-10: Structural steel, miscellaneous metal work, and supports for prefabricated metal buildings, not exposed to view in finished building.	Commercial Blast Cleaning (SSPC-SP6/NACE 3	(10) Zinc Rich Epoxy

FM-12: Ferrous metal exposed to view, inside and outside of buildings.	Near White Metal blast cleaning SSPC-SP10/NACE 2	(2) Inorganic zinc/ epoxy/polyurethane
FM-13: Surfaces of indoor equipment, not submerged.	Commercial Blast Cleaning SSPC-SP6/ NACE 3	(5) Epoxy, equipment
FM14: Exterior (exposed) surfaces shop-coated with fusion-bonded epoxy.	Light abrasive blast to roughen surface	(6) Aliphatic polyurethane

B. Coating System Schedule, Ferrous Metal – Galvanized: Apply pretreatment coatings, barrier coatings, or washes as recommended by the coating manufacturer.

SCHEDULE NO. AND APPLICATION	SURFACE PREPARATION	SYSTEM NO./ DESCRIPTON
FMG-1: Exposed surfaces indoors and outdoors, except those listed below.	Alkaline cleaning SSPC-SP1	(1) or (4) Aliphatic Polyurethane, or Acrylic
FMG-2: Surfaces in chlorination room, chlorine storage room, and sodium hypochlorite storage room.	Alkaline Cleaning SSPC-SP1	(100) Amine-cured epoxy
FMG-3: Surfaces submerged in water or wastewater, including surfaces lower than 2 feet above high-water level and surfaces inside hydraulic structures and vents	Alkaline cleaning SSPC-SP1 followed by Brush-Off blast cleaning SSPC-SP7/ NACE 4	(100) Amine-cured epoxy
FMG-4: Surface exposed to view, inside and outside of building.	Alkaline Cleaning SSPC-SP1	(1) or (4) Aliphatic polyurethane, or Acrylic

C. Coating System Schedule, Interior Surface of Welded Steel Tanks: Coat interior surfaces, including tank nozzles, manholes, nozzle necks, and flange faces. For steel tank exterior coating systems, see paragraph 3.15.1, Coating System Schedule, Ferrous Metal – Not Galvanized.

PRODUCT STORED	SURFACE PREPARATION	SYSTEM NO. /DESCRIPTION
Zinc Orthophosphate	White metal blast cleaning SSPC-SP5/NACE1	(104) Natural rubber (soft) or neoprene
Liquid Alum	White metal blast cleaning SSPC-SP5/NACE1	(104) Natural rubber (soft) or neoprene
Polymer	White metal blast cleaning SSPC-SP5/NACE1	(104) Natural rubber (soft) or neoprene
Sodium Bisulfite	White metal blast cleaning SSPC-SP5/NACE1	(104) Natural rubber (soft) or neoprene
Ferric Chloride	White metal blast cleaning SSPC-SP5/NACE1	(104) Natural rubber (hard)
Aqueous Ammonia	White metal blast cleaning SSPC-SP5/NACE1	(104) Chlorobutyl rubber
Caustic Soda	Commercial Blast Cleaning SSPC-SP6/NACE 3	No Coating
Sodium Hypochlorite	White metal blast cleaning SSPC-SP5/NACE1	(104) Chlorobutyl Rubber
Sulfuric Acid (max. 45% concentration)	White metal blast cleaning SSPC-SP5/NACE1	(107) Hypalon
Sulfuric Acid (above 40% concentration)	White metal blast cleaning SSPC-SP5/NACE1	(107) Viton
Hydrofluosilicic Acid	White metal blast cleaning SSPC-SP5/NACE1	(107) Chlorobutyl Rubber
Water, Potable Water, Utility Water	White metal blast cleaning SSPC-SP5/NACE1	(100) Amine-Cured Epoxy

3.13 COATING SYSTEM SCHEDULES, NONFERROUS METAL, PLASTIC, FIBERGLASS

A. Where isolated non-ferrous parts are associated with equipment or piping, use the coating system for the adjacent connected surfaces. Do not coat handrails, gratings, frames, or hatches. Use primers recommended by coating manufacturer.

SCHEDULE NO. AND APPLICATIONS	SURFACE PREPARATION	SYSTEM NO./ DESCRIPTION
NFM-1: Exposed surfaces, indoors and outdoors, except those listed below.	Solvent cleaned SSPC-SP1	(1) Aliphatic Polyurethane
NFM-2: Chlorination room, chlorine storage room, sodium hypochlorite storage room.	Solvent cleaned SSPC-SP1	(100) Amine-Cured Epoxy
NFM-3: Aluminum surfaces in contact with concrete, or with any other metal except galvanized ferrous metal.	Solvent cleaned SSPC-SP1	(8) Aluminum Metal Isolation
NFM-4: polyvinyl chloride plastic, indoors and outdoors, not submerged.	Solvent cleaned SSPC-SP1	(4) Acrylic
NFM-5: Fiberglass surfaces.	Per paragraph 3.09, Plastic, Fiberglass, and Non-Ferrous Metals Surface Preparation	(6) Aliphatic Polyurethane Fiberglass

END OF SECTION

SECTION 11317

SUBMERSIBLE WASTEWATER PUMP - CUTTER-TYPE

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Submersible, cutter-type centrifugal sewage pump with integral submersible motor, power cable, monitoring equipment, and accessories.

1.02 RELATED SECTIONS

A. Coordinate pumps and motors with electrical work as specified in Division 16, Electrical.

1.03 REFERENCES

A. American National Standards Institute (ANSI)

B. American Society for Testing and Materials (ASTM)

C. Anti-Friction Bearing Manufacturers Association (AFBMA)

D. Hydraulic Institute

E. Institute of Electrical and Electronic Engineers (IEEE)

F. National Electric Code (NEC)

G. National Electrical Manufacturers Association (NEMA)

H. Steel Structures Painting Council (SSPC)

1.04 PERFORMANCE REQUIREMENTS

A. Furnish and install submersible, cutter-type centrifugal wastewater pumps capable of handling skimmer flows with rags and floatable solids in accordance with these Specifications and as shown on the Drawings.

B. Number of pumps, minimum and maximum operating capacities, total dynamic head, suction and discharge size, and other pump design data is shown in Section 2.3 of this specification.

C. Use pumps designed for continuous operation without cavitation within the specified operating range.

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01300 - Submittals.

B. Submit a list of not less than 10 installations where pumping equipment of similar type and size to those specified has been in successful operation for at least 15 years.

C. Submit locations of the nearest permanent service headquarters of pump and motor manufacturer for size of pump and motor submitted.

D. Submit descriptive literature, including a cross-sectional view of each pump and motor combination, which indicates materials of construction, weights, principal dimensions and other important details.

E. Submit certified characteristic curves showing head-capacity relationship, brake horsepower, net positive suction head requirements, pump efficiency (ratio of water horsepower to brake horsepower) and pump speed. Curves shall be complete for the entire range of operation from shut-off to zero head conditions. Submit manufacturer's L-10 bearing life calculations for radial and thrust bearings at pressure heads and flow rates shown on the Drawings.

F. Manufacturer's Certifications:

1. Submit manufacturer's certification that Contract Documents have been examined by the manufacturer for proposed electrical, mechanical, and structural systems affecting performance of the pumping equipment.

2. Submit manufacturer's certification that the maximum power requirement, if used, shall not exceed the motor rating under operating conditions on the pump characteristic curve.

3. Submit manufacturer's certification that the seal is designed for service and application specified and is installed and aligned properly.

G. Operation and Maintenance Data: Submit operation and maintenance data under provisions of Section 01730 - Operations and Maintenance Data.

H. Commercial testing shall be required and include the following:

1. The pump shall be visually inspected to confirm that it is built in accordance with the specification as to HP, voltage phase and hertz.

2. The stator motor shall be tested for integrity using a meg-ohm meter at the highest setting.

3. Pump shall be allowed to run dry to check for proper rotation.

4. Discharge piping shall be attached; the pump submerged in water and amp readings shall be taken in each leg to check for an imbalanced stator winding. If there is a significant difference in the readings, the stator windings shall be

checked with a bridge to determine if an unbalanced resistance exists. If so, the stator shall be replaced.

5. The pump shall be removed from the water, meg-ohm meter tested again, dried and the motor housing filled with dielectric oil.

1.06 QUALITY ASSURANCE

A. Use new materials of high grade, and with properties best suited to the work required.

B. Manufacturer's Qualifications:

1. Provide pumping equipment of manufacturers whose products have proven reliable in similar service for at least 15 years.

2. Manufacturer shall demonstrate a consistent capability for the following level of service:

a. Provide local (within 50 miles of the project site) factory trained personnel to service pumps and allied equipment when needed within a 24 hour period.
b. Provide for delivery of rotating parts for the pumps, except for the impeller and motor within a 24-hour period. Provide for delivery of the impeller and motor within 2 weeks.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver to site, store and protect equipment as required by Section 01600 - Material and Equipment.

B. Store equipment off the ground in enclosed shelter. Store and maintain equipment in accordance with manufacturer’s direction.

1.08 WARRANTY

A. Pump manufacturer shall furnish to the Owner a warranty written expressly from the manufacturer to the Owner, covering workmanship, material, and performance deficiency under normal use and service. The full warranty shall cover 100 percent of parts and labor for one full year.

B. The warranty period shall commence on the day of start-up acceptance by the owner. Warranty shall be in printed form and previously published as the manufacturer's standard warranty for similar manufactured units.

PART 2 P R O D U C T S

2.01 MATERIAL AND EQUIPMENT

A. Select equipment which is designed and built for continuous service at all points within the specified range of operation, without overheating, without cavitation, and without excessive vibration or strain.

B. Furnish each pump with a stainless steel data plate containing the manufacturer's name, pump size and type, serial number, speed, impeller diameter, capacity and head and any other pertinent data.

C. Motors, cables, and anchor bolts shall be furnished by the pump manufacturer. Coordinate the torsional analysis, when required, to include pump, driver and bearings.

D. Shaft seals shall be furnished by the pump manufacturer and sized to accommodate shaft and maximum deflection and misalignment in both shaft and seal.

E. Use anchor bolts, nuts and washers made of type 316 stainless steel.

2.02 ACCEPTABLE MANUFACTURERS

A. Through shop drawing submittals, the following named manufacturers will be considered, provided the submitted equipment meets the specified requirements and system operating conditions:

1. Hayward Gordon, Halton Hills, ON, Canada

3. Vaughn Pumps, Montesano, WA

2. Other manufacturers that submit data to Engineer and are approved by Addenda.

B. Listing as an acceptable manufacturer will not relieve the manufacturer from conforming to these Specifications.

2.03 PUMPS

A. Description. Provide submersible, centrifugal, cutter-type, sewage handling-type pumps which are specifically designed for wastewater application.

B. Performance Requirements. When operating at the maximum output speed of the motor, under load and including slip (at 60 Hz), verify that the selected pump has a curve which meets all minimum conditions for Pumping Station Data as tabulated following. The pump motor shall be capable of operating satisfactorily under the full range of conditions as defined in the data. Pump capacity, head and efficiency defined in the data corresponding to firm station capacity shall be the "guaranty point". Provide a pump with a characteristic performance curve which meets system curve requirements.

CLARIFIER SCUM PUMPING STATION NO. 1

Parameter	Unit
Number of Pumping Units	2
Required Total Dynamic Head (TDH), ft	30
Capacity at required TDH, gpm	225
Minimum total head, ft.	22
Capacity at minimum total head, gpm	375
Maximum total head, ft.	34
Capacity at maximum total head, gpm	125
Minimum shutoff head, ft.	36
Maximum shutoff head, ft.	40
Operating head range, ft.	22 - 34
Pump operating speed, rpm	1750
Max input bhp at the input shaft for any point in the operating head range	4.0
Minimum wire (electric power) to water (power) pump efficiency at rated head, percent	45
Discharge, connection elbow, in.	4
Electrical characteristics:	
Current Phase	3
VAC	460
Hz.	60
Motor HP required	5
Acceptable Model: Hayward Gordon	CHOPX3-B

CLARIFIER SCUM PUMPING STATION NO. 2

Parameter	Unit
Number of Pumping Units	2
Required Total Dynamic Head (TDH), ft	26
Capacity at required TDH, gpm	225
Minimum total head, ft.	23
Capacity at minimum total head, gpm	275
Maximum total head, ft.	30
Capacity at maximum total head, gpm	125
Minimum shutoff head, ft.	30
Maximum shutoff head, ft.	34
Operating head range, ft.	26 - 34
Pump operating speed, rpm	1750
Max input bhp at the input shaft for any point in the operating head range	3.5
Minimum wire (electric power) to water (power) pump efficiency at rated head, percent	45
Discharge, connection elbow, in.	4
Electrical characteristics:	
Current Phase	3
VAC	460
Hz.	60

Motor HP required	5
Acceptable Model: Hayward Gordon	CHOPX3-B

DISINFECTION BASIN SCUM PUMPING STATION

Parameter	Unit
Number of Pumping Units	3
Required Total Dynamic Head (TDH), ft	16.5
Capacity at required TDH, gpm	400
Minimum total head, ft.	10
Capacity at minimum total head, gpm	450
Maximum total head, ft.	20
Capacity at maximum total head, gpm	350
Minimum shutoff head, ft.	34
Maximum shutoff head, ft.	36
Operating head range, ft.	10-20
Pump operating speed, rpm	1750
Max input bhp at the input shaft for any point in the operating head range	4.0
Minimum wire (electric power) to water (power) pump efficiency at rated head, percent	45
Discharge, connection elbow, in.	4
Electrical characteristics:	
Current Phase	3
VAC	460
Hz.	60
Motor HP required	5
Acceptable Model: Hayward Gordon	CHOPX3-B

C. Pump Casing:

1. Casing: The pump casing will be constructed of ASTM A48 Cast Iron (*Optional: ASTM A532 High Chrome Iron 450 BHN minimum, 316SS or CD4MCU*). Flanged suction and discharge connections shall conform to the requirements of ANSI B16.1, Class 125. Casings with 4” or larger discharge diameter shall have an inspection port with removable cover to allow access to the casing passage. An inspection port shall also be provided in the suction spool piece to allow access to the front of the impeller and cutter bars. The casing backplate shall have spiral cutting groove on the surface that is in close clearance to the rear of the impeller. The casing shall be a clamp type design, with integrally cast feet to allow removal of the power frame for maintenance without disturbing the suction or discharge piping.

D. Impeller:

1. The pump impeller shall be an open or semi-open type with either serrated cutting teeth or sharpened vane edges incorporated into the rear of the

impeller which provides cutting action against the backplate spiral groove, preventing fouling behind the impeller. Primary chopping/conditioning of materials shall be accomplished by the action of the sharpened leading edges of the impeller blades moving across the cutter bar at the intake openings with a set clearance between the impeller and cutter bar of .010" to .015" on pumps with less than 14" diameter impellers or .020" to .030" on pumps with 14" diameter or larger impellers. Impeller shall be constructed of ASTM A148 cast alloy steel, case hardened to minimum Rockwell C 60 (Optional: ASTM A532 High Chrome Iron 450 BHN minimum, 316SS, or CD4MCU) and shall be dynamically balanced. The impeller shall be keyed to the shaft and the axial clearance at the front and rear of the impeller shall be externally adjustable.

E. Cutter Bar:

1. The casing will be fitted with a replaceable, externally-adjustable suction plate with integral cutter bars constructed of ASTM A148 alloy steel case hardened to minimum Rockwell C 60. The surface of the suction plate facing the impeller shall have multiple radial cutting slots to prevent binding of material between it and the impeller vanes. Pumps with 15" or larger impeller diameters shall have separately replaceable cutter bars independent of the main suction cover.

F. Deflector Nut:

1. The impeller shall be secured to the shaft using a deflector nut made from 410 Stainless Steel hardened to 400 BHN, designed protrude in front of the cutter bars and deflect stringy materials and prevent binding.

G. Upper Cutter:

1. The area behind the impeller shall be protected from fouling by the cutting and expulsion action of serrated cutting teeth or sharpened vane edges sweeping across spiral grooves in the casing backplate.

H. Shaft and Sleeve:

1. Fabricate pump shafts as one piece of AISI Series 400 stainless steel. Make shaft of sufficient diameter to assure rigid support of the impeller and to prevent excessive vibration at all speeds. An O-ring between sleeve and shaft will prevent pumped fluid from leaking along the shaft.

I. Bearings:

1. Radial bearings on all sizes of pump shall be cylindrical roller type to withstand high radial loads during chopping. Axial thrust in both directions shall be taken up by double row angular contact thrust bearings on pumps with less than 14” diameter impellers or by higher capacity double row tapered roller bearings for pumps with 14” diameter or larger impellers. The bearing lives are to be rated for a minimum of 100,000 hrs. L10 life, based on calculated loads due to hydraulic thrust encountered at the duty point, as well as other mechanical loading due to belt drives or shaft and impeller weight.

J. Bearing Housing:

1. The bearing frame shall be A48 Class 30 cast iron and should be fitted with grease nipples for grease lubrication or with an oil level sight gauge, vent and drain plugs for oil lubrication. The axial thrust bearing shall be contained in a separate housing mounted within the powerframe to allow for external axial adjustment of the impeller clearance. The bearing frame shall be removable for servicing without disturbance of the suction or discharge piping.

K. Seal Housing:

1. The stuffing box will be constructed of 316SS.

L. Seal Types:

1. Flushless mechanical seal system designed to require no clean water flushing. System to consist of the stuffing box portion of the seal housing having a tapered opening of no less than 20° to promote the expulsion of solids back into the pumped flow. The seal shall be front loading and of the cartridge type with Viton O-rings, silicon carbide faces and 316SS metal parts. The cartridge seal shall be pre-assembled and pre-tested so that no seal settings or adjustments are required. Any springs used to push the faces of the seals together must be shielded from the pumped fluid to prevent binding or hang-up of the seal. A separate oil chamber shall not be required for the mechanical seal.

   Any leakage will be retained by a drainable reservoir, with a 0.75" NPT hole provided to connect drainage piping.

M. Pump and Motor Base:

1. The pump shall be supported by an independent pedestal base fabricated from steel or Cast Iron, designed to provide rigid support of the pump and

motor. The independent pump support pedestal shall be designed for easy access to the handhole cleanout and such that the suction elbow can be removed for maintenance without having to remove or dismantle any of the pump components.

N.. Power Cable

1. Provide a cable entry water seal which precludes specific torque requirements to ensure a watertight and submersible seal. Seal the cable entry by an elastomer grommet, epoxy potting material, or a combination of both. Provide a cable entry sealing system with strain relief for the terminal connections and with access to the terminal connections without adversely affecting the integrity or function of the seal system.

2. Provide cables that are oil, grease and abrasion resistant. Use cables with an outer jacket of silicone rubber or other material equally suitable for immersion in wastewater.

3. For motors 20 horsepower and less, use cables capable of operating on either 230 volt or 460 volt, 3 phase service and under continuous submergence to a depth of 65 feet without loss of watertight integrity.

4. Provide motors with reconnectable terminal blocks or wire lugs. Number all leads.

M. Submersible Motor

1. Pump Motor Characteristics:

a. The stator, rotor and bearings shall be mounted in a sealed submersible type housing. The stator windings shall have Class F insulation (311EF), and a dielectric oil filled motor, NEMA B design.
b. The pump and motor shall be designed so that they may be operated partially or completely in the liquid being pumped. The pump shall not require cooling water jackets.
c. Stators shall be securely held in place with a removable end ring and threaded fasteners so they may be easily removed in the field without the use of heat or a press. Stators must be capable of being repaired or rewound by local motor service stations. No special tools shall be required for pump and motor disassembly.
d. Pump shall be equipped with heat sensors. The heat sensors shall be a low resitance; b-metal disc that is temperature sensitive. IT shall be mounted directly on the stator windings and sized to open at 120EC and automatically reset 30 - 35 EC differential.
e. Designed for continuous duty, capable of sustaining a minimum of 15 starts per hour, evenly spaced.

f. Capable of operating at liquid temperature of 140 EF without overheating or operating in the service factor.

g. Non-overloading over the entire range of the pump operating curve within the nameplate horsepower.

F. Shaft: Fabricate pump shafts as one piece of AISI Series 400 stainless steel. Make shaft of sufficient diameter to assure rigid support of the impeller and to prevent excessive vibration at all speeds.

G. Pump Seals:

1. Each pump shall have two mechanical seals, mounted in tandem, with an oil filled chamber between the seals. John Crane Type 21, BF1C1, seals shall be used with the rotating seal faces being carbon and stationary seal faces to be ceramic. The lower seal shall be replaceable without disassembly of the seal chamber and without the use of special tools.

2. The pump shall be equipped with a seal leak detection probe and warning system. This shall be designed to alert maintenance personnel of lower seal failure without having to take the unit out of service for inspection or requiring access for checking seal chamber oil level and consistency.

H. Bearings: An upper radial bearing and a lower thrust bearing shall be required. These shall be heavy duty single row ball bearings which are permanently lubricated by the dielectric oil which fills the motor housing. Both bearing shall have a minimum B-10 life at the specified condition of 40,000 hours. Bearings shall be locally available.

I. Impeller: Impeller shall be of the two-vane, enclosed non-clogging design and have pump-out vanes on the front and backside of the impeller to prevent grit and other materials from collecting in the seal areas. Single vane design is not acceptable. Fabricate the impeller of fine grained gray cast iron, Class 30 or better. Balance the impeller both statically and dynamically.

J. Fasteners: Bolts, Studs and Nuts: Series 300 stainless steel for all fasteners on the submersible pump and motor casing.

K. Support: Pumps shall be provided with “feet” to support the unit when removed from service.

2.02 ACCESSORIES

A. Pump Guide System: Provide a guide rail system acceptable to the pump manufacturer complying with the following requirements:

1. Dual 2-inch rails, schedule 40 type 304 stainless steel pipe, allowing pump replacement without manhole entry into the wetwell.

2. Lower bracket integral with pump support/discharge fitting, cast iron or type 304 stainless steel.

3. Type 316 stainless steel upper bracket bolted to access cover frame.

4. Type 316 stainless steel intermediate brackets as shown on the Drawings and additionally as required.

B. Bolts, Studs and Nuts

1. Bolts, studs and nuts: American National form right-hand machine cut threads in conformity with the current ANSI B1.1, Screw Threads, Coarse Thread Series, unless otherwise specified. Provide nuts and bolts with the standard hexagonal shape.

2. Finish for bolt heads and nuts: Semi-finished in conformity with ANSI B18.2, Wrench-Head Bolts and Nuts and Wrench Openings, Heavy Series, unless otherwise specified.

3. Anchor bolts, flange bolts, studs and nuts: Type 316 stainless steel in conformity with ASTM A 276.

2.03 PUMP PROTECTION SYSTEM

A. Pump manufacturer shall furnish a pump monitoring and protection components to interface with of solid state monitoring to be installed in the motor starter enclosure, and independent probes integral to the pump/motor wired to a sealed cable entry terminal box for connection of submersible control cables.

B. Have sensors independently wired to the monitoring system. Make provision for the following sensors for each pump:

1. Seal leak (one required).

2. Stator temperature (one per phase).

2.04 SHOP PAINTING

A. Provide pump and motor with a factory-applied exterior protective coating systems:

PART 3 E X E C U T I O N

3.01 INSTALLATION

A. Install pumps in strict accordance with the manufacturer’s written instructions in locations shown on the Drawings. Provide sufficient clearances for thermal expansion and contraction.

SPECIFICATION 11762

BELT FILTER PRESSES

PART 1 – GENERAL

PART 1 GENERAL REQUIREMENTS

1.01 Scope of Work

This section shall include furnishing, unloading at the jobsite, handling, storage and installing a complete sludge dewatering system including TWO (2) belt filter presses, complete with ancillary equipment, as specified and indicated on the drawings and as required to meet the specified performance requirements.

1.02 Reference Standards

A. AGMA, American Gear Manufacturers Association.
B. ASME, American Society of Mechanical Engineers.
C. ASTM, American Society of Testing and Materials.
D. ANSI, American National Standards Institute.
E. IEEE, Institute of Electrical and Electronics Engineers.
F. NEC, National Electrical Code.
G. OSHA, Occupational Safety and Health Act.
H. City of Houston Building Code with Amendments.

1.03 General

Equipment furnished and installed 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 the engineer notes exceptions.

1.04 Workmanship and Design

All components of the sludge dewatering equipment shall be engineered for long, continuous, and uninterrupted service. Provisions shall be made for easy lubrication, adjustment, or replacement of all parts. Corresponding parts of multiple units shall be interchangeable.

1.05 System Description

The sludge dewatering system shall consist of TWO (2) belt filter presses and all appurtenances. Each belt filter press shall be a complete prefabricated unit consisting of at least a sludge conditioning system, a gravity drainage section, a pressure section, a belt alignment and tensioning system and a belt washing system. Only units having a measured belt width of 2.2 meters, and an effective belt width of 2.0 meters shall be considered acceptable under this specification. The units shall be the Klampress 2.0 Meter with Extended Gravity and Wedge Section Belt Filter Presses as

manufactured by Ashbrook Simon-Hartley, Houston, Texas, or equal pre-approved ten days prior to the bid date.

The overall dimensions of the belt filter press room shall be such that the installation of the press allows clearance on one side equal to the overall width of the belt filter press for the removal of rollers, as well as a minimum clearance of 3'-0" on all other sides of the press.

The belt filter press shall have the maximum dimensions, 102 inches high, 245 inches long, and 142 inches wide. The overall static weight of the belt filter press shall not exceed 24,800 pounds so as to minimize installation and civil work.

The minimum clearance requirements specified herein shall not relieve the contractor from allowing additional clearances for the proper installation, operation, and maintenance of the units. Should equipment other than that specified be proposed, the contractor shall be responsible for any redesign based on the requirements contained herein.

1.06 Quality Assurance

Consideration will be given only to products of manufacturers who can demonstrate that their equipment fully complies with all requirements of the specifications and contract documents. The equipment shall be supplied by a firm which has been regularly engaged in the design, fabrication, assembly, testing, start-up and service of full scale belt filter presses, of the same model and size as proposed, operating in the U.S., with similar sludges, for a period of not less than ten (10) years prior to the bid date of this contract. To insure that the highest standards are met each bidder shall be certified to ISO 9001 quality standards as a belt press manufacturer in the United States. The bidder shall submit data to substantiate the manufacturers experience in accordance with the contract documents.

If a bidding belt press manufacturer does not have a formal quality system in place, or documentation to prove so, a performance/maintenance bond in the amount of 100% of the installed price (including equipment, labor, piping, and wiring associated with the system covered under this specification) shall be included in the bid proposal. The bond should be made out to the owner for 100% of the amount bid, and shall be in force for a minimum of five (5) years from the date of first beneficial use of the equipment. The five (5) year minimum is to cover all warranties listed under this specification.

To accommodate future process changes, the belt filter press shall be designed to accept extended gravity and wedge sections as well as additional plows in the gravity section and rollers in the pressure section to increase the system’s performance.

1.07 Patents

The manufacturer warrants that the use of this system and its equipment, in the process for which the system has been expressly designed, will not infringe any U.S. or foreign patents or patents pending. In the event of any claim of infringement the manufacturer shall defend and indemnify the owner free from any liabilities associated with the use of the patented equipment or process.

The manufacturer hereby grants to the owner, in perpetuity, a paid-up license to use any inventions covered by patent or patents pending, owned, or controlled by the manufacturer in the operation of the facility being constructed in conjunction with the equipment supplied under this contract, but without the right to grant sublicenses.

1.08 Warranty

The manufacturer shall warrant, in writing, that all equipment supplied by them shall be free from defects in material and workmanship, for a period of twelve (12) months from the date of start up, not to exceed eighteen (18) months from the date of delivery, unless noted otherwise within the specifications.

1.09 Conditions of Service

The sludge dewatering equipment shall be designed to adequately condition and dewater the sludge so that a dewatered sludge cake is produced that easily discharges from the dewatering unit without blinding and that may be handled by the pump or conveying equipment.

Each unit shall be designed to operate in the environment for which it is intended, continuously or intermittently on demand, and shall perform the required dewatering operations without spillage of water or sludge beyond the nominal machine envelope.

The description of the sludge to be fed to the belt filter presses is waste activated sludge which has been aerobically digested.

feed solids, percent d.w.s.	1.0 - 3.0
volatile feed solids content, percent	60 - 80

1.10 Performance Requirements

Each belt filter press shall be capable of meeting the following minimum performance criteria:

sludge throughput, lbs. d.w.s./hour/meter	750 lbs./hour/meter of belt width
hydraulic capacity, g.p.m./meter	100 gpm/meter of belt width @ 1.5%
cake solids, percent d.w.s.	16% - 17%
solids capture, percent	95%
polymer, lbs/ton of d.w.s. in feed	18 lbs./ton active

The manufacturer shall guarantee the above performance criteria, backed by a performance bond or irrevocable letter of credit in the full amount of the equipment price, presented with the submission of engineering submittals. The manufacturer shall be allowed two opportunities to demonstrate compliance with the performance criteria. Should the equipment fail to meet the performance criteria after the second test, the manufacturer shall forfeit the bond or irrevocable letter of credit and remove the equipment.

The performance test shall consist of 2 tests that shall last three hours each. Samples shall be collected at the end of every hour. Both tests shall be averaged and the installed equipment shall demonstrate that it can meet or exceed the specified Performance Criteria. If the equipment fails to meet the specified Performance Criteria after the second attempt to pass the test, the Owner shall have the option to bring in a trailer-mounted, competitive, one-meter belt filter press that meets the mechanical design criteria of this specification section. Should the competitive unit meet the Performance Criteria, the installed equipment supplier shall be liable to compensate the Owner for future expenses, such as sludge cake hauling, excess polymer dosage, throughput and solids capture due to failure to meet the Performance Criteria. The penalty amount shall be equal the extra cost, on a present worth basis, that will be incurred by the Owner, over a twenty (20) year period using the current prime interest rate, as a result of the non-conformance of the belt filter press. The equipment supplier shall be liable for the extra expenses, but not to exceed 100% of equipment price.

If the competitive unit cannot meet the Performance Criteria as specified, this shall be evidence that the Performance Criteria cannot be met and the Owner shall accept the equipment and return the Irrevocable Letter of Credit to the manufacturer. If the Owner cannot provide sludge as specified in the Conditions of Service within 90 days after the Contractor's notification of readiness to perform the performance test, the test shall be deemed to be satisfied and the Owner shall accept the equipment and return the Irrevocable Letter of Credit to the manufacturer.

PART 2: PRODUCTS

2.01 Materials and Coatings

All materials used in the construction of the sludge dewatering equipment shall be of the best quality and entirely suitable in every respect for the service required. All structural steel shall conform to the ASTM Standard Specification for Structural Steel, Designation A36/A36M. All iron castings shall conform to the ASTM Standard Specifications for Gray Iron Castings, Designation A48, and shall be of a class suitable for the purpose intended. Other materials shall conform to the ASTM Specifications where such specifications exist and the use of such materials shall be based on continuous and successful use under similar conditions of service.

All electrical components shall be U.L. listed where such listing exists and all electrical control panels shall be assembled in U.L. approved facilities. All structural carbon steel plates and shapes shall have a minimum thickness of 1/4 inch and shall be hot dip galvanized in accordance with ASTM A-123.

Unless specified otherwise herein, all metals in contact with polyelectrolyte or sludge, and all other components specified to be stainless steel, shall be type 316L stainless steel.

The following materials and coatings shall be provided for the belt filter press and related components unless specified otherwise herein:

Bearing housings	Nylon coated, cast iron

Belt support grids	Stainless steel, 10 gauge fitted with UHMW polyethylene wiper bars
Belt wash housing	Stainless steel, 14 gauge.
Belt wash spray tube and nozzles	Stainless steel.
Belt wash piping	Schedule 80 PVC, 1 1/2 inch.
Chicanes	Galvanized steel support rods, galvanized cast iron holders and U.H.M.W. polyethylene blades.
Chutes (feed and discharge)	Stainless steel, 10 gauge.
Doctor blades	U.H.M.W. polyethylene.
Drain trays	Stainless steel, 14 gauge.
Drain tray piping	Schedule 40 PVC.
Electrical junction box	Stainless steel or FRP
Electrical conduit	SO Cord
Electrical switch enclosures	NEMA 4, press mounted
Frame	A36 steel, hot dip galvanized, ASTM A123, minimum 3.9 mils.
Hardware, fasteners, springs, etc.	316 stainless steel.
Hydraulic cylinders:	
body:	FRP tube with high strength glass filled nylon head
rod:	Solid 316 stainless steel with hard surface treatment
Miscellaneous	Carbon steel surfaces to be hot dipped galvanized per ASTM A123
Polymer mixer housing	Cast 316ss
Counterweight	Cast iron, galvanized
Injection ring	UHMW polyethylene
Splitter Manifold	UHMW polyethylene
Rollers (solid)	Carbon steel, 1/2 -inch wall,. Drive rollers coated with Buna N rubber, 1/4 inch, other solid rollers coated with thermoplastic nylon, 25 mils.

Rollers (perforated)	1/4 –inch wall carbon steel hot dip galvanized, or nylon coated
Roller shafts	Forged steel ASTM 572 Grade 50, perforated roller shall have 8620
Sludge containment barriers	Stainless steel, 14 gauge.

Other types of protective coatings shall not be acceptable. All hot dip galvanizing shall be applied in accordance with ASTM-A123. Zinc flame spray shall not be considered an acceptable substitute to this specification.

The heat setting thermoplastic nylon coating, specified herein, shall have the following properties:

Coating Properties	**Test Method**	**Value**
Hardness, Shore D	ASTM D-2240	77
Specific Gravity	ASTM D-792	1.06-1.20
Impact, RT & 45 F	ASTM D-2794	160 in lbs Direct Pass
Tensile Strength	ASTM D-638	6000 PSI
Elongation	ASTM D-638	15%
Melting Point	ASTM D-789	370^0F
Abrasion Resistance	ASTM D-4060	8-18 mg. Wt. loss
(varies with color)	CS17/1000/1000	Taper Abrader

Buna N rubber coating shall have the following properties:

Tensile strength, ASTM D-412	2500 psi
Tear strength, die C, ASTM D-624	250 psi
Elongation at break, ASTM D-412	160%
Hardness, Shore A, ASTM D -676	90

2.02 Sludge Conditioning System

Each belt filter press shall be provided with a sludge conditioning system, designed to efficiently mix polymer with the sludge and to adequately condition the sludge, for optimum dewatering.

The sludge conditioning system shall be mounted upstream of the press and shall consist of an in-line, non-clog, static mixer with a variable orifice and a vortex polymer injection ring. The belt

filter press manufacturer shall be required to provide, to the engineer, a proper layout for the system. The sludge conditioning system shall be capable of providing the following performance:

1) The polymer and sludge must be instantly mixed (less than 1.0 seconds at 60 GPM).
2) Mixing energy must be independently adjustable during operation.
3) Flocculation time must be independently adjustable, by the displacement of flanged pipe sections, with the mixer, at a minimum of three locations in the sludge feed piping.

The manufacturer shall be required to demonstrate, during the start-up and calibration phase, that flocculation time can be adjusted by one man, within sixty minutes. The sludge conditioning system shall meet the following mechanical specifications:

1) The in-line mixer shall have a flanged, cast housing, an adjustable orifice plate with shaft and O-ring seal connected to an externally mounted lever and counterweight and a removable side plate for inspection and cleaning.
2) The open throat area shall be fully adjustable downward and shall open automatically to prevent clogging.
3) The position of the counterweight on the externally mounted orifice plate lever shall be fully adjustable, within a 360 degree circle, to allow for adjustment of the mixing energy, regardless of the mounting angle, while the unit is in operation.
4)

The polymer mixer shall be designed specifically for it's intended use. The use of modified check valves or mixers requiring electrical motors and controls shall not be acceptable to this specification.

2.03 Structural Main Frame

The structural main frame shall be fabricated of steel members conforming to AISC Standard Specifications for Structural Steel, into a rigid structure, adequately braced to withstand intended loads without excessive vibration or deflection.

The frame shall have a minimum safety factor of > 5 and maximum deflection of 0.025 inches under maximum loading. The moment of inertia of the structural members shall be adequately chosen to provide the safety factor and deflection rate specified herein.

Maximum load on the frame shall be based on the summation of forces applied to the frame from roller mass forces, weight of the rollers including the sludge and belts and belt tension forces. Belt tension forces shall include, but not be limited to, a belt tension of 50 pli per belt plus the tension produced by the driving torque of the motor at nameplate ph. Certified calculations, showing the frame to be in compliance with the specification, shall be submitted as set forth in the contract documents.

The framework shall be of welded and/or bolted construction. All welding shall conform to the American Welding Society Structural Welding Code.

The structure shall be designed for installation on a prepared concrete foundation and secured with anchor bolts. Permanent lifting lugs shall be provided as necessary to allow installation and removal of the belt filter press.

The construction shall allow easy access and visual inspection of all internal components.

The manufacturer shall warrant the frame and the coating for a period of three years from the date of start-up, not to exceed three and a half years from the date of delivery. The frame shall not require preventive maintenance during the warranty period. Any defects or corrosion occurring within the warranty period shall be repaired or replaced at no additional cost to the owner.

2.04 Gravity Drainage Section

Each belt filter press shall be furnished with a gravity drainage section to accept sludge from the sludge conditioning system. The gravity drainage section shall be furnished with a sludge feed chute and an inlet distributor to evenly distribute the conditioned sludge over the effective width of the moving filter belt.

The conditioned sludge shall be contained on the belt with adjustable containment barriers equipped with replaceable rubber seals to prevent leakage. Rubber seals are designed to be attached to the containment barriers, with a friction fit, to allow for easy replacement without the use of tools.

The gravity drainage section shall have a minimum dewatering area of 93 square feet.

The filter belt, while in the gravity drainage section, shall be supported by a steel grid fitted with high-density polyethylene wiper bars. The wiper bars shall be spaced at a maximum of two and one half inches and shall have a nominal wear thickness of one half inch, to minimize the frequency of replacement. The wiper bars shall be arranged in a chevron pattern, with the apex toward the sludge inlet, to reduce the possibility of belt creasing. The belt support grid shall be a minimum of 2 inches wider than the belt on each side and so designed to reduce belt wear. Wiper bars constructed of fiberglass, other high friction materials, or table rollers, which require extra maintenance due to coatings, and additional bearings shall not be considered an acceptable substitute to this specification.

The gravity drainage section shall be furnished with chicanes (plows) to adequately furrow the conditioned sludge to facilitate drainage. Each row of chicanes shall be provided with a single lifting handle, designed to remove the entire row of chicanes at least 6 inches from the belt, out of the sludge flow, to facilitate cleaning. Chicanes shall be designed to be individually adjustable laterally and shall pivot to allow them to pass over obstructions on the belt. The minimum of number of chicanes shall be 84, and the minimum number of rows shall be 10.

The manufacturer shall be required to demonstrate that each individual chicane shall be capable of allowing a one-inch vertical obstruction on the belt to pass under them without damage to the equipment.

Vacuum assisted, inclined gravity drainage sections, which are subject to flooding, or independent gravity drainage sections, which require a separate belt drive motor and tensioning device will not be considered an acceptable substitute to this specification.

2.05 Pressure Section

Each belt filter press shall be furnished with a pressure section following the gravity drainage section. The pressure section shall consist of two stages.

The first stage of the pressure section shall be the increasing pressure (wedge) zone, where the upper and lower belts gradually converge, creating a belt/sludge sandwich. In the wedge zone the sludge cake is prepared for the shear pressure zone by generating continuously increasing pressure on the sludge as it travels through the zone.

For process flexibility, the amount of pressure exerted on the sludge and the rate at which the increasing pressure is applied shall be independently adjustable while the machine is in operation utilizing an adjustable steel wedge plate located between the belts, pressing down on the sludge. These adjustments shall be capable of being performed without causing undue wear on the belts or other components and without causing the belts to be moved from their normal path between rollers. The sludge inlet height at the entrance to the wedge plate shall be adjustable between one and three inches.

The minimum effective dewatering area in the increasing pressure zone shall be 59 square feet. The belt in the increasing pressure zone shall be supported in the same manner as supported in the gravity drainage section.

The second stage of the pressure section shall be the shear pressure zone consisting of a 12” radius curved grid and a minimum of 8 pressure rollers arranged to provide a serpentine pattern of belt travel.

The curved grid shall further enhance dewatering by causing the pressure on the sludge between the belts to increase and press out free water. The horizontal wiper bars shall give a wiping action to the bottom of the belt in the wedge zone that will quickly remove water from the belt allowing faster drainage. The belt-supporting grid in the wedge zone shall be horizontal for the first several feet and blend into a gradual downward curve, which shall be tangent to the perforated pressure roller that follows.

The first roller in the increasing pressure zone shall be a 16” perforated roller. Rollers shall be constructed as specified under "Rollers". The rollers shall be supported by bearings mounted on the end shafts as specified under "Bearings".

The minimum effective dewatering area in the shear pressure zone shall be 121 square feet. The effective dewatering area in the shear pressure zone shall be defined as the area of curved grid and rollers in contact with the belts, meaning full width of the belt.

2.06 Rollers

Construction:

All Solid Rollers shall be constructed using one-piece forge shafts and end plates. The forged stub shaft unit shall eliminate all welding of the roller shafts in the region of highest stress where the shafts join with the end plates. Welded up constructions of round bar and flat plates that create built in stresses and stress concentrations will not be considered equal to this specification. The forged stub shaft unit shall be welded to the roller shell with a machine-applied weld using

the submerged arc process. The weld depth shall be equal to the wall thickness of the roller shell. The roller shall be machined so that the total indicated runout of the shell relative to the journals is 0.010 inch maximum. Total surface machining is required to provide a smooth surface for the coating of thermoplastic nylon or to prepare the roller for cladding.

The perforated roller, which is the first roller in the pressure section, is designed to allow water to escape out both ends. It shall be constructed with a solid through shaft and at least five (5) radial vanes to support the perforated shell.

Materials:

The forged stub shaft unit shall be made of ASTM A572 Grade 50 Type 2 or equal. The roller shells may be ASTM A53 or equal. The perforated roller shall have a solid shaft of cold drawn carbon steel, AISC 8620 and the shell and radial vanes shall be ASTM A36 or equal, or stainless steels may be substituted on special order.

Drive rollers shall be coated up to the point of insertion into the bearings by a 1/4-inch minimum thickness of Buna-N rubber. Solid and perforated rollers shall be coated with a 30-mil minimum thickness of thermoplastic nylon. See detail spec for these coatings in Section 2.01.

Solid rollers may also be clad with 304 or 316 stainless steel. The cladding will be welded to the fully machined roller entirely covering the roller up to the point of insertion into the bearings. Welded stainless steel shafts in lieu of the forging are not acceptable for this application due to the lower strength and higher stress.

Dimensions:

All solid roller shells shall have a mill spec minimum wall thickness of 1/2 inch. Heavier walls shall be used where required to meet the maximum stress and deflection limits. The roller bearing journals shall be turned to 75 mm to accept direct mounted 75 mm bore bearings. The minimum thickness of the forged flange that forms the end plates shall be one (1) inch.

The perforated roller shall have punched holes of 1 1/4 inch diameter minimum to prevent bridging of solid material. The punched shell shall be rolled with the smooth side out. The shell shall be a minimum 1/4-inch thick.

Stress and Deflection:

The rollers shall be analyzed using finite element stress analyses. Certified calculations, showing the maximum stress to be less than 1/5 the yield strength of the material and the maximum deflection at mid span to be less than 0.050 inch shall be submitted as set forth in the contract documents. The standard load case for the pressure rollers shall be a distributed load in the belt contact area equivalent to 50-pli belt tension, weight loading and drive torque. The standard load case for the other rollers shall be a distributed load in the belt contact area equivalent to 50-pli belt tension and weight loading.

2.07 Bearings

All rollers shall be supported by greaseable type, high capacity design roller bearings, in sealed, splash proof, horizontal split case pillow block housings. The bearings shall be direct mounted on the shaft with a shrink fit backed by a retaining snap ring.

Bearings supporting the steering rollers shall be non-self aligning cylindrical roller bearings in pivot mounted pillow block housings.

All other rollers shall be supported by self-aligning Type "E" spherical roller bearings with metallic cages, (plastic cages in spherical roller bearings are not acceptable) mounted in fixed pillow block housings.

Bearings supporting all the rollers except the steering rollers shall be 75mm bore double row spherical bearings (type E construction) AFBMA size number 22215 with a dynamic radial capacity of 41,500 lb.. Bearings supporting the steering rollers shall be 75mm bore single row cylindrical roller bearings AFBMA size number 2215 with a dynamic radial capacity of 36,500 lb.

Bearing housings shall be cast iron with two mounting bolts and four cap bolts. The outer side of the housing shall be solid, without end caps or filler plugs. The housings shall be designed with an integrally cast water trough which, when shrouded by a shaft mounted water flinger, shall divert water from the bearing seal area. The housings shall be cleaned, iron phosphate, and coated with nylon to a thickness of 8-12 mil.

The bearing seal in the pillow block housing shall be of nonmetallic construction with a carrier/flinger, which rotates with the roller shaft. A static sealing arrangement between the carrier/flinger and the shaft shall be a triple rubber seal, constructed in a manner that prevents relative rotation between the seal and the shaft. A dynamic sealing arrangement between the carrier/flinger and the bearing housing shall consist of a primary dynamic contact seal of ozone resistant rubber which shall seal by rotational contact with a machined housing surface. A secondary dynamic seal shall be a labyrinth seal between the carrier/flinger and the bearing housing which utilizes a nonmetallic retaining ring to hold the seal assembly in position within the housing.

Bearing lubrication shall be performed through stainless steel grease fittings mounted on each bearing housing. All bearings shall be outboard (externally mounted) and shall be greaseable while the unit is in operation. Lubrication shall not be required more often than once every six months.

The manufacturer of the belt filter press shall warrant the complete bearing assembly, as specified herein, for a period of five years from the date of start-up, or acceptance of the equipment, whichever occurs first. The warranty shall include all parts and labor for repairing or replacing any bearing that fails during the warranty period.

2.08 Belt Wash System

Each belt filter press shall be equipped with individual belt wash stations for both the upper and lower belts. Each station shall consist of a spray pipe, fitted with spray nozzles, contained within

a fabricated housing which encapsulates a section of each belt. The housing and nozzle assembly shall be readily removable.

Nozzle spacing and spray pattern shall be such that the sprays from adjacent nozzles overlap one another at the belt surface. Individual spray nozzles shall be replaceable.

The housing shall be sealed against the belt with rubber seals. The spacing between the upper and lower housing shall be adjustable to insure continuous contact between the seals and belt. The seals shall be replaceable without disassembly of the wash station.

Each belt wash station shall be furnished with a drain valve having an external handwheel to which is mounted a stainless steel cleaning brush located inside the spray pipe. One full turn of the handwheel shall cause the brush bristles to enter each spray nozzle, and dislodge any solid particles which have accumulated, open the valve and allow the solids particles to be flushed into the drainage system.

Belt wash stations shall be the type manufactured by Appleton Manufacturing, Menasha Corporation, Menasha, Wisconsin or equal.

Each belt wash station shall be positioned such that the washing is performed after the cake has been discharged from the belt. The belt wash station shall extend over the full width of the filter belt by a minimum of two (2) inches. The belt shall be cleaned by the belt wash with no blinding. The belt wash system shall be suitable for use with plant effluent water supplied at a minimum pressure of 85 psig and shall be designed to operate at a flow of 80 gpm.

Washwater pressure shall be supplied to each washwater pump (one required per belt press) at **45** psig, and the belt press manufacturer shall furnish a separately mounted in-line booster pump rated at sufficient capacity and discharge head to meet the process requirements. All controls and equipment necessary to provide a complete and operating system shall be provided for the pumps by the belt press manufacturer, including the controls from the machine control panel as specified hereinafter.

Each belt filter press shall be provided with a 1 1/2 inch female PVC connection for belt wash water.

2.09 Belt Alignment System

Each belt shall be provided with an automatic belt alignment system to assure proper alignment of both belts at all times. Belt alignment shall be accomplished using a self-contained system that does not require an external power source, except for electrical power.

The belt alignment system shall be provided with sensing devices designed with a counter-weighted arm fitted with a ceramic plate, which rides on the edge of the belts to detect their position. The arm shall operate a pilot valve, which in turn affects the position of a hydraulic actuator connected to a pivoted belt alignment roller. The pivoting action of the belt alignment roller shall cause this roller to skew from its transverse position to guide the belts centrally along their path.

The alignment systems shall function as a continuous automatic belt guidance system and shall be an integral part of the press. The alignment system shall operate with smooth and slow motions resulting in a minimum of belt travel from side to side. The use of electrical servos or systems which utilize devices that maintain alignment by a large snap action type alternating movement of the alignment roller shall not be considered acceptable to this specification.

Rollers for the belt aligning system shall be constructed as specified under "Rollers". Support bearings for these rollers shall be as specified under "Bearings".

Backup limit switches for the belt alignment system shall be provided on the machine with sufficient contacts to de-energize all drives and sound an alarm in case of belt over-travel.

A hydraulic unit shall be provided, as specified under "Hydraulic Power Unit".

2.10 Belt Tensioning System

Each belt shall be provided with a belt tensioning system. The belt tensioning system shall be hydraulically actuated. The design of the tensioning system shall be such that adjustments in tension shall result in immediate changes in dewatering pressure.

The belt tensioning system shall be furnished with a control station located on the press so that shutoff of belt tension is possible. Actual belt tension, shall be maintained automatically despite process changes or belt stretching and not require additional adjustment by the operator to maintain the setpoint.

The belt tensioning system shall be designed to accommodate maximum belt stretching during the useful life of the belt.

The tensioning system shall have two hydraulic cylinders for each belt, directly connected to a rigid tensioning yoke, to provide absolute parallel tension across the entire width of the belt. The tension force shall be constant over the full range of the cylinder.

Manual tensioning systems or pneumatic bellows systems, which do not automatically maintain a pre-set pressure on the sludge despite process changes, are not acceptable. Furthermore, air bladders change diameter and, as a result, force as they extend.

Sensing devices shall be furnished for each belt with sufficient electrical contacts to de-energize all drives and sound an alarm in the event of failure of the belt or the tensioning system.

Rollers for the belt tensioning system shall be constructed as specified under "Rollers". The roller shaft bearings shall be as specified under "Bearings".

2.11 Hydraulic Power Unit

Each belt filter press system shall be provided with a dedicated hydraulic power system to provide pressurized oil for the steering and tensioning. The unit shall consist of a one-gallon reservoir; variable-displacement pressure compensated hydraulic oil pump and drive motor, hydraulic oil filter (reusable), pressure gauges, piping, valves and cylinders to make a complete operational system.

The pump, motor, reservoir, oil filter and valves shall be mounted directly to the belt press frame to minimize excess piping runs, fittings and hoses. All hydraulic lines shall be properly sized for the pressure and flow of the unit. Pressurized hydraulic lines shall be 316ss tubing and shall be rigidly supported on the structural frame of the press. Flexible lines to cylinders, low-pressure connections to the reservoir, etc. shall be hose of the material and construction appropriate to the application. The hydraulic reservoir shall be made of high-density polyethylene (HDPE) and shall be translucent to allow visual inspection of the oil level.

The pump motor shall be a 1 HP and shall not exceed a noise level of 70 DbA. The motor shall be a cast iron TEFC 1,200 rpm, NEMA B design with a "C" face mounting for the hydraulic pump adapter.

Maximum system pressure shall be set equal to the highest pressure required to obtain the desired operating belt tension. The maximum system operating pressure is 1,000 psi.

Hydraulic system controls shall be grouped for easy access and ease of operation. There shall be means provided to retract the belt tension cylinders for service. The valves, fittings, manifold and associated parts shall be of non-corroding materials such as FRP, glass filled Nylon and stainless steel.

The oil pressure gauge(s), one for each pair of belt tension cylinders (upper & lower belt) shall indicate oil pressure in PSI and the belt tension in PLI. Normal operating limits shall be indicated on the face of each gauge. Low-pressure switch (es) shall be provided to sense the absence of belt tension pressure.

Hydraulic cylinders shall have a non-corrosive body and 316 stainless hardware and cylinder rod. The cylinder rod shall be solid stainless with a hardened polished seal contact surface. Chrome or nickel plated rods are not acceptable.

2.12 Belt Drive

Input power to the drive roller shaft shall be supplied through an A.C., variable frequency drive unit. Speed shall be controlled through cyclical variation in motor current, which is operator set at the control panel. The drive roller speed reduction is obtained through a helical gear reducer.

Drive Motor Data:

Quantity per Machine	1
Maximum Horsepower	3 horsepower
Power Requirements	230/460 VAC, 3 phase, 60 cycle.
Rated Speed	1740 rpm
NEMA Design	B
Insulation Class	F
Enclosure	TEFC

Service Factor	1.15
Special Features	Severe duty rating

The variable input power shall be transmitted through a helical gear reducer connected to the drive roller. The drive roller shall be constructed as specified under "Rollers" and shall be surfaced with a Buna-N rubber coating to permit slip free transmission of driving torque to the belt.

2.13 Dewatering Belts

Each belt filter press shall incorporate the use of two dewatering belts. Belts shall be fabricated of monofilament polyester and shall have 316 Stainless Steel seams. The mesh design shall be selected for optimum dewatering of the sludge to be processed and provide for a 2,000-hour belt life when operated in accordance with the manufacturer's instructions.

Belt selection shall be based on the manufacturer's experience obtained from testing the sludge during start-up of the belt filter press (es) and at other installations dewatering similar sludges with similar polyelectrolyte conditioning chemicals.

Each belt and connecting seam shall be designed for a minimum tensile strength equal to five times the normal maximum dynamic tension to which the belt shall be subjected. The seam shall be designed to fail before the belt.

Belts shall be designed for ease of replacement with a minimum of belt filter down time. Belt replacement shall be such that disassembly of the equipment is not required.

2.14 Discharge Blades

Discharge blades shall be provided to scrape dewatered sludge from the belt at the final discharge rollers. The blades shall be of ultra high molecular weight polyethylene (UHMW) construction and shall be readily removable.

2.15 Drainage Pans

Drainage pans shall be provided as necessary to contain filtrate from all dewatering areas within the belt filter press without splashing and to prevent rewetting of downstream cake. All drainage piping shall be furnished, adequately sized for the intended service, and rigidly attached to the press frame. Drainage piping shall terminate inside the structural frame at the bottom of the press. Drain connection shall be self-venting to prevent overflow. Drainage pans shall be located so that the moving belts do not come into contact with the pans under any condition.

2.16 Control System

Each belt filter press shall be provided with a control panel that will contain the necessary control devices and equipment for controlling the dewatering process as described herein.

GENERAL CONSIDERATIONS

The control panel shall accept a 460 VAC, 60 hertz, 3-phase power input. A main disconnect circuit breaker and operator mechanism shall be included. When the disconnect is in the open

position, all power shall be removed from the control system. IEC rated motor starters shall be provided for the hydraulic unit and washwater pump. A VFD will be supplied for the belt drive. A control power transformer shall be included that will provide 120 VAC control power to the system. All logic functions for the system shall be performed by an industrial programmable logic controller (PLC) located in the control panel.

Located on the front of the control panel shall be a CONTROL POWER OFF/ON switch. When in the ON position, the CONTROL POWER ON pilot light will be illuminated and control power shall be distributed to the control system. When in the OFF position, the control system shall be held de-energized. Also located on the control panel shall be an EMERGENCY STOP pushbutton. It shall be an illuminated mushroom head style pushbutton that when depressed shall immediately de-energize all moving equipment in the system. An alarm horn shall be included for audible alarm annunciation.

SYSTEM OPERATION

As a minimum, the following control pilot devices shall be located on the front of the control panel:

HAND/OFF/AUTO MODE selector switch

HAND MODE indicator

AUTO MODE indicator

AUTO START pushbutton

AUTO STOP pushbutton

SYSTEM RESET pushbutton

ALARM SILENCE pushbutton

LAMP TEST pushbutton

PRESS READY indicator

DEWATERING OFF/ON selector switch

WASHDOWN CYCLE ON indicator

BELT INSTALLATION OFF/ON selector switch

WASHWATER VALVE OPEN pushbutton

WASHWATER VALVE CLOSE pushbutton

WASHWATER WATER RUNNING indicator

HYDRAULIC PUMP START pushbutton

HYDRAULIC PUMP STOP pushbutton

HYDRAULIC PUMP RUNNING indicator

BELT DRIVE START pushbutton

BELT DRIVE STOP pushbutton

BELT DRIVE RUNNING indicator

BELT DRIVE SPEED controller (0-100%)

CONVEYOR START pushbutton

CONVEYOR STOP pushbutton

CONVEYOR RUNNING indicator

SLUDGE PUMP START pushbutton

SLUDGE PUMP STOP pushbutton

SLUDGE PUMP RUNNING indicator

SLUDGE PUMP SPEED controller (0-100%)

POLYMER PUMP START pushbutton

POLYMER PUMP STOP pushbutton

POLYMER PUMP RUNNING indicator

POLYMER PUMP SPEED controller (0-100%)

LOW WASHWATER PRESSURE indicator

LOW HYDRAULIC PRESSURE indicator

BELT MISALIGNED indicator

BELT BROKEN indicator

NO CAKE indicator

EMERGENCY STOPPED indicator

BELT DRIVE FAIL indicator

The control panel shall require the following discrete signal inputs from others. The signals shall be normally open dry contacts and shall close when the equipment is running.

a) Sludge pump running

b) Polymer pump running

c) Conveyor running

The control panel shall provide the following discrete signals for use by others. The signals shall be dry contacts.

a) Press running (N.O. close when running)

b) Press fault (N.O. close on alarm)

c) Conveyor run (N.O close to run)

d) Sludge pump run (N.O. close to run)

e) Polymer pump run (N.O. close to run)

The control panel shall require the following analog signals from others.

a) Sludge pump speed or flow (4-20 mA)

b) Polymer pump speed or flow (4-20 mA)

The control panel shall provide the following analog signals.

a) Sludge pump speed (4-20 mA)

b) Polymer pump speed (4-20 mA)

SEQUENCE OF OPERATION

The press may be operated in the automatic mode by placing the HAND/OFF/AUTO selector switch in the AUTO position. The AUTO MODE indicator will illuminate and the operator will press the AUTO START pushbutton. At this time, the hydraulic pump, washwater pump and washwater valve will be energized and a belt tensioning time delay will start.

After the belt tensioning timer times out, the belt drive will be energized and a belt pre-wet time delay will start. After the pre-wet timer times out, the conveyor will be energized, the PRESS READY pilot light will be illuminated and, if the DEWATERING ON/OFF selector switch is in the ON position, the sludge and polymer pumps will be energized. .

Pressing the AUTO STOP pushbutton will de-energize the sludge and polymer pumps illuminate the WASHDOWN ON pilot light and start a wash down time delay. After the wash down timer times out, the belt drive, washwater valve, washwater pump, hydraulic pump and conveyor will be de-energized.

To operate the press in the manual mode, the operator will place the HAND/OFF/AUTO selector switch in the HAND position. The HAND MODE indicator will be illuminated. The operator will start the washwater pump by pressing the WASHWATER PUMP START pushbutton; start the hydraulic pump by pressing the HYDRAULIC PUMP START pushbutton. Anytime the washwater pump is running, the washwater valve shall be energized.

The operator should not proceed until the belts have been fully tensioned. No interlock is provided to prevent the operator from starting the belt drive in the manual mode. Pressing the BELT DRIVE START pushbutton will energize the belt drive and after a pre-wet time delay will illuminate the PRESS READY pilot light. At this time, the operator will start the conveyor by pressing the CONVEYOR START pushbutton, start the sludge pump by pressing the SLUDGE PUMP START pushbutton and start the polymer pump by pressing the POLYMER PUMP START pushbutton.

Pressing the respective STOP pushbutton in the reverse order stated above will stop the system.

FAULTS

When any of the following fault conditions occur, in automatic or manual mode, the appropriate fault indicator will be illuminated, the alarm horn will sound and the belt filter press and associated equipment will be de-energized.

EMERGENCY STOP

LOW WASHWATER PRESSURE

HYDRAULIC PRESSURE FAULT

BELT MISALIGNED

BELT BROKEN

BELT DRIVE FAIL

The following fault conditions will cause the wash down cycle to be initiated in the automatic mode (annunciation only in the manual mode):

NO CAKE

ENCLOSURES

Control panel enclosures shall be fabricated of type 304 stainless steel and shall be suitable for NEMA 4X service. Enclosures shall be manufactured by Hoffman Manufacturing, Steeline or equal.

WIRING

All power and control wiring shall be 600 volt, type THHN/THWN or MTW insulation stranded copper and shall be sized for the required load, 14 AWG minimum.

CIRCUIT BREAKERS

The circuit breaker for the main disconnect shall be thermal magnetic molded case units. The circuit breaker shall be Allen Bradley type 1404 or equal.

MOTOR STARTERS

Motor starters shall be full voltage, non-reversing, IEC style across-the-line units. Coils shall be 120 VAC. The starters shall be Allen Bradley style 140Mw/100 contactors.

SPEED CONTROLLERS

The speed controllers shall be capable of outputting a 4-20ma DC or 0-10v DC setpoint control signal and accept a 4-20ma DC or 0-10v DC status signal. The controller shall be capable of PID control. The controller shall be Red Lion P48 or equal.

SELECTOR SWITCHES

All selector switches shall be heavy duty, oil tight/watertight, corrosion resistant units rated for NEMA 4X service. Contact blocks shall be rated for 10-ampere continuous service. Selector switches shall be Allen Bradley, type 800 H or equal.

PUSHBUTTONS

All pushbuttons shall be heavy duty, oil tight/watertight, corrosion resistant units rated for NEMA 4X service. Contact blocks shall be rated for 10-ampere continuous service. Pushbuttons shall be Allen Bradley, type 800 H or equal.

PILOT LIGHTS

Pilot lights shall be heavy duty, oil tight/watertight, corrosion resistant units rated for NEMA 4X service. Units shall be 120 VAC transformer type. Pilot lights shall be Allen Bradley, type 800 H or equal.

TERMINAL BLOCKS

Terminal blocks shall be high density, spring cage clamp style, with 600 volt rating. Terminal blocks shall be Wago, Class 280, or equal.

PROGRAMMABLE LOGIC CONTROLLER (PLC)

The PLC shall be a modular type with discrete and analog capabilities. The CPU shall have 4K minimum RAM for user instructions. The unit shall have battery backed RAM and EEPROM backup. The PLC shall be an Allen Bradley Micrologix, SLC 500 or equal.

VARIABLE FREQUENCY DRIVE (VFD)

The VFD shall be UL listed and shall be Allen Bradley Powerflex style or approved equal.

2.17 Spare Parts

The following spare parts shall be furnished with the belt filter presses:

1. One set of filter belts for each press supplied.

2. Two complete sets of doctor blades for each press supplied.
3. One of each size and type of roller bearing complete.
4. Two complete sets of rubber seals for the gravity and wedge zone for each press supplied.
5. Two complete sets of belt wash box seals for each press supplied.

PART 3 EXECUTIOIN

3.01 Start-up and Operator Training

Services of the manufacturer's factory trained representative, who is specifically knowledgeable in the type of equipment specified herein, shall be provided during the equipment installation period. Upon complete installation of equipment by installing contractor, including placement of equipment, setting and leveling the equipment, piping and electrical connections to all the equipment specified herein, the manufacturer’s service representative will approve the installation and begin start up and training.

Upon approval of the installation, the services of the manufacturer's factory trained representative shall be provided at the project site for equipment start-up and calibration. During the start-up and calibration phase the manufacturer's representative shall inspect all system components for proper connection and alignment and assist the installation contractor in placing the equipment in a proper operating condition.

Upon satisfactory completion of the start-up and calibration, a representative of the manufacturer shall be provided to instruct Owner's personnel in the proper operation and maintenance of the equipment. The manufacturer's representative who will be providing the instruction shall have prior operation, maintenance and instructing experience acceptable to the Engineer. The contractor shall submit the individual's name and qualifications to the Engineer for approval at least one week prior to the scheduled operating and maintenance instruction sessions. The number of days listed below for services of the manufacturer's factory trained representative shall be provided when requested by the Owner or the Engineer during the contract period.

The manufacturer’s representative shall complete all of the above sessions in a total of two trips to the jobsite. The equipment manufacturer will request in writing that all installation prior to arriving at the jobsite be completed by the contractor. If the equipment manufacturer arrives at the jobsite and equipment installation is not complete, the equipment manufacturer shall bill the contractor at the manufacturer's standard service rates, or as agreed to at the time of the service request.

Period	Number of 8-hour days/Unit
Inspection / Start Up and Calibration	4
Operator Training	2

Start-Up. Beneficial use will not occur until after the start-up activities have been performed and accepted by the City Engineer. Start-up activities include the following:

Receipt and acceptance by the City Engineer of draft Operation and Maintenance manuals, including the wiring and ladder diagrams.

Installation inspection by City operating, electrical and instrumentation staff followed by any corrective measures required by the Contractor.

Satisfactory operation of belt filter press systems for 7 consecutive days under the City's control. If malfunctions or other operational problems halt the 7-day test period, the Contractor shall make appropriate corrections and restart the 7-day test period.

Receipt by the City Engineer of accessories and spare parts.

END OF SECTION

Section 13111

CATHODIC PROTECTION FOR WATER TANK INTERIORS (SACRIFICIAL ANODE)

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Requirements for sacrificial anode cathodic protection systems for the interior submerged surfaces of steel water storage tanks.

B. Specifications for anodes, wiring, test station and long life reference electrodes.

C. Requirement that all materials in contact with the water or exposed to the interior of the tank to be classified in accordance with ANSI/NSF 61 - Drinking Water System Components.

D. Reference to the National Electrical Code (latest edition) which is part of this specification.

1.02 RELATED SECTIONS

A. Section 01110 – Summary of Work

B. Section 01330 – Submittal Procedures

C. Section 01351 – Environmental Safety and Worker Protection

D. Section 13113 – Cathodic Protection for New Tank Bottoms

E. Section 13201 – Welded Steel Water Storage Tanks

1.03 UNIT PRICES

A. There is no separate measurement and payment for work performed under this Section. Include the cost for this work in the contract bid price for work of which this is a component part.

B. Payment will be full compensation for all labor, equipment, materials and supervision for the installation of the cathodic protection system, complete in place including anodes, reference cells, wiring, and all field welding, connections, adjustments, testing, cleanup, and other related work necessary for construction as shown on the Drawings and specified herein.

1.04 REFERENCES

A. ANSI/NSF 61 - Drinking Water System Components

B. ASTM D1248 – Polyethylene Plastics Extrusion Material for Wire Cable.

C. AWWA D100 - Standard for Welded Steel Tanks for Water Storage

D. AWWA D102 – Standard for Painting Steel Water-Storage Tanks

E. City of Houston Electrical Code.

F. NEC 70 - National Electrical Code (latest revision).

G. DOT 199 – Federal Substance Abuse and Testing Regulations

H. NACE International SP0196 – Galvanic Anode Cathodic Protection of Internal submerged surface of Steal Water Storage Tanks

I. UL 83 - Thermoplastic-Insulated Wires.

J. UL 467 - Bonding and Grounding Equipment

K. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors

1.05 SUBMITTALS

A. General: Submittals to conform to the requirements of Section 01330 - Submittals.

B. Design Drawings and Computations: Prepare all computations and drawings by or under the direct supervision of a Corrosion Engineer who is a Professional Engineer, registered in the State of Texas with a minimum of ten years experience in cathodic protection design for water storage tanks. Design the system to provide effective corrosion control in accordance with the criterion for protection which is a tank-to-water potential, IR drop free, within a range of -0.850 volts to -1.050 volts relative to copper-copper sulfate reference electrode. Measure this potential free of the effect of voltage gradients (IR drops).

The Corrosion Engineer to base system capacity on:

1. Total surface area of the tank. Total surface area includes to the high water level (HWL) in bowl and wet risers in elevated tanks, which are 30 inch diameter or larger.

2. High quality interior coating.

3. Protection of bare steel surfaces due to coating deterioration of up to 10% of the total submerged surface area.

4. Chemical analysis of water including resistivity.

5. Minimum anode system life of twenty (20) years.

Provide certificate, signed and sealed by Professional Engineer stating that computations and Drawings are in conformance with these design criteria.

C. Catalog Cuts: Submit manufacturer's catalog cuts for the system which demonstrates classification in accordance with ANSI/NSF 61 - Drinking Water System Components.

D. Operating and Maintenance Manual: Submit six (6) operating, monitoring and maintenance manuals for the cathodic protection system. Include operating instructions, maintenance data, product data and test procedures in the manuals.

E. Drawings: Maintain as-built Drawings of the corrosion system during installation and construction. Revise drawings to show exact locations of all wiring, connections and terminal boxes. Properly identify all items of equipment and material. Submit the original as-built Drawings to the City of Houston representative.

1.06 QUALITY CONTROL

A. Certification: Provide manufacturer's certification that all components of the cathodic protection system meet the requirements of the Drawings and specifications.

B. Drawings: The Drawings for the cathodic protection systems are diagrammatic. Do not scale the Drawings for exact locations unless scales are explicitly stated on the specific drawing. Determine exact locations by field conditions and non-interference with mechanical and structural features.

C. Inspection: All materials, fabrication and installations are subject to inspection and testing by the City of Houston or its designated representative.

1.07 QUALIFICATIONS

A minimum of five years experience installing and servicing the types of system described in this specification is required of the Cathodic Protection Contractor. Install the system by employees of the Cathodic Protection Contractor who have experience in the installation of water tank systems. All personnel subject to Federal Substance Abuse and Testing Regulations as required by DOT 199.

PART 2 PRODUCTS

All materials in contact with the water or exposed to the interior of the tank are to be classified in accordance with ANSI/NSF 61 “Drinking Water System Components”.

2.01 ANODES

A. General: Anode material to be high potential magnesium, having a diameter of 2.024 ±0.024 inches, extruded on a solid, 1/8 inch steel core with nominal length of 10 feet for each anode.

B. Composition: High potential magnesium alloy to conform to the following:

Element	% by Weight
Silicon	0.05 maximum
Copper	0.01 maximum
Nickel	0.001 maximum
Iron	0.002 maximum
Aluminum	2.5 – 3.5
Zinc	0.7 – 1.3
Manganese	0.2 minimum
Other	0.3 maximum
Magnesium	Remainder

C. Anode Lead Wire: Use No. 8 AWG stranded copper wire with medium density, high molecular weight polyethylene (HMWPE) insulation. Polyethylene to conform to ASTM D 1248, Type I, Class C, Grade 5.

D. Connection: Connect the anode-to-wire with a Thomas & Betts, C tap, crimp connector sized for No. 8 AWG stranded copper conductor. First crimp the wire to the 1/8-inch anode core and then silver solder to ensure electrical continuity and strength.

E. Anode Eye Ring: Drill and tap the end of the anode to a depth of 1-1/2 inches adjacent to the core wire. Screw a 3/8-inch diameter eye ring with a 3-inch shaft and a 1-inch inside diameter eye loop, 1-½ inches into the anode.

F. Encapsulation: Encapsulate the crimped connection and the shaft of the eye ring in epoxy. See Drawings.

2.02 MONITORING STATION

A. Enclosure: Use a NEMA 4X enclosure for the cathodic protection system monitoring station.

B. Meter: Cathodic protection potential/anode current DC voltmeter to have a push to read button connecting the permanent reference cell to the digital voltmeter with an internal resistance of not less than 1,000,000 ohms/volt and a minimum full scale of 1999 mV.

C. Shunt: Place a calibrated shunt in the anode circuit wired to the DC voltmeter for measuring DC current.

D. Resistor: Equip the monitoring station with a variable resistor (rheostat) sized not less than a 100 watt, 100 ohm, connected between the anode header cable and the tank lead wire.

E. Tank Negative Lead: Use No. 8 AWG stranded copper with THHW insulation for the system ground.

F. Test Lead: Install independent structure test lead not smaller than No. 18 AWG stranded copper TW or THHW insulation on the potential test circuit.

G. Tank Connections: Space the anode system structure and test structure connections six (6) or more inches apart on ladder stand off welded to tank shell. Connect with brass bolts as shown on Drawings.

H. Monitoring Station Mounting: Locate the monitoring station on the exterior of the tank for convenient operator serviceability approximately five (5) feet off the ground near the ladder.

2.03 REFERENCE ELECTRODES

A. General: Install two (2) copper-copper sulfate electrodes, manufactured with 99.99% pure copper coiled element. Cells are to remain stable (plus or minus 10 mV) in fresh water for a minimum of ten years.

B. Lead Wires: Use No. 14 AWG stranded copper wire with blue, medium density, high molecular weight polyethylene (HMWPE) insulation for the reference cell lead wire. Polyethylene to conform to ASTM D 1248, Type I, Class C, Grade 5. Terminate lead wire at monitoring station.

C. Encapsulation: Encapsulate the reference electrode to lead wire connection in epoxy to prevent water penetration.

2.04 ANODE SUSPENSION SYSTEM

A. Cord: Suspend the anode from a minimum 5/16 inch diameter polyester cord, tied to the anode eye ring and anchored to the roof of the tank as shown on the Drawings.

B. Lead Wires: Do not use the anode lead wire to support the weight of the anode.

2.05 ANODE HEADER CABLE

A. General: Use No. 8 AWG stranded copper, HMWPE insulated cable. Install header cable without cutting any strands of copper and run from each anode completing a full 360^0 circle. Extend both ends of the anode header cable to the monitoring station where one end will terminate on a variable resistor. Connect the other end of the resistor to the tank with a No. 8 AWG copper wire. Terminate the other end of the header cable with a wire nut.

B. Interior Wiring: Insulate all wiring within the tank to prevent copper conductor contact with the potable water.

C. Exterior Wiring: Use stranded copper conductors, run in rigid, galvanized steel conduit for all wiring on the exterior of the tank.

2.06 ANODE CONNECTIONS

A. Connectors: Use a Thomas & Betts, C tap, crimp connector for a No. 8 AWG stranded to No. 8 AWG stranded copper wire connection for the anode lead wire to header cable splices.

B. Sealant: Seal splices between anode lead wires and collector cable with Scotchfill Insulation Putty, Scotch 130C Rubber Tape, and Scotch Super 88 Plastic Tape as manufactured by 3M. Coat the completed splice with Scotchkote.

PART 3 EXECUTION

3.01 PERFORMANCE

Perform all work in accordance with the following requirements:

A. General: Install components of the cathodic protection system in the manner and at the locations shown on the Drawings prepared by the Corrosion Engineer.

B. Inspection: Prior to installation, have the City of Houston or its designated representative, inspect materials and equipment. Replace any defective materials or components that do not satisfy the requirements of this specification.

C. Tank Attachments: All attachments to the interior, wetted surfaces of the tank should be constructed of non-metallic materials or mild steel that is provided with the same protective coating system as the tank shell. Where stainless steel accessories are used, such as ladders or safety rails, the stainless steel shall be electrically isolated from the tank.

D. Welding, Cutting and Coating: Follow AWWA Standards D 100 and D 102 for welding, cutting, and coating.

E. Electrical Continuity: Assure continuity by spot welding all sections of bolted or riveted tanks. Tank Construction Contractor to perform the welding.

F. Wiring: Handle and install lead wires to prevent damage from abrasion.

G. Connections: Seal electrical connections within the tank to prevent water penetration.

H. Monitoring Station: Mount the monitoring station at a convenient height (eye level) above grade for monitoring and service purposes.

I. Disinfection: The Tank Construction Contractor is responsible for disinfection.

J. Workmanship: Complete the work in a clean and safe manner.

K. Tank Closure: Security of all tank access locations (e.g. hatches) is the responsibility of the City of Houston.

3.02 ENERGIZING SYSTEM

A. General: After the system is installed and the tank is filled, provide startup service, which includes energizing, testing, and adjusting the system for optimum performance.

B. Prior to native state, polarized potential testing and commissioning of the system, give a minimum of 48 hours notice to the City of Houston, Engineering Project Manager to facilitate observation of the tests by a City Representative.

C. Method: Record all tank-to-water potential measurements with a calibrated, portable, copper-copper sulfate reference electrode and a portable, high impedance voltmeter. Measure native state, current "on" and "instant off" potentials at a minimum of five locations within the tank. Record potential and current measurements at the monitoring station.

D. Report: Review and evaluation of all test data is the responsibility of the Corrosion Engineer. In addition to the startup service, submit "as-built" drawings and an Operations and Maintenance Manual in accordance with Section 1.05.

END OF SECTION

Section 13440

PROCESS CONTROL SYSTEM

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Programmable logic controllers (PLCs), remote input/output (I/O) units, Human Machine Interface (HMI), and programmer.

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA).

1. NEMA ICS 1 - General Standards for Industrial Control and Systems.

2. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.

3. NEMA ICS 3 - Industrial Systems.

4. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

5. NEMA ST 1 - Standard for Specialty Transformers (Except General Purpose Type).

B. Instrument Society of America (ISA).

C. Underwriters Laboratories, Inc. (UL).

D. Factory Mutual (FM).

E. Institute of Electrical and Electronic Engineers (IEEE).

F. National Fire Protection Association (NFPA). ANSI/NFPA 70 - National Electrical Code (NEC).

G. Joint Industrial Council (JIC).

H. American National Standards Institute (ANSI).

1.03 SUBMITTALS

A. Submit product data, shop drawings and samples (if samples are requested by the City Engineer) under provisions of Section 01330 - Submittal Procedures.

1. Submit in complete packages grouped to permit review of related items as outlined in these specifications.

2. Bind submittals in three-ring binders with complete indexing and tab dividers. Completely tag and label equipment information to correspond with Drawings.

3. Review of Submittals will be for conformance to Contract Documents and for application to specified functions.

B. Product Data: Submit descriptive product literature including manufacturer's specifications for each component specified.

C. Shop Drawings: Indicate layout and mounting of completed assemblies and systems, interconnecting piping and cabling, dimensions, weights, external power and communication connections and programming information.

1. Panel, Console and Cabinet Information.

a) Layout drawings, including the following:

1) Front, rear, end and plan views to scale.

2) Dimensional information.

3) Tag numbers and functional names of components mounted in and on panels, consoles or cabinets.

4) Product information on panel components.

5) Nameplate locations and legends, including text, letter sizes and colors to be used.

6) Location of anchoring connections and holes.

7) Location of external wiring and piping connections.

8) Mounting and installation details.

9) Proposed layouts and sizes of graphic display panels.

b) Wiring and piping diagrams, including the following:

1) Name of panel, console or cabinet.

2) Wiring sizes and types.

3) Piping and tubing sizes and types.

4) Terminal strip numbers.

5) Color coding for each wire and color coding legend.

6) Functional name and manufacturer's designation of components to which wiring and piping are connected.

c) Electrical control schematics in accordance with JIC standards.

d) Plan showing equipment layout in each area.

2. Field Wiring and Piping/Tubing Diagrams

a) Wiring and piping/tubing sizes and types.

b) Terminal strip, device terminal and wire numbers.

c) Color coding.

d) Designation of conduits in which wiring is to be located.

e) Location, functional name and manufacturer's designation of items to which wiring or piping are connected.

f) Point-to-point wiring diagrams identifying every termination point and connection.

3. Instrumentation Diagrams

a) Prepare instrument loop diagrams for analog and digital displays, and control and I/O loop diagrams, using ISA standard symbols in accordance with ISA Standard S5.4. and include the following:

1) Instrument tag numbers.

2) Functional name, manufacturer's name, product name and model or catalog number of each item.

3) Location of each item.

b) Submit loop diagrams, wiring diagrams, PLC and control schematics on DVD, formatted as AutoCAD files using the latest release of AutoCAD current and available on bid date, or any subsequent version as well as PDF format. Identify diagrams, schematics and other files with computer-printed labels affixed

to each diskette. Leave at least 200,000 bytes free space available on each DVD.

c) In addition, submit such diagrams and schematics laser-printed on 8.5-inch x 11-inch paper. Use lettering and numerals of at least 1/16-inch nominal height.

4. Programmable Controller System I/O Loop Wiring Diagrams

a) Prepare drawings on a module-by-module basis. Include the following information:

1) Rack numbers, module types and slot numbers, module terminal point numbers, and location and identification of intermediate panel and field terminal block and strip numbers to which I/O wiring and power supply wiring is connected. Identify power supply circuit numbers and ratings.

2) Wiring sizes, types, wire numbers and color coding.

3) Designation of conduits in which field I/O wiring is to be run.

4) Locations, functional names, tag numbers and manufacturer's names and model numbers of panel and field devices and instruments to which I/O wiring is connected. Label wiring and cables at both ends and within junction and terminal boxes. Use sleeve-type plastic wire markers covered with clear heat-shrink labels, or machine-printed permanent ink heat-shrink labels by Brady or approved equal.

b) For each drawing, submit one reproducible hardcopy and one copy on DVD, formatted as AutoCAD files using the latest release of AutoCAD current and available on bid date, or any subsequent version as well as PDF format. Identify diagrams, schematics and other files with computer-printed labels affixed to each diskette. Leave at least 200,000 bytes free space available on each DVD.

c) In addition, submit such diagrams and schematics laser-printed on 11 x 17 inch paper. Use lettering and numerals of at least 1/16 inch nominal height.

5. System Programming Information

a) At least six weeks prior to substantial completion, submit

detailed programming information consisting of ladder logic and proposed program code, complete input, output, relay, register and controller identification labels, memory allocation table, and written description of program operation.

b) Ladder logic diagrams shall contain a written descriptive note for each line of program code describing the function and logic of that line.

c) Submit documents in hard copy and as computer-readable files on DVD. Leave at least 200,000 bytes free space available on each DVD. PLC, HMI, MPR, VFD and all other operational, installation and application related programs required necessary by the City of Houston with the installation shall be submitted in native programming language files.

d) The SCADA software engineer shall provide submittals per the Wastewater Operations SCADA Software Engineering Security and Quality Requirements (Section 13441).

D. Quality Control Submittals

1. Factory Test Reports: If specified, submit 6 copies.

2. Testing Procedures: Submit testing procedures proposed to verify input, output, loop and register operations, system logic verification, and spare memory capacity. Testing procedures shall detail, as a minimum, verification of required functions as follows:

a) Verification of pump start, pump stop, and well level alarm outputs by simulation of analog signals representing pump level.

b) Verification of each discrete input via external manually-operated switch.

c) Verification of each analog input by connection of external analog indicator in input loop.

d) Verification of each analog output by connection of external analog indicators.

e) Verification of communications system by hardwire connection via modem and wiring to a similar unit. Demonstrate operation and status monitoring of each register specified for external monitoring.

f) Verification of spare memory capacity by hard copy printout of full memory bit map after successfully demonstrating that

system logic, inputs, outputs and communications features are fully installed and operational.

g) Test and verify system with external devices required to simulate field connections connected simultaneously for a full system test.

h) Reconnecting external devices to verify portions of the systems at a time is not acceptable.

3. Certificates: Under provisions of Section 01450 - Contractor's Quality Control, submit manufacturers' certificates that equipment and systems meet or exceed specified requirements.

4. Instructions: Submit manufacturer's installation instructions for each component specified.

5. Field Reports: Submit 6 copies of Manufacturer's Installation Inspection, Field Calibration and Field Testing Reports.

E. Operations and Maintenance (O&M) Data.

1. Submit operation and maintenance data notebook in accordance with Section 01782 - Operations and Maintenance Data.

2. Information and drawings submitted must reflect the final installed condition. Revise documents requiring updates following testing and start-up.

3. In addition to the content specified in Section 01782 - Operation and Maintenance Data, provide the following information:

a) Name, address and telephone number of the control system supplier's local service representative.

b) Complete list of supplied system hardware parts with full model numbers referred to system part designations, including spare parts and test equipment provided.

c) Copy of approved submittal information and system shop drawings as specified in Paragraph 1.3, Submittals, with corrections made to reflect actual system as tested, delivered and installed at the site. Provide half-size blackline reproductions of all shop drawings larger than 11 inches x 17 inches.

d) Complete up-to-date system software documentation.

e) Original copies of manufacturer's hardware, unprotected software, installation, assembly and operations manuals for the programmable controller and data communication system, single loop and multi-loop controllers and other control system components. In addition to hard copy versions, provide all manuals in PDF format on DVD.

f) Instructions for PLC replacement adjustment, and preventive maintenance procedures and materials.

g) Control system description and system operation sequence instructions.

h) For each major system/subsystem, in separate binders, submit PLC ladder logic programming documentation (fully annotated of each network headers, logical elements, control descriptions), PLC I/O schematics, control and loop diagrams, electrical drawings, system description, operation instructions AutoCAD and PDF format and files on DVD.

F. Project Record Documents

1. Submit record documents under provisions of Section 01785 - Project Record Documents.

2. Revise system shop drawings, software documentation and other submittals to reflect system as installed. Accurately record locations of controller cabinets and input and output devices connected to system. Include interconnection wiring and cabling information and terminal block layouts on rite in the rain all weather writing paper in a suitable drawing pocket installed inside the controller cabinet door.

3. Insert half-size blackline prints of wiring diagrams applicable to each control panel in a clear plastic envelope and store in a suitable print pocket or holder inside each control panel.

1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer shall be a company specializing in manufacturing products specified in this Section, having proven compatibility with the City's existing facilities and at least 5 years of documented experience. The company shall maintain service facilities within 100 miles of the City of Houston.

B. System Integrator / Panel shop Qualifications: System Integrator / Panel shop shall be a company specializing in installation of products specified in

this Section, having proven experience with the City's existing facilities and at least 5 years of documented record. The company shall maintain service facilities within 100 miles of the City of Houston.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site in factory-sealed containers. Store and protect products under provisions of Section 01610 - Basic Product Requirements.

B. Check for damage upon receiving products on site.

C. Store products in a clean, dry area; maintain temperature in accordance with NEMA ICS 1.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Maintain temperature above 32 degrees F and below 104 degrees F during and after installation of products.

B. Maintain area free of dirt and dust during and after installation of products.

C. Provide temporary heating and air conditioning units and equipment required to maintain environmental conditions specified for control and MCC panels.

1.07 MAINTENANCE SERVICE

A. Provide manufacturer's maintenance services for programmable logic controllers for one year from Date of Substantial Completion without additional cost to the City.

PART 2 P R O D U C T S

2.01 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. PLC CPU

1. Manufacturer and Model: Siemens Industry, S7-1214C

2. Port: Ethernet, RJ45

3. Built-in Discrete I/O: 14 Discrete Inputs (24 VDC), 10 Relay Outputs

4. Built-in Analog I/O: 2 Analog Inputs

5. Power: 24 VDC

6. Expandability: 8 Signal Modules, 1 Signal Board, 3 Communication Modules

B. Discrete Input Expansion Module

1. Manufacturer and Model: Siemens Industry, S7-1221
2. Discrete Inputs: 16
3. Input Type: 24VDC, Current Sourcing/Sinking

C. Relay Output Expansion Module

1. Manufacturer and Model: Siemens Industry, S7-1222
2. Relay Outputs: 16
3. Output Type: 5-30 VDC, 30W / 5-250 VAC, 200W

D. Discrete Input / Output Expansion Module

1. Manufacturer and Model: Siemens Industry, S7-1223
2. Discrete Inputs: 8
3. Input Type: 24VDC, Current Sourcing/Sinking
4. Relay Outputs: 8
5. Output Type: 5-30 VDC, 30W / 5-250 VAC, 200W

E. Analog Input Expansion Module

1. Manufacturer and Model: Siemens Industry, S7-1231
2. Analog Inputs: 4
3. Input Types: 0-20 ma

F. Analog Output Expansion Module

1. Manufacturer and Model: Siemens Industry, S7-1232
2. Analog Outputs: 4
3. Output Types: 0-20 ma

G. Memory Card

1. Manufacturer and Model: Siemens Industry, S7-954

2. Capacity: 4 MB or larger.

2.02 NETWORKING

A. Communication interfaces

1. Profibus-DP: Integral to CPU, master/slave, capable up to 12 Mbit/sec, configured in standard PLC programming environment. Supports Profibus-DP Master, Profibus-DP Slave, MPI with programmer, HMI and S7 communications.

2. Ethernet Interface: Integral to CPU, 10/100 Mbps with automatic speed detection, supports open TCP/IP, PLC programming, HMI communications, ST Communications, Profinet CBA and Profinet IO-Controller.

3. Ethernet Switch: Managed Industrial Ethernet Switch to be mounted in control panel and connected to PLCs with Ethernet interface.

B. ETHERNET SWITCH

1. Industrial Ethernet Switch: Managed Industrial Ethernet Switch to be mounted in control panel and connected to PLCs with Ethernet interface.

a) Fiber Optic Networks: SCALANCE X204-2

1) Manufacturer and Model: Siemens X204-2

2) Electrical Ports: Four RJ45, 10/100 Mbps, Connectors latch to housing for strain relief.

3) Optical Ports: Two female ST pairs, 100 Mbps

4) Fiber Topology: Bus, Star, and Ring

5) Power: Redundant 24 VDC

6) Mounting: Standard DIN rail, PLC Rail

7) Diagnostic LEDs: Power, Link Status, Communications

8) Housing: Metal

9) Include C-Plug Configuration Plug

b) Copper-Only Networks: SCALANCE X208

1) Manufacturer and Model: Siemens X208

2) Electrical Ports: Eight RJ45, 10/100 Mbps, Connectors latch to housing for strain relief.

3) Power: Redundant 24 VDC

4) Mounting: Standard DIN rail, PLC Rail

5) Diagnostic LEDs: Power, Link Status, Communications

6) Housing: Metal

7) Include C-Plug Configuration Plug

C. ETHERNET CABLING

1. Industrial Ethernet Cable, Copper, for Runs Outside Control Panels

a) Manufacturer and Model: Siemens Energy & Automation, 6XV1-840-2AH10

b) Style: Industrial Ethernet Fast Connect (FC) Standard Cable

c) Type: Four-wire, shielded

d) Jacketing: Green PVC Sheath, 6.5 +/- 0.4 mm OD

e) Temperature: -40 to 158 deg. F operating, transport and storage

f) Include Stripping Tool: Siemens Energy & Automation, 6GK1-901-1GA00

2. Industrial Ethernet Connectors, Copper

a) Manufacturer and Model: Siemens Energy & Automation 6GK1-901-1BB10-2AA0 (straight) or 6GK1-902-1BB20-2AA0 (90-degree)

b) Permissible Cable: Industrial Ethernet FastConnect Cable

c) Installation: Insulation Displacement via simple cable insertion and housing closure

d) Strain relief: Via quarter-turn locking mechanism

e) Housing: Metal with metal spring clip

3. Industrial Ethernet and Profibus Cable, Fiber Optic

a) Manufacturer and Model: Optical Cable Corp)

b) Fibers: 6 multimode fibers minimum, 25% spare pairs minimum, 62.5/125 graded index

c) Type: Tight-Buffered, Riser-Rated, Multi-fiber Breakout-Grade Cable

d) Jacketing: Indoor/outdoor PVC outer jacket, Color-coded subcables protected to permit direct field termination without patch boxes, jumpers, splices, etc.

e) Primary Fiber Buffer: 500 micron acrylate buffer over each optical fiber

f) Secondary Fiber Buffer: 900 micron elastomeric tight buffer over each optical fiber

g) Connectors: ST, Factory-terminated or field-installed and tested

h) Diameter: 9.5 mm (0.37 in)

i) Tensile Load Rating: 270 lbs. long-term, 670 lbs. short-term (installation)

j) Minimum Bend Radius: 3.7” under long-term tensile load, 7.4” under installation load

k) Temperature: -40 to 185 deg. F operating

4. Industrial Ethernet and Profibus Fiber Optic Patch Panel

a) Manufacturer :

1) Panduit

2) Black Box

3) 3M

4) Leviton

5) Corning

b) Design: Metal box with latching door covering two chambers

c) Connectors: Populated 6-packs with ST connectors

d) Mounting: Wall mount

e) Minimum 12 ports and up to 24 ports.

D. PROFIBUS NETWORKING

1. Profibus Cable, Copper

a) Manufacturer and Model:

1) Siemens Energy & Automation, 6XV1-830-0EH1

2) Beldon, 3079A

b) Style: Profibus Fast Connect (FC) Standard Cable

c) Type: Two-wire, shielded

d) Jacketing: Purple PVC Sheath, 8.0 +/- 0.4 mm OD

e) Include Stripping Tool:

1) Siemens Energy & Automation, 6GK1-905-6AA00

2) Phoenix Contact, PSM-STRIP-FC/PROFIB

2. Profibus Connector, Copper

a) Manufacturer and Model:

1) Siemens Energy & Automation, 6ES7-972-0BA50-0XA0

2) Helmholz, 700-972-0BA50/-0FA50

b) Cable Outlet: 90-degree, dual cable path

c) Terminating Resistor: Integrator resistor combination, slide switch enabled

d) Interfaces: DB9F connector and four insulation displacement terminals

2.03 PROGRAMMING, SOFTWARE PROGRAMMING EQUIPMENT

A. Configure system and program for operation as specified in this Section.

B. System Software: Siemens Step 7 software will be loaned by City for utilization by contractor on this project. Contractor to supply any other software or interfaces and cables needed to support equipment supplied on this project.

C. Control Program: A generic lift Station PLC Control Program will be provided by Wastewater Operations. Contractor shall provide necessary programming modifications and enter the required variable parameters to provide a complete functional and integrated system. Contractor shall customize the generic software to meet site-specific conditions. The system shall be fully tested to be operational prior to substantial completion.

D. Control Program Data Sheet: Contractor shall complete and submit Lift Station Data Sheet to Control Program Librarian designated by City of Houston. System I/O list shall be submitted with Data Sheet to the City of Houston two weeks prior to the 7-day test where communication can be verified by the Control Center.

E. Programmer (City of Houston Wastewater Plant applications only): HP ZBook Mobile Workstation or equivalent current model, new, submitted in the original package including manuals having at least the following features as minimum:

1. Operating system: Genuine Windows 7 Professional 64

2. Processor: Intel Core i7-4700MQ Processor (2.4 GHz, 4MB L3 cache)

3. Memory: 8GB 1600 MHz DDR3L SDRAM.

4. Hard drive: 750 GB 7200 rpm SATA, 32GB MSATA SSD

5. Optical drive: DVD-ROM; DVD+-RW SuperMulti DL LightScribe; Blue-ray R/RE DVD+/-RW SuperMulti DL

6. Display: 15.6 diagonal LED-backlight HD anti-glare

7. Graphics: NVDIA Quadro FX 1800M graphics with 1 GB dedicated GDDR5 video memory.

8. I/O Ports: External – 3USB 2.0, 2USB 3.0, 1eSATA, 1 external VGA monitor, 1 Display Port, 1 1394a, 1 stereo microphone in, 1 stereo headphone/line-out, 1 AC power, 1 RJ-11, 1 RJ-45, 1 docking connector, 1 secondary battery connector.

9. Slots: 1 Express Card/54, 1 Smart Card Reader, 1 Secure Digital.

10. Network interface: Integrated Intel Gigabit Network Connection (10/100/1000 NIC).

11. Wireless: HP Mobile Broad (powered by Gobi) with GPS; Intel Centrino Ultimate-N 6300 (3x3) 802.11 a/b/g/n; HP Integrated Module with Bluetooth 2.1 Wireless Technology.

12. Energy Efficiency: ENERGY STAR

13. Battery: HP Long Life 8-cell (68 WHr) Li-Ion

14. Power supply: External 150-watt Smart AC adapter; External 120-Watt Smart AC adapter; External 90-watt Smart AC adapter; HP Fast Charge

15. Security management: Standard – Integrated Smart Card Reader, HP ProtectTools, TPM Embedded Security Chip 1.2, Enhanced Pre-Book Security, HP Spare Key (require initial user setup), HP Disk Sanitizer, Enhanced Drive Lock, drive Encrption for HP ProtectTools, Credential Manager for HP ProtectTools, File Sanitizer for HP Protect Tools

16. Warranty: HP services offers limited 3-year standard parts and labor onsite, next business day warranty, and toll-free 7 x 24 hardware technical phone support; 1-year limited warranty on primary battery. On-site service and warranty upgrades are also available.

17. Preinstalled Microsoft Windows in latest versions currently available that are compatible with HMI software.

18. Programming cable and adapter for PLC programming.

19. Compaq Workstation carrying case (overall size 18"x13"x5").

F. Provide at least 25% of each PLC module furnished as spare parts. Minimum spare parts will include the following for each type furnished:

1. Two (2) discrete input, of each type.

2. Two (2) discrete output, of each type.

3. Two (2) analog input, of each type.

4. Two (2) analog output, of each type.

5. Two (2) PLC power supply, of each type.

6. Two (2) CPU with Profibus-DP and Ethernet ports.

7. One Ethernet Switch used (Siemens X-204)

8. One Touch Panel TP-900

G. Connect PLC inputs/outputs including analog inputs through snap-on isolated fused terminal blocks.

H. Separate the AC and control signals from DC and loop signals by at least 6 inches. Provide a barrier between AC and DC within the raceways.

2.04 LOCAL WORK STATION

A. General

1. Manufacturer and Model: Siemens Energy & Automation, TP-900 touch panel.

2. Display: 9.0” 800 x 480 TFT LCD Touch Panel (Belt press, Dechlorination, Polymer system, and NPW)

3. Keyboard: Numeric / Alphabetic Entry.

4. Memory: 12 MB.

5. Memory Card: Two MMC/SD combination slot

6. Operating System: Windows CE

7. Ports: One RS 422/485, USB, Ethernet RJ-45

8. Power: 24 VDC.

9. Certifications: IP65 / NEMA 4 / FM Class I, Division 2 when mounted.

10. Configuration: A generic Lift Station HMI Configuration will be provided by Wastewater Operations. The SE shall provide necessary modifications and enter the required variable parameters to provide a complete functional and integrated system. The SE shall customize the generic software to meet site-specific conditions. The system shall be fully tested to be operational prior to substantial completion.

11. Configuration Software: Configuration software not including cable will be loaned by City for utilization by SE on this project. The SE to supply any other software needed to support equipment supplied on this project.

12. Provide necessary cables and connectors to communicate between Operator Panel and PLC processor. Following is a list of sample displays to be provided for each system:

    a. BELT PRESSES PLC: Display all existing screens (below see a sample of display as minimum)

        1) PLC Screen List

        2) NPW pumps run/fail status, tank high pressure and system high pressure alarms, Pumps start/stop command, pressure and level

        3) Aerobic Digester level indication and low level alarm

        4) Run/alarm status of each BFP pump

        5) Run/alarm status of each belt drive

        6) Flow and flow totalizer and Run/alarm status for WAS pump

        7) Level indication, run and fail alarms for Dewatered sludge transfer pump.

        8) Run/alarm for polymer pumps and system low pressure alarm.

        9) PLC I/O Health Status

        10) 7-day flows and levels trends/alarm summary

    b. RAS PUMPS STATIONS PLC:

        1) Station name, facility number, and address.

        2) Screen Listing.

        3) Status and alarm display for each pump or devices

        4) PLC I/O health Status.

        5) Level Set points for each pump.

        6) Levels and Flow Readings.

        7) One-day levels and flow trends

        8) Seven-day levels and flow trends

c. POLYMER SYSTEM PLC:

1) Station name, facility number, and address.

2) Screen Listing.

3) Status and alarm display for each pump or devices

4) PLC I/O health Status.

5) Level or pressure Set points for each pump.

6) Level, Pressure or Flow Readings.

7) One-day level, pressure or flow trends

8) Seven-day level, pressure and flow trends

d. SCUM PUMPS STATIONS PLC:

1) Station name, facility number, and address.

2) Screen Listing.

3) Status and alarm display for each pump or devices

4) PLC I/O health Status.

5) Level Set points for each pump.

6) Level Reading.

7) One-day level trend

8) Seven-day level trends.

13. Supply configuration software, latest version, and download cable.

14. Note: Pump Information and necessary status points shall be configured as needed. All configurations shall be performed by the contractor.

PART 3 E X E C U T I O N

3.01 SYSTEM DESCRIPTION

A. RAS PLC Station No. 1 and No. 2 Control Panels:

1) Contractor shall provide new RAS pumps PLC control panels with new Stainless Steel NEMA 4X panels with PLC, HMI, H-O-A switches, runs and fails indications shall be provided as shown on the drawing. When H-O-A switch is in Auto, PLC shall start/stop pumps per control set points and conditions. Software mode shall be developed within the plant iFIX and local Siemens HMI. PLC shall generate fail alarm set within the PLC. Run indication (RED pilot light) and Alarm indication (Amber pilot light) shall be provided at the pump panel.

2) Refer to the P&ID diagrams as well as control schematics for all PLC I/O points to be monitored.

B. Belt Presses PLC No. 1 and No. 2 Control Panels:

1) Contractor shall provide new Stainless Steel NEMA 4X Belt press control panel with PLC, HMI, H-O-A switches, Red Lion controllers, runs and fails indications shall be provided as shown on the drawing. When H-O-A switch is in Auto, PLC shall be start/stop pumps per control set points and conditions. PLC program application shall be developed to control all belt filter press feed, WAS, wash water booster, dewatering sludge and polymer pumps. Software mode shall be developed within the plant iFIX and local Siemens HMI.
The belt press control panel shall provide all required interlocks and timer and relay controls when start/stop command is initiated by PLC. PLC shall generate fail alarm set within the PLC. Run indication (RED pilot light) and Alarm indication (Amber pilot light) shall be provided at the pump panel as well as scum pump local disconnect panel. H-O-A, Run, and Alarm shall be connected to the MCC-2 starter buckets for SCADA monitoring as and start/stop outputs. Provide screens for NPW and polymer system to allow operator to monitor level, pressure, run, start/stop of each pump and common alarms.

3) Refer to the P&ID diagrams as well as control schematics for all PLC I/O points to be monitored.

C. Clarifiers Scum Pumps PLC Control Station No. 1 and No. 2 Control Panels. (Manufacturer provided panel).

1) The scum pumps shall be controlled by local PLC control panel. Panel shall be stainless steel NEMA 4X with a main disconnect, motor starters, 3-pos selector switches, pushbutton, pilot lights, PLC and submersible transducers as shown on the P&ID drawing. Power on (Green pilot light), Run indication (RED pilot

light) and Alarm indications (Amber pilot light).

2) General: The scum pump transfers the scum from the scum pit located at each clarifier and moves it to the digesters.

3) Hand: When the Hand-Off-Auto (HOA) switch is set to hand the pump runs continuously unless tripped on over temp or locked out based on low level.

4) Auto: PLC shall start/stop pumps when level reaches the start level and until tripped of by the stop level per control set points and conditions. PLC shall generate fail alarm set within the PLC. Run indication (RED pilot light) and Alarm indication (Amber pilot light) shall be provided at the pump panel.

5) Alarming: During pump failure alarm at scum pump that can be reset via the reset button on the local control panel. Pump failure and high level is monitored by the SCADA.

6) Monitoring: The SCADA monitors on/off, Fails, and high/low levels status for each pump. Software mode shall be developed within the plant iFIX HMI.

D. Chlorine Scum Pumps PLC Control Panel

1) The scum pumps shall be controlled by local PLC control panel. Panel shall be stainless steel NEMA 4X with a main disconnect, motor starters, 3-pos selector switches, pushbutton, pilot lights, PLC and submersible transducers as shown on the P&ID drawing. Power on (Green pilot light), Run indication (RED pilot light) and Alarm indications (Amber pilot light).

2) General: The scum pump transfers the scum from the scum pit located at chlorine contact basin and moves it to the static screens.

3) Hand: When the Hand-Off-Auto (HOA) switch is set to hand the pump runs continuously unless tripped on over temp or locked out based on low level.

4) Auto: PLC shall start/stop pumps when level reaches the start level and until tripped of by the stop level per control set points and conditions. PLC shall generate fail alarm set within the PLC. Run indication (RED pilot light) and Alarm indication (Amber pilot light) shall be provided at the pump panel.

5) Alarming: During pump failure alarm at scum pump that can be reset via the reset button on the local control panel. Pump failure and high level is monitored by the SCADA.

6) Monitoring: The SCADA monitors on/off, Fails, and high/low levels status for each pump. Software mode shall be developed within the plant iFIX HMI.

E. Sludge Thickener Pumps Control Panel

1) The thickener pumps shall be controlled by local control panel. Panel shall be stainless steel NEMA 4X with a main disconnect, motor starters, 3-pos selector switches, pushbutton, pilot lights and HydroRanger ultrasonic transmitter as shown on the P&ID drawing. Run indication (RED pilot light) and Alarm indications (Amber pilot light).

2) General: The sludge thickener pumps transfer the sludge from the gravity thickener tank and moves it to the digesters.

3) Hand: When the Hand-Off-Auto (HOA) switch is set to hand the pump runs continuously unless tripped on over temp or locked out based on low level.

4) Auto: When the HOA switches are set to Auto the sludge pumps will start when the ultrasonic transmitter level reaches the start levels and run until tripped off by the stop levels.

5) Alarming: During pump failure alarm at sludge pump that can be reset via the reset button on the local control panel. Pump failure and high level is monitored by the SCADA.

6) Monitoring: The SCADA monitors on/off, Fails, and high/low levels status for each pump. Software mode shall be developed within the plant iFIX HMI.

F. Communications: PLC shall be capable of full two-way communications with the City of Houston Central Control facility. Communications shall have the capability to transmit all station and pump status and alarms, well levels, PLC status and additional information indicated in the Drawings, and shall receive pump start/stop set points, alarm set points and miscellaneous data via City of Houston SCADA software package and protocol. Provide necessary hardware and software required to implement the communications system as part of pump station control system work. Programming and modifications required at the City of Houston Central Control facility will be performed by the City of Houston. The project SE shall be responsible for coordinating and performing the communication testing verification of I/O via wireless system with wastewater operation staff.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions and Drawings. Provide sufficient clearance for calibration and maintenance access.

B. Do not install products until major construction is complete and building interior is enclosed.

C. Connect input and output devices as shown on Drawings.

D. Provide complete programming, testing and verification of the programmable controller and associated inputs and outputs, including work required to interface with the existing City of Houston system.

3.03 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems under provisions of Section 01755 - Starting Systems.

3.04 DEMONSTRATION

A. Provide systems demonstration under provisions of Section 01770 - Closeout Procedures.

B. Demonstrate operation and programming of controller. Provide 2 sessions of 4 hours of instruction each for 4 persons, to be conducted at project site with manufacturer's representative.

C. System demonstration shall include the following:

1. Complete verification of field wiring.

2. Complete verification of system software.

3. Demonstration of functionality of each discrete input and output by simulation of actual field device action.

4. Demonstration of functionality of each analog input and output by actual variations in the process variable (e.g. well level, etc.).

5. Complete demonstration of each alarm by simulation of actual field device action.

6. Complete demonstration and verification (status/alarm points) of 2-way communication with City of Houston Central Monitoring Facility.

3.05 TRAINING

A. Provide engineering and programming schools preferably at the Houston offices of the PLC manufacturer or distributor or at the manufacturer's factory, as specified below. This training shall be performed by fully-qualified and manufacturer-certified training personnel who can clearly illustrate experience in teaching previous courses. Obtain approval from the Owner's representative for training facility and course outline before scheduling training.

B. If such training is provided somewhere other than Houston, then the system supplier shall provide coach airfare (weekday travel), motel expenses ($95.00/day/person), rental cars ($50.00/day/2 people), and meal allowances $35.00/day/person) for selected City personnel for the duration of the schools.

C. Schedule classes at the City of Houston's convenience. The supplier should not assume that the City's personnel will attend these courses in a continuous and sequential manner. When training is submitted in voucher form, it shall be valid for a minimum of 2 years at no extra cost to the City.

D. Training shall consist of the following as a minimum:

1. PLC basic/advanced programming/maintenance (5 days): Four people

END OF SECTION

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Section 13441

SOFTWARE ENGINEERING REQUIREMENTS

PART 1 P U R P O S E

1.01 The Wastewater Operations Automation and Electrical Support Service Group maintain this document for the communication of the requirements of the SCADA software used for the control and monitoring of the wastewater facilities. These requirements are intended to address three related areas: A) SCADA Homeland Security Requirements, B) Texas Engineering Practice Act, C) COH Wastewater SCADA system quality requirements:

A. According to the National Strategy for Homeland Security Wastewater treatment facilities are part of the nation's critical infrastructure and the government agencies that are responsible shall take specific steps to improve SCADA security.

1. Government agencies are required to "Establish policies to minimize the likelihood that organizational personnel will inadvertently disclose sensitive information regarding SCADA system design, operations, or security controls" and "Release data related to the SCADA network only on a strict, need-to-know basis, and only to persons/entities explicitly authorized to receive such information".

2. In compliance with these Homeland Security requirements all SCADA related information is restricted to authorized personnel.

3. Only SCADA information directly related to the scope of this project will be transferred to SE.

B. In compliance with Texas Engineering Practice Act (Article 3271a) and the recognition that SCADA software is an integral part of the electrical control of the Wastewater facilities and is therefore within the jurisdiction of the act:

1. All SCADA software related work shall be performed by a licensed engineering firm meeting the qualifications as specified in these requirements and referred to within as the Software Engineer (SE). The software produced for the project shall be stamped by SE in accordance with (Article 3271a §137.33 Sealing Procedures for engineering software).

C. Additionally, these requirements are to refine and perpetuate software engineering and software quality standards that will benefit the Wastewater Operation Branch in the areas of facility operations, maintenance, and facility construction projects:

1. The requirements are intended to benefit facility operations through encouraging SCADA standards of consistency in facility functionality and operation, improved process visibility, improved efficiency and control, lower operating costs and reduced potential permit violations. The SCADA standardization also addresses improved technical support and ease of maintenance.

2. These requirements specify SCADA related issues in construction, deliverables and qualifications that will help ensure the availability and quality of SCADA system integration.

3. SCADA related software integration activities have been identified as a key point of quality control for construction projects. The SE shall subcontract directly to the general contractor and shall perform an independent assessment of the SCADA related work of the other subcontractors and equipment suppliers to ensure complete system and software integration within the facility per the construction specification and Wastewater SCADA design guidelines.

PART 2 S C O P E

2.01 The requirements defined in this document apply to Wastewater facility SCADA software including system control, monitoring and integration. The scope includes new and existing facility construction projects where new SCADA software is required or where the existing SCADA software is modified.

2.02 SCADA software activities shall be performed only by the pre-approved SE and include: PLC programming, HMI configuration and graphics development, historical logging software application and report generation, network configuration and programming.

2.03 Manufactured packaged subsystems with pre-engineered software may be specifically excluded if specified in that subsystem equipment specification, that the system shall be shipped with the software as a fully functional unit. The system PLC and HMI hardware and software application shall meet the requirements for SCADA integration and software documentation. The packaged system provider shall deliver all software to SE as soon as possible for the purpose of review and integration.

2.04 These requirements apply to all SCADA security related activities including configuration of servers, workstations and network equipment.

PART 3 SOFTWARE ENGINEERING REQUIREMENTS

3.01 The SE shall perform the software engineering functions as required within the scope section meeting the requirements within.

A. The SE shall use the Wastewater standards for SCADA software (iFIX and Wonderware applications) engineering and Homeland Security in all work performed.

1. The SE shall identify and communicate omissions and required modifications to these standards.

2. Details on these standards are restricted to authorized personnel only according to the Homeland Security requirements and are not included in these requirements. The pre-approved SE is authorized for access to these standards.

3.02 The SE shall provide the SCADA related submittals as defined in the submittals section.

A. The SE shall perform the work required to complete the required SCADA software submittals.

B. The SE shall review and report on the SCADA related submittals of the project subcontractors and equipment providers.

3.03 The SE shall assist the project team including; the engineer, the Wastewater operations SCADA Group and equipment suppliers with the SCADA integration issues.

A. The SE shall attend project meetings as required by the project team.

B. The SE shall assist the project team with functional test of the system.

C. The SE shall provide project related process data from the SCADA system.

PART 4 SUBMITTALS

4.01 Within 45 days of the notice to proceed the SE shall submit a letter of SE qualifications specifically addressing each item of qualification as defined in these requirements.

A. Include the SE professional engineering firm licensed number and date of issuance.

B. Include a statement addressing the awareness of the Homeland Security concerns and intention to restrict the dissemination of security sensitive SCADA network information to those who are authorized by the COH and require the information in the support of this project.

4.02 Within 90 days of the notice to proceed the SE will submit the Software Engineering Manual (Preliminary Report).

A. Include the software conventions for the use in the HMI development.

B. Include diagrams and schedules for all network devices associated with the process control and monitoring for the facility/facilities.

C. Include the interfaces for the City SCADA network.

D. Identify every network component (new and existing).

E. The Software Engineering Manual will be updated for the final O&M.

4.03 The SE will submit letters of software and network integration compatibility to be included in all the control related submittals.

A. Included but not limited to: PLCs, network devices, computers, HMI devices.

B. Include deviations from City standards and the construction specifications for electrical control drawings and tag naming conventions.

C. Include deviations from the submitted Software Engineering Preliminary Report.

D. Include the manufacturer supplied package systems with control panels.

E. The SE shall distribute monthly a Software Engineering Integration Schedule highlighting software and system integration progress and issues.

4.04 Factory demonstration test confirmation report

A. After the required factory demonstration test the SE shall submit a report confirming the related software and network compatibility.

4.05 Field Acceptance Functional Test

A. Shall be completed prior to performance and reliability testing.

B. Field Acceptance Functional Test Submittals shall include:

1. Field Acceptance Functional Test Plan Submittal.

2. Description of plan for testing field devices.

3. Description of plan for function test and system integration of each subsystem.

4. Field Acceptance Functional Test Schedule shall be submitted after the acceptance of the test plan submittal.

5. Field Acceptance Functional Test plan completion report shall be submitted.

4.06 Software Engineering Manual (Updated Final Version)

A. Update and submit a singled CD with all related SCADA software.

B. Control and network components.

C. Inventory of software components.

D. Network device configuration documentation.

E. Software Engineering documentation.

F. PLC and HMI software shall be documented using the product development tool.

G. Software shall be stamped as required in Texas Engineering Practice Act (Article 3271a §137.33 Sealing Procedures) with the date, the engineers name, the PE designation with license number.

H. The SE will collect and submit all software and network device configuration programs and data developed for the project.

PART 5 S O F T W A R E E N G I N E E R (S E) Q U A L I F I C A T I O N S

5.01 The Wastewater Operations Automation and Electrical Support Services group has set forth these qualifications for performing all SCADA related

software activities for the wastewater facilities as defined in these requirements.

5.02 The SE shall be approved by Wastewater Operations SCADA staff.

5.03 Specific qualifications for approved SE:

A. The SE shall be a Texas Registered Professional Engineering firm with a minimum of five (5) years of licensed history with the software engineering of the control systems for wastewater treatment processes.

B. The SE shall be experienced with the software application development packages which are used as standards for Wastewater Operations including a minimum five (5) years of software engineering experience with G.E. IFIX HMI application development packages and Siemens PLCs.

C. The SE shall demonstrate a minimum of five (5) years of network System expertise. This ensures the SE has the required expertise to configure, secure and maintain the SCADA system network for applicable projects

D. The SE shall have errors and omissions insurance with coverage required by COH.

E. The SE shall have an existing office, within the City of Houston area of less than 75 miles, and shall maintain that office for the duration of the warranty and extended software service requirement.

F. To ensure effectiveness and objectivity in the review and reporting of SCADA related integration issues, the SE shall be an independent entity and provide only software engineering services for the construction projects.

END OF SECTION

SECTION 13443

FIBER OPTIC NETWORK SYSTEM

PART 1 G E N E R A L

1.1 SUMMARY AND SCOPE OF WORK

A. This Section covers requirements for the Fiber Optic Network System (FONS) and outlines requirements for procurement, installation, termination and testing of fiber optic data communication networks. This Section does not stand alone and must be read in conjunction with the following Specification Sections:

1. Section 13440, Plant Control System
2. Section 13441, Software Engineering Requirements
3. Section 13446, Primary Instrumentation Devices
4. Division 16, Electrical.

B. This Specification covers requirements of install new Fiber Optic Network throughout the plant at the Willowbrook WWTP for the City of Houston Project.

1. The Fiber Optic Network System procurement, installation, termination, and testing shall be jointly implemented by the Fiber Optic Network Subcontractor with the Process Control System (PCS) supplier.

C. Fiber optic data communication links are shown on the block Network Diagrams included as part of the individual site's Drawings. The Fiber Optic Network Subcontractor is responsible for furnishing, terminating, and testing of all specified fiber optic data links. Drawings are diagrammatic and show only functional requirements. Optical signal to data conversion equipment at both ends of each optical link is specified under Section 13440, Plant Control System and all other hardware e.g., connectors, termination kits, and other related materials shall be provided by Fiber Optic Network subcontractor.

D. The Fiber Optic Network subcontractor is responsible to coordinate with equipment suppliers (network components) to ascertain compatibility of each fiber optic link with specific type of data link.

E. All new outdoor interconnecting fiber optic cable shall be routed through the existing aerial raceways and on existing cable tray support and conduits.

F. Fiber Optic Network Subcontractor shall install indoor fiber optic cables in indoor areas in the raceways installed by the PCS supplier. Fiber Optic Network Subcontractor shall coordinate raceway requirements with the PCS supplier. Use existing raceways where possible.

H. All copper data cables between network systems, and programmable logic controller (PLC) equipment and the fiber optic interfaces shall be installed by PCS supplier.

I. Fiber Optic Network Subcontractor is responsible for conducting and documenting the dB loss tests and proving that his installation meets the dB loss limits.

1.2 DEFINITIONS

A. Abbreviations:

1. ANSI: American National Standards Institute.
2. ATM: Asynchronous transfer mode.
3. AUI: Attachment unit interface.
4. dB: Decibel.
5. CS: Computer Systems and Subsystems.
6. DNI: Desktop network interface.
7. EIA: Electronic Industries Association.
8. FDDI: Fiber distributed data interface.
9. FOIRL: Fiber Optic Inter Repeater Link.
10. LAN: Local area network.
11. M: Meter.
12. Mbps: megabits per second.
13. MHz: Megahertz.
14. Micro: x 10-6.
15. N: Newton.
17. Nano: X 10-9.
18. NEC: National Electrical Code.
19. O&M: Operation and Maintenance.
20. OTDR: Optical time-domain reflectometer.
21. PICS: Process Instrumentation and Control Systems.
22. PLC: Programmable Logic Controller.
23. PCS: Process Control System.
24. TIA: Telecommunications Industries Association.
25. UPS: uninterruptible power supply.
26. V ac: Volts alternating current.
27. WAN: Wide area network.

1.3 SUBMITTALS

A. Shop Drawings, Hardware:

1. In Cooperation with Division 16, Electrical, Site Layout Diagram Showing:

a) Access holes, with identification.
b) Underground and above grade cable routings, with cable identifications.

c) Cable routing in trays and raceways including cable, tray, and raceway identification.

2. Cable Schedule Showing:

a) Cable identifications.
b) Fiber counts for each cable, and identifications of used fiber pairs.
c) Cable length and attenuation, with two connector pairs and zero splices, based on TIA-568-A Annex H. If calculation indicates that any cable will attenuate signals more than 8 dB reroute in cooperation with the Engineer.

3. Component Submittal: For each Fiber Optic Network component:

a) Manufacturer and model number.
b) General data and description.
c) Engineering specifications and data sheet.
d) Scaled drawings and mounting arrangements.
e) Manufacturer's suggested installation practice.

B. Installation Schedule:

1. Supplement the overall Project Progress Schedule by coordinating Fiber Optic Network construction sequence with Project construction sequence.
2. Associate installation of cables with other construction activities.
3. Show commissioning milestones correlated with overall Project requirements.

C. Quality Control Submittals:

1. Testing related submittals, verifying and documenting dB losses in actual installation.

2. O&M Manuals, Hardware: Hard copies of listed items:

a) Updated versions of Hardware Shop Drawings Submittals.
b) Component Manufacturers' O&M Manuals: Instructions for installation, operation, maintenance, and troubleshooting.
c) List of spare parts provided.
d) List of recommended additional spare parts.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Optical Fiber Cable: All indoor and underground fiber optic cable shall be in conduit as shown on Electrical Drawings.

B. Other Equipment:

1. Outside, Above Ground: Wet/icy, minus 20 to 40 degrees C.
2. Control Rooms, Equipment Rooms and Telecommunications Closets: 30 to 55 percent relative humidity, 18 to 24 degrees C.
3. Other Areas: 0 to 100 percent relative humidity, 5 to 35 degrees C.

1.5 SCHEDULING AND COORDINATION

A. Coordinate Fiber Optic Network work with other work done under this Contract.

1.6 TESTING

A. Test components of the installation in accordance with standards and Specifications.

B. Provide equipment, instrumentation, supplies and skilled staff necessary to perform testing.

C. Advise Engineer at least 72 hours in advance of each test. Engineer shall have option to witness and participate actively in tests.

D. Document test results of each cable to confirm that the specified number of fibers per cable meet standards, in accordance with Supplement, As-Built Fiber Optic Cable Installation.

E. For each conduit and cable tray, complete As-Built Conduit/Cable Tray Installation documentation included in supplement to this Section.

F. Document results of tests. Refer to Article, Cable Testing, for minimum documentation required.

G. Submit documented test results.

1.7 Fiber Optic Network SUBCONTRACTOR QUALIFICATIONS

A. Submittals with Bid (for Other Subcontractors to do the Fiber Optic Network Work):

1. Fiber Optic Network Subcontractor: Minimum of 5 years' experience providing, integrating, installing, and starting up similar systems as required for this Project.

2. Fiber Optic Network Subcontractor's Site Representative: Minimum of 5 years' experience installing systems similar to Fiber Optic Network as required for this Project.

3. Fiber Optic Network Subcontractor(s) Required Evidence of Qualifications:

a) Block Diagram: For proposed Fiber Optic Network Subsystems,

show all major components and their interrelationships.

b) Overview Descriptions: Two-page overview description of proposed Fiber Optic Network.

c) Equipment List: List of major equipment proposed for the Project, including equipment specified in Part 2 of the Section.

d) Catalog Cuts: Complete set of catalog cuts for equipment in equipment list. Do not include catalog cuts for equipment that is not specific to this Project. Indicate proposed options, sizes, and speeds, on catalog cuts by highlighting or encircling.

e) Project Schedule: Progress Schedule for implementation of system based on duration stated in Contract Documents. List major Milestones, and discuss all anticipated problems and their solutions.

f) Statement of Experience: List of at least three fiber optic data communications systems comparable to system specified which have been furnished and placed into operation by prospective Fiber Optic Network Subcontractor. For each system, provide following information:

1) Owner’s name, address, telephone number, and name of current operations supervisor or other contact.
2) Description of system hardware configuration, including major equipment items, number of nodes, and communication standards implemented.
3) System block diagram.
4) Dates when contract was signed, equipment was delivered, and system was accepted by Owner. State also originally scheduled completion date and if different from actual date, explain why.
5) Approximate value of listed Fiber Optic Network provided in dollars.

g) Financial Statement: Financial statement consisting of prospective Fiber Optic Network Subcontractor's most current and previous year's balance sheet. If Fiber Optic Network Subcontractor is a division or a subsidiary of a parent organization, financial statement should reflect only prospective Fiber Optic Network Subcontractor division's or subsidiary's contribution to parent company's financial statement.

h) Qualification of Personnel:
1) Resumes giving management and technical qualifications of supervisory, local service representative, and all key personnel.
2) For each maintenance organization, identify location of

base of service and how required coverage will be achieved.

i) Evaluation Factors:
   1) Conformance with Contract Documents.
   2) Quality of products proposed.
   3) Responsibility, experience, and qualifications.
   4) Responsiveness.

PART 2 P R O D U C T S

2.1 FIBER OPTIC CABLE

A. Manufacturers

1. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

   a) Mohawk division of Belden, Richmond, IN, Multimode Mohawk Advance Lite OM1 Grade 3: 62.5/125MM Type
   b) Belden, Richmond, IN, Multimode OM1 Grade 3: 62.5/125MM Type
   c) Corning Cable Systems, Hickory, NC, Multimode ALTOS OM1 Grade 3: 62.5/125MM Type
   d) Approved equal confirmed by wastewater operation electrical staff.

2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

B. General:

1. Temperature Range: Minus 40 to 85 degrees C.
2. Constructions that are Suitable for outdoor and indoor installation. Heavy Duty: Crush resistance 2,200 N/cm minimum.

B. Fiber Characteristics Outside Plant Type (All outdoor or in under grade raceways)

1. Fiber shall comply with requirements of TIA-568-A and ANSI X3T9.5.
2. 62.5/125 µm glass multimode graded-index.
3. Maximum Attenuation:
   a) 850 nm: 3.0 dB/km.
   b) 1,300 nm: 1.0 dB/km.
4. Minimum Bandwidth:
   a) 850 nm: 200 MHz/km. b) 1,300 nm: 500 MHz/km.
5. Color coded tubes and fibers, in accordance with TIA-568-A.

6. Minimum Bend Radius 9 inches, individual fiber strand: 1 inch.

C. Tube Configuration:

1. Loose tube gel-filled.

2. Fibers Per Tube: 6 maximum.

D. Cable:

1. Fiber Count: Refer to fiber optic network diagram.
2. All-Dielectric Construction: Corrugated steel armor tape.
3. Strength Member:
   a) Steel; integral part of cable; supports stress of installation and load during use.
   b) Minimum Tensile Strength: 600 pounds.
4. Protective Covering:
   a) UV-resistant, flame-retardant outer sheath.
   b) Polyethylene (PE) or Polyvinyl Chloride (PVC).
   c) In any single length of cable continuous and free from holes, splices, blisters, and other imperfections.
5. Minimum Bend Radius:
   a) Short-Term Under Tension: Twenty times cable diameter.
   b) Long-Term Without Tension: Fifteen times cable diameter.
6. Terminate and test all fibers, including installed spares.

E. Fiber Characteristics (Indoor Application):

1. Fiber shall comply with requirements of TIA-568-A and ANSI X3T9.5.
2. 62.5/125 □m glass multimode graded-index.
3. Maximum Attenuation:
   a) 850 nm: 3.75 dB/km.
   b) 1,300 nm: 1.5 dB/km.
4. Minimum Bandwidth:
   a) 850 nm: 160 MHz/km.
   b) 1,300 nm: 500 MHz/km.
5. Color coded tubes and fibers, in accordance with TIA-568-A.
6. Minimum Bend Radius, Buffered Fiber: 1 inch.
7. Tube Configuration:

.

   a) Fibers Per Tube: 6 maximum.

8. Cable:
   a) Fiber Count: Refer to fiber optic network diagram.
   b) All-Dielectric Construction: Corrugated steel armor tape.
   c) Strength Member:
      1) Steel; integral part of cable; supports stress of installation and load during use.
      2) Minimum Tensile Strength: 600 pounds.

d) Protective Covering:
   1) UV-resistant, flame-retardant outer sheath.
   2) Polyethylene (PE) or polyvinylchloride (PVC).
   3) In any single length of cable continuous and free from holes, splices, blisters, and other imperfections.

e) Minimum Bend Radius:
   1) Short-Term Under Tension: Twenty times cable diameter.
   2) Long-Term Without Tension: Fifteen times cable diameter.

f) Terminate and test all fibers, including installed spares.

g) Manufacturers: Corning, freedom cable suitable for indoor raceway/cable tray installations Or equal.

2.2 CONNECTORS

A. Acceptable Manufacturers

1. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   a) Corning Corp., Hickory, NC
   b) Berk-Tek, a Nexans Company Fuquay-Varina, NC
   c) Leviton
   d) Or approved equal.
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

B. Termination Connectors:

1. Provide ceramic ferrule ST style UV or Anaerobic cure type connectors with Housing Material of metal. The connectors shall be designed for use with 9/125 micron cable for single mode and 62.5/125 micron for multimode. Each connector shall cause a maximum signal attenuation of 0.5 dB. Connector specifications shall be as follows:
   a) Insertion loss (typical): 0.2 dB
   b) Durability (mating cycles): 1000 (minimum)
   c) Repeatability: Less than 0.2 dB
   d) Operating Temperature: minus 40 to plus 75 degrees C with less than 0.3 DB change in attenuation.
   e) Must Meet TIA/EIA 604 for Intermateability.

2.3 JUMPER CABLES

A. In accordance with requirements of TIA-568-A 12.5.

B. Function: To connect from fiber patch panels to hubs or network nodes.

C. Fiber Characteristics: In accordance with requirements for fiber optic cable.

D. Tube Configuration:

1. Individual tight thermoplastic buffer tubes.
2. Protected with kevlar strength members and enclosed in thermoplastic jacket.

E. Length: Standard lengths to meet requirements, plus minimum 3 m spare at workstations.

F. Connectors: To meet requirements of article Connectors, and:

1. As required to match existing or new equipment, or as shown on Drawings.
2. On-axial Pull Strength: 33 N.
3. Normal-to-Axial Pull Strength: 22 N.

G. Spares: Provide 100 percent spare jumpers of each length needed.

2.4 FIBER OPTIC PATCH PANELS

A. Function: Provides a secure place to terminate fiber-optic cables.

B. Locations: Install securely in field panels, as specified.

C. General Features:

1. Compartments: Two; one for fiber-optic cable, one for patch cords to individual equipment.
2. Size: Patch panel shall be sized to adequately accommodate all installed fibers for proper bending radius and required strain relief of incoming cables.
3. Coil Former: Former to wind slack cable around, provides controlled long-radius bends.
4. Grounding: Provide grounding lug to meet any applicable requirements of NFPA 70 (National Electric Code).
5. Enclosure: NEMA 250, Type 1.
6. Mounting: Refer to drawings.
7. Connectors:

a) See paragraph Connectors, in this Section.
b) Quantity: As required to terminate all fibers in field.

D. Industrial Ethernet and Profibus Fiber Optic Patch Panel 24 ports modular rack mounted.

1. Manufacturer :

a) Panduit

b) Black Box

c) 3M

d) Leviton

e) Corning

2. Design: constructed of steel material.
3. Tray: Removable top cover to provide easy access to splices and cable storage. Pre-loaded tray shall have a removable patch panel to allow for rear access from front of unit.
4. Cable entry: Rear
5. Connectors: Populated 24-packs with ST connectors

E. Industrial Ethernet and Profibus Fiber Optic Patch Panel 12 or 24 ports wall mounted and panel mounted.

1. Manufacturer:

a) Panduit

b) Black Box

c) 3M

d) Leviton

e) Corning

2. Design: Metal box with latching door covering two chambers
3. Connectors: Populated 6-packs with ST connectors
4. Minimum 12 ports and up to 24 ports.

PART 3 E X E C U T I O N

3.1 INDOOR FIBER OPTIC CABLE INSTALLATION

A. Indoor cable installation shall be in conduits provided under Division 16, Electrical.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Avoid splicing of fiber optic cable as far as practical. If splicing is unavoidable, get the Engineer's approval before implementing the splice. End to end dB loss shall be maintained within specified limits, even if the cable includes a splice.

B. All cable bends shall meet larger of the manufacturer's recommended or the specified bending radii limits.

C. Use of conduit elbows is not permitted for bends. Use pull boxes sized in accordance with NEC guidelines and the fiber optic cable manufacturer's recommendations.

D. Conduit for fiber optic cables shall be sized per NEC Code but not less than 2-inch diameter.

E. Each fiber shall be terminated in a fiber patch panel.

3.3 FIBER OPTIC CABLE

A. Install cables in accordance with manufacturer's requirements.

B. Install cable directly from shipping reels. Ensure that cable is not:

1. Dented, nicked, or kinked.
2. Subjected to pull stress greater, or bend radius less, than manufacturer's specification.
3. Subjected to treatment that may damage fiber strands during installation.

C. Cables Per Conduit: In accordance with NEC conduit fill limitations and the fiber optic cable manufacturer's recommendations.

D. Splices: Install fiber optic cables in unspliced lengths from fiber patch panels to switches or hubs. Generally, splices are not acceptable. Should splices become necessary and are approved by Engineer on case by case basis, then use the following guidelines:

1. With splices above grade in buildings, protected by splice housings.
2. Outside splices in access holes protected by splice closures.

E. Identification:

1. Identify each cable on both ends and in all access holes and pull points it goes through.
2. Use waterproof tags and identifications.

F. Sequencing:

1. Provide cables in accordance with sequencing requirements.
2. Coordinate sequencing requirements with the PCS supplier.

G. Sealing: Seal cables into innerducts to stop ingress of water and grit with fabricated expansion plugs.

H. Access Holes:

1. Provide supports for cables in access and handholes.
2. While maintaining minimum bend radii, lace cables neatly to supports to keep them out of the way of personnel.

3.4 CABLE TERMINATIONS

A. Terminate cables in accordance with TIA-568-A.

B. Each cable shall be terminated in a fiber optic patch panel.

C. Fan out fiber cable to allow direct connection of connectors. Sleeve over individual fibers with transparent furcation tubes. At point of convergence of furcation tubes, provide strain relief with metal or high density plastic fan-out collar.

D. Breakout Kits:

1. Terminate all cables using manufacturer-supplied breakout kits.
2. Terminate in accordance with manufacturers' recommendations.

E. Identification: Ensure that each fiber's identification is clearly visible, or identify individually.

F. Slack:

1. In Fiber Centers and at Hubs and Switches: Minimum 3 m slack fiber at each end, coiled neatly in the cable management equipment.
2. In Communications Management Outlets: Minimum 1 m slack fiber, coiled neatly in the outlet box.

G. Connectors:

1. Terminate 100 percent fibers in each cable to specified connectors.
2. Connect connectors into fiber management system.

3.5 CABLE TESTING

A. Provide equipment, instrumentation, and supplies necessary to perform testing. Engineer shall have option to witness and participate actively in onsite tests.

B. Conduct tests after the installation is complete. Complete the As-Built Fiber Optic Cable Installation Supplement at the end of this Section, in addition to any other necessary forms, when providing information regarding the results of testing the fiber optic cable.

C. TIA-568-A: Demonstrate that 100 percent fibers in each cable meet requirements of TIA-568-A, Annex H as modified here:

1. Maximum attenuation as specified in Article, Fiber Optic Cable.
2. Measure attenuation in both directions, not in one direction only.
3. Measure attenuation at both 850 nm and 1,300 nm.
4. Measure reference power reading.
5. Installation shall meet or exceed limits specified in the Supplement, As-Built Fiber Optic Cable Installation.

D. Until requirements are met, replace and retest all cables that do not have specified number of fibers that meet attenuation standards.

END OF SECTION

FIBER OPTIC NETWORK SYSTEM

Project: City of Houston Southwest WWTP Improvement Package 3

Contractor:_____

Signed by:_____

AS-BUILT FIBER OPTIC CABLE INSTALLATION

Cable Identification:_____

Routing: From:_____ In:

_____(Identify field panel, control room, etc. In building)

Through: 1

(Identify access hole, building, gallery, etc.)

Through: 2 Through: 5

Through: 3 Through: 6

Through: 4 Through: 7

To: In:

See AS-BUILT CONDUIT / INNERDUCT INSTALLATION sheets for identification of conduits/innerducts cable is routed through.

Acceptable Attenuation:

cable length*

850 nm: (3.5 dB/km x km) + 1.5 dB = dB
1300 nm: (1.0 dB/km x km) + 1.5 dB = dB

*Contractor to provide actual length installed, within ±0.1 km

Fiber ID	Use/Spare	Measured Attenuation (dB)			
		Hub-to-Node		Node-to-Hub	
		850 nm	1,300 nm	850 nm	1,300 nm

END OF SUPPLEMENT

FIBER OPTIC NETWORK SYSTEM

Project: City of Houston Southwest WWTP Improvements Package 3

Contractor:_____

Signed by:_____

AS-BUILT CONDUIT/CABLE TRAY INSTALLATION

From:_____ In:_____

(Identify building, access hole, field panel, etc.) Sheet____of ___

Conduits:
Used: 4-inch; 2-inch
Spare: 4-inch; 2-inch Confirm all spares unrestricted: Yes /
(Provide number of conduits in each category)

Conduit ID	Cable Tray ID	Cable ID / Spare

END OF SUPPLEMENT

Section 13446

PRIMARY INSTRUMENTATION DEVICES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

Submersible transmitters, magnetic flow meter, pressure switches, pressure transmitters, ultrasonic level transmitter, diaphragm seal, pressure gauge, power monitor, control power transformers, phase/voltage monitor relay, terminal blocks, control switches and indicator lights, control relays, time delay relays and accessories for use with instrumentation.

1.02 REFERENCES AND STANDARDS

A. NEMA ICS 1 - General Standards for Industrial Controls and Systems.

B. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.

C. NEMA ICS 3 - Industrial Systems.

D. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

E. NFPA 70 - National Electrical Code (NEC).

F. Underwriters Laboratories, Inc. (UL).

G. ANSI B40.1 - Gauges, Pressure Indicating Dial Type Elastic Element.

1.03 SUBMITTALS

A. Comply with Section 01330 - Submittal Procedures.

B. Submit shop drawings indicating layout of completed assemblies, interconnecting cabling, dimensions, weights and external power requirements.

C. Submit product data for each component specified.

D. Submit manufacturer's certificate that all equipment meets or exceeds specified requirements. Submit manufacturer's installation instructions.

1.04 PROJECT RECORD DOCUMENTS

A. Submit record documents under provisions of Section 01770 - Closeout Procedures.

B. Accurately record actual locations of controller cabinets and input and output devices connected to system. Include interconnection piping, wiring and cabling information, and terminal block layouts in controller cabinets.

C. During drawing submittal phase, submit detailed programming information consisting of ladder logic and line code of proposed program, and complete input, output, relay, register and controller identification labels.

D. Submit factory testing procedures proposed to verify input, output, PID loop and register operations, system logic verification, and spare memory capacity.

1.05 OPERATION AND MAINTENANCE DATA

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

1.06 QUALIFICATIONS

A. Manufacturer: A company specializing in manufacturing the products specified in this Section having at least 5 years documented experience maintaining service facilities within 100 miles of project and having proven compatibility with existing City wastewater facilities. Like devices shall be of the same Manufacturer.

1.07 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70 (NEC).

B. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for the purpose specified and shown; install in accordance with UL requirements.

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver products in factory-sealed containers. Store, handle and protect products under provisions of Section 01610 - Basic Product Requirements.

B. Upon delivery, inspect products for damage.

C. Store products in clean, dry area; maintain temperature in compliance with NEMA ICS 1.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Maintain temperature above 32 degrees F and below 104 degrees F during and after installation of products.

B. Maintain area free of dirt and dust during and after installation of products.

PART 2 P R O D U C T S

2.01 SUBMERSIBLE PRESSURE TRANSMITTERS

A. Manufacturer:

1. Endress and Hauser: Model FMX167-A2B FE1C7.

2. Blue Ribbon: Model Birdcage 01 (15, 30 psi)

3. AMETEK: Model 575P

4. Dwyer: PBLT2 series

5. Noshok: 613 series.

B. Description: Solid-state two-wire submersible electronic differential pressure transmitter with 4-20 mA output proportional to input pressure.

C. Range: 0-30 feet range, or as required by wet well depth, with +/- 0.3 % accuracy and 0.5% max temperature across calibrated span.

D. Power: Loop-powered, 24 VDC

E. Spare Unit: Provide a spare unit in addition to the unit installed.

F. Transmitters to be calibrated to match the chart recorder range.

G. Warranty: 18 months minimum from the time acceptance by City.

2.02 MAGNETIC FLOW METER

A. Manufacturer:

1. Rosemount
2. ABB
3. Krohne

4. Siemens
5. Endress+Hauser

B. Hardware:

1. Provide sufficient lengths of Manufacturer's specialty cables for installation of power and signal conductors as provided with each instrument.
2. Output: 4-20 mA DC with HART. Output shall be linear for pressure applications.
3. Metering Tube:
   a) Carbon steel with 304 Stainless interior unless otherwise indicated.
   b) Tube Flanges: Match piping AWWA rating of the pipe. Minimum AWWA 150# Flange.
   c) Tube Liner: Polyurethane or EDPM unless noted otherwise.
   d) Tube Electrodes: ANSI 316 stainless steel, bullet nosed or elliptical self-cleaning type unless otherwise noted.
4. Transmitter:
   a) Transmitter Enclosure: NEMA 4X.
   b) Microprocessor based intelligent type.

C. Accuracy: Plus or minus 0.5 percent of rate (including converter/transmitter.

D. Accessories:

1. The Transmitter shall be installed inside a NEMA 4X 316 Stainless Steel enclosures as shown in the drawings.
2. Factory calibration: Each meter shall be factory calibrated, with a copy of the Report delivered with the device and in the O&M manual.
3. Grounding: Meter shall be grounded with rings. Provide 316 Stainless Steel ground rings, ground wires, and gaskets, etc. All materials shall be suitable for the liquid being measured.
4. Provide a hand held programmer for each transmitter, where full setup is not available for the instrument directly.

E. Power Connection: As shown on the Drawings.

F. Operating Temperature: -20 to + 160 deg. F

G. Warranty: 1 year parts and labor warranty.

2.03 PRESSURE SWITCHES

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Static-O-Ring (SOR)
2. United Electric
3. Ashcroft

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. General

1. Ratings shall be equal to or exceed the piping.

D. Type:

1. Diaphragm actuated.

E. Function/Performance:

1. Repeatability: Greater than 1.0 percent of pressure.
2. Setpoint: Field adjustable and set between 30 and 70 percent of the adjustable range.
3. Dead Band: Adjustable
4. Reset: Unit shall be of the automatic reset type unless noted otherwise on the Instrument Device Schedules.
5. Over Range Protection: Over range protection to maximum process line pressure.
6. Switch Rating: 250V AC at 10 amps; and 30V DC at 5 amps.

F. Physical:

1. Housing: NEMA 4X.
2. Switching Arrangement: Single pole double throw (SPDT) unless double pole double throw (DPDT) switches are shown on the instrument device schedule.
3. Wetted Parts: 316 Stainless Steel Alloy, Hastelloy C or Monel diaphragm, viton seals, stainless steel connection port as confirmed compatible with the process fluid by the manufacture.
4. Connection Size: ½-in NPT.

G. Power Requirements

1. None

H. Required Options/Accessories

1. Shutoff Valve: Provide process shutoff valve which can be used as an

adjustable pressure snubber.

2.04 PRESSURE TRANSMITTERS

A. Manufacturer:

1. Rosemount
2. ABB
3. SIEMENS

B. Description:

1. Solid-state two-wire transmitter with 4-20 mA with HART output proportional to input pressure.
2. Provide sufficient lengths of Manufacturer's specialty cables for installation of power and signal conductors as provided with each instrument.
3. Microprocessor based intelligent type.
4. Accuracy: 0.1 percent of span (linear output).
5. Sensor Technology: Digital.

C. Range: As shown on the Drawings

D. Power: Loop-powered, 24 VDC

E. Spare Unit: Provide a spare unit in addition to the unit installed.

F. Physical:

1. Electrical Classification: Intrinsically safe for Class I and Class II, Division 1 locations.
2. Enclosure: NEMA 4X.
3. Sensor Diaphragm Material: Cobalt-Nickel-Chrome alloy or Hastelloy C.
4. Gaskets: Teflon.
5. Sensor Fill Fluid: Shall be suitable for process fluid being measured. When used for chemical metering service, sensor fill fluid shall be rated specifically for the chemical being measured.
6. Diaphragm Seals: 316 SS, fill liquid with Ethylene Glycol (Anti-Freeze)

G. Warranty: 18 months minimum from the time acceptance by City.

2.05 ULTRASONIC LEVEL TRANSMITTERS

A. Manufacturer:

1. Siemens HydroRanger 200, Echomax XPS Transducer Series

B. General:

1. Type

a) The emitter in the sensor is excited electrically to send ultrasonic pulses in the direction of the surface of the liquid or solid which partially reflects the pulses. This echo is detected by the same sensor and is converted back into electrical signal. The time between sending and receiving the ultrasonic wave is proportional to the distance between the sensor and the reflection surface.

2. Monitor/Transmitter:

a) Function/Performance

1. Power Requirement: 120 VAC 50/60 Hz

2. Output Signal: 2 isolated 4-20 mA analog signals

3. Alarms: 6 SPDT programmable relays. Relays shall be rated 5 amps at 250 VAC.

4. Minimum Range: 0.3 meter to 15 meters (1 ft to 50 ft)

5. Accuracy: 0.25 % of programmable range or better

6. Temperature compensation shall be provided for the entire range of measurement.

7. Operating Temperature Range: –4°F to 140°F

8. Repeatability: 0.25 % of full scale

9. Level transmitter shall be programmed by entering all operational data via a removable, non-intrusive infrared programming module.

b) Physical

1. Enclosure: Panel, rail or wall mounted NEMA 4X (IP 45) polycarbonate enclosure. All mounting hardware shall be 316-stainless steel.

2. Single Cable: Provided by the manufacturer with sufficient length to reach the sensor without the risk of electromagnetic interference.

3. Transmitter shall be provided with Nema 4X 304SS sunshield if mounted outside.

3. Level Element

a) Function/Performance

1. Power Requirement: Provided by the transmitter

2. Minimum Range: 0.3 meter to 15 meters (1 ft to 50 ft)

3. Frequency (23°C): 10-60 kHz

4. Maximum Beam Angle: 6°

5. Altitude: Up to 2000 meters

6. Operating Temperature Range: -40°F to 203°F (-40°C to 95°C)

b) Physical

1. Housing: Non-contact, Type 304 stainless-steel encapsulated sensor. Approved to be used in Classes I, II, and III, Division 1, 2.

2. Mounting: 2" pipe mounting or flange mounting. Flange diameter shall be 6-in, 150-lb RF, Teflon-coated. See Instrumentation drawings for mounting details.

3. All level elements shall be provided with submergence shields.

4. Accessories/Options

   a) All necessary mounting brackets

   b) Provide one hand held programmer

2.06 DIAPHRAGM SEAL - THREADED

A. Manufacturers:

1. Ashcroft
2. Ametek
3. Marsh Bellofram
4. Precision Instrument, Inc.

B. General

1. Rating shall be equal to or greater than pipe rating.
2. Diaphragm seal/tubing/instrument assembly shall be assembled, filled, calibrated, tested and certified in a NIST traceable ISO 9001 certified calibration facility prior to shipping to project site.

C. Type

1. Thread attached
2. Welded Metal Diaphragm
3. Exposed Surfaces: 316 stainless steel

D. Function/Performance

1. Purpose: To protect instruments from the process medium.
2. A flexible diaphragm shall separate the process medium from the instrument element. Space on the instrument side of the diaphragm shall be completely filled with a suitable silicone or instrument oil. The process pressure is transmitted by the liquid filled system to the instrument element.
3. Filling Screw: include on all units
4. Pressure Limit: 1,000 PSI
5. Flushing Connection: include on all units
6. Tubing as required to connect with associated instrument; ¼-inch inner diameter minimum flexible stainless steel

E. Physical

1. Process connection: minimum 1/4- inch NPT
2. Top housing: carbon steel, cadmium plated
3. Diaphragm: 316 ELC stainless steel

4. Exposed surfaces: 316 stainless steel

5. Sensing Sleeve: Buna-N

6. Bolts, nuts and plugs: 18-8 stainless steel or 316 stainless steel.

2.07 PRESSURE GAUGE

A. Manufacturers:

1. Ashcroft Model 1279

2. Dwyer

3. Hellicoid

4. Approved equal

B. General

1. Rating shall be equal to or greater than pipe rating.

C. Type:

1. Bourdon tube actuated pressure gauge.

D. Function/Performance:

1. Accuracy: Plus or minus 1.0 percent of span or better.

F. Physical:

1. Case: Phenolic shock resistant or 316 stainless steel for surface/stem mounting with a pressure relieving back. The case shall be vented for temperature/atmospheric compensation. Gauge shall be capable of being liquid filled in the field or at the factory.

2. Window: Clear acrylic or shatter proof glass.

3. Bourdon Tube: 316 stainless steel

4. Connection: ½-inch NPT.

5. Gauge size: Minimum 4.0 inches viewable.

6. Pointer travel: Not less than 200 degrees or more than 270 degree arc.

7. Size: 4-1/2 inches.

G. Required Options/Accessories

1. Shutoff valve: Each gauge shall have a process shutoff valve which can also be used as an adjustable pressure snubber.

2. Special scales: The Engineer reserves the right to require special scales and/or calibration if the manufacturer's standard is not suitable for the application.

3. Gauges shall be liquid filled at the manufacturer's factory.

2.08 POWER MONITOR:

A. Manufacturer: Siemens Energy & Automation PAC3200, or approved equal.

B. Measurements: Voltage (L-L, L-N, 3-ph Avg), Current (Per Phase, 3-ph Avg), Apparent Power, Active Power, Power Factor, Frequency, 6 Limit Values.

C. Harmonics Monitoring: THD only

D. Clock: Real-time clock with calendar

E. Display: Backlit LCD.

F. Configuration: Via front panel or with Sentron PowerConfig Software supplied with unit

G. Communications: Ethernet Profinet to PLC via Expansion Module.

H. Digital Inputs and Outputs: One multifunctional input, One multifunctional output.

I. Certifications: cULus, CE, C-Tick, GOST.

J. Temperature Ratings: -10 to 55 deg. C operating.

K. Power: 95 to 240 VAC

2.09 CONTROL POWER TRANSFORMERS

A. Transformer: NEMA ST 1 machine tool transformer with isolated secondary winding.

B. Power Rating: 250 VA or 200 percent power requirement, whichever is greater.

C. Voltage Rating: 480/240 volt primary, 120 volt secondary, single phase.

2.10 PHASE/VOLTAGE MONITOR RELAY

A. Manufacturer, Product: Diversified Electronics Inc.; Model PBD Series or approved equal.

A. Description: All three phases monitored individually for preselected under and over voltage limit phase loss, phase unbalance, phase reversal, frequency shift and phase shift. Automatic reset after adjustable release delay when line conditions return to normal.

B. Indicators: LED indicators for under and over voltage limit.

C. Output Rating: DPDT, 3 amps resistive at 600 VAC.

D. Phase Sequence: ABC.

E. Sampling Time: 2 seconds.

F. Spare Unit: In addition to the unit installed, furnish one spare phase/voltage monitor relay.

2.11 TERMINAL BLOCKS

A. Manufacturers

1. Bussmann.
2. Phoenix Contact.
3. General Electric Company.
4. Weidmuller.
5. Allen Bradley.

B. Substitutions: Comply with Section 01630 - Product Substitution Procedures.

C. Terminal Blocks: Provide isolated fused snap-on type terminal blocks.

D. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

E. Signal and Control Terminals: Modular construction type suitable for channel mounting with tubular pressure screw connectors; 300 volt rating.

F. Provide color-coded (green/yellow) ground bus terminal block, with each connector bonded to enclosure.

2.12 CONTROL SWITCHES AND INDICATOR LIGHTS

A. Manufacturers

1. Automatic Timing and Controls Company.
2. Eaton Corporation.
3. Eagle Signal Company.
4. General Electric Company.
5. Schneider Electric
6. Allen Bradley.
7. Siemens

B. Substitutions: Comply with Section 01630 - Product Substitution Procedures.

C. Control Switches

1. Contacts: NEMA ICS 2; at least two Form C contact sets.
2. Contact Ratings: NEMA ICS 2; 120V, 10 ampere inductive.
3. Selector Switch Operators: NEMA ICS 2; heavy-duty, oil-tight, NEMA 4 multi-position rotary selector switch.
4. Push-button Operator: NEMA ICS 2; heavy-duty oil-tight NEMA 4 unguarded and lockable type; black for start, red for stop.

D. Indicator Lights: Red for run, amber or yellow for alarm, green for control mode; LED, oil-tight, 100,000-hour rated life expectancy; rated voltage approximately 125 percent of nominal 120 VAC operating voltage. To be push-to-test type.

2.13 CONTROL RELAYS

A. Contacts: Three Form C contact sets (3PDT).

B. Rating: 120 volt, 10 ampere inductive.

C. Coil Voltage: 120 volt, 60 Hz AC.

D. Socket: DIN Rail, Include hold-down clip.

E. Features: 11-pin tube socket relay base, external color-coded test button, mechanical and electrical status indications, impact-resistant thermoplastic case.

F. Manufacturer: Turck, Siemens, or equal approved by end user.

G. Spare Units: In addition to units installed, furnish 2 spare units.

2.14 TIME DELAY RELAYS

A. Contacts: Three Form C contact sets (3PDT).

B. Contact Ratings: DPDT Class; 120 volt 10 ampere inductive.

C. Coil Voltage: 120 volt 60 Hz AC.

D. Socket: Turck S3B with coding system, label and label holder (11-pin).

E. Description: Control relay as specified above in Paragraph 2.04, with added Time Cube Module as manufactured by Turck, Inc.; series CT3, with on or off delay, as indicated.

F. Features: DIP switch-selectable timing ranges of 0.2 to 3 seconds, 0.8 to 12 seconds, 0.1 to 1.5 minutes and 0.8 to 12 minutes; externally-adjustable graduated time dial; solid-state digital timing system.

Spare Units: In addition to units installed, furnish 2 spare units.

2.15 ACCESSORIES

A. Plastic Raceway: Plastic slotted wireway with snap-on locking covers.

B. Manufacturer

1. Anixter Bros., Inc.

2. Delaware Industries, Inc.

3. Panduit Corp.

4. Iboco

PART 3 E X E C U T I O N

3.01 INSTALLATION

A. Furnish complete enclosure, factory tested and ready for installation and field termination.

B. Terminate wiring with spade lugs at terminal strips corresponding to designations on Drawings.

C. When not installed in plastic wireways, such as along back of door, neatly bundle and support air tubing and internal panel wiring with self-adhesive nylon clips. Provide adequate slack for proper door operation without damage to wiring or tubing.

D. Identification: Identify system components in accordance with Section 16195 - Wiring and Conduit Identification.

1. Identify conductors and termination points (device and relay terminals).

2. Identify transmitters, switches and devices with stainless steel tags.

3. Provide nameplates for panel-mounted devices and instruments as shown on drawings.

3.02 SYSTEM TESTING

A. Perform system testing as required by individual component Sections. Calibrate and adjust components for proper operation. Submit 6 copies of Manufacturer's Installation Inspection, Field Calibration and Field Testing Reports. Replace components found to be defective.

END OF SECTION

Section 13471

CONTROL CABINET ENCLOSURES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Indoor and outdoor control cabinets for Lift Station instrumentation.

1.02 REFERENCES

A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

B. ANSI/NFPA 70 - National Electrical Code (NEC).

C. Underwriters Laboratories, Inc. (UL).

D. Factory Mutual (FM).

E. Occupational Safety and Health Administration (OSHA).

F. American National Standards Institute (ANSI).

1.03 SUBMITTALS

A. Conform to Section 01330 - Submittal Procedures.

B. Product Data: Provide manufacturer's product literature and specifications.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Paragraph 1.04, Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70 (NEC).

B. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and shown; install in accordance with UL requirements.

1.05 EXTRA MATERIALS

A. Provide two keys for each cabinet; key locks as directed by City Engineer to operate in current City of Houston master keying system.

B. Insert half-size blackline prints on rite in the rain all weather writing paper model 8511 of the complete wiring diagrams, schematics, and loop diagrams applicable to each control panel in a clear plastic envelope and store in a suitable print pocket or holder inside each control panel.

PART 2 P R O D U C T S

2.01 MANUFACTURERS

A. Acceptable Manufacturers

1. Rittal, Corporation

2. Hoffman Engineering.

3. Hammond Manufacturing

4. The EMF Company.

5. Rose Enclosure.

6. Weigman Company.

7. N.E.M.A. Enclosure Mfg. Co.

B. Substitutions: Comply with Section 01630 - Product Substitutions and Procedures.

2.02 INDOOR CONTROL CABINETS [Specifier to evaluate the required system listed for indoor control panel within the building and delete if used for outdoor control panel]

A. Enclosure: NEMA 250, Type 12; if requested by City Engineer, obtain Underwriters Laboratory, Inc. approval after completion.

B. Enclosure Size: As indicated on Drawings; or, if not indicated, at least 72 inches high by 20 inches deep by 48 inches wide, or larger, as required to mount equipment indicated to U.L. Standards.

C. Backboard for mounting terminal blocks and components: 12 gauge steel, finished in white enamel.

D. Fronts: Steel pan-type doors with concealed stainless steel hinges, held closed by stainless steel 3-point latch operable by pistol-grip handle.

E. Provide solid metal barriers to separate compartments containing control wiring operating at less than 50 volts from power wiring.

F. Clean surfaces to remove dirt and corrosion residue. Phosphatize for corrosion protection. Prime with two coats, and finish with one coat, of factory-applied textured polyurethane, minimum 5 mils thickness, color as selected by City Engineer from manufacturer's standard colors.

G. Panel Construction: Provide panel stiffeners and bracing. Fully gasket doors. Weld seams and grind smooth.

H. Conduit Entrances: Bottom entry unless otherwise indicated on Drawings.

I. Material: Minimum 12 gauge steel.

J. Finish: Enamel; gray outside, white inside.

K. Provide convenience outlets and internal fluorescent lighting, as shown on Drawings.

L. Nameplates: On the outside of each cabinet's inner door, provide motor data nameplate information for each pump motor; copy all information exactly as shown on each motor nameplate. Provide engraved laminated plastic nameplates; black letters with white background; fasten to outside of cabinet door of each motor starter section with stainless steel screws. Provide nameplates for all devices within panel.

M. Install wiring in open-slot plastic wiring duct.

N. On indoor panels install a 4-inch passive vent in the side near the top and near the bottom of an adjacent side panel. These vents shall have removable filters to resist dust and insect entry.

2.03 OUTDOOR CONTROL CABINETS [Specifier to evaluate the required system listed for outdoor control panel and delete if used for indoor control panel within the building]

A. Enclosures: NEMA 3 type 5052-H32 aluminum with 0.125 inch

thickness 5052-H32 aluminum back panel for mounting components. If requested by City Engineer, obtain inspection and approval by Underwriters Laboratory, Inc., after installation of control system in cabinet.

B. Enclosure Size: As indicated on Drawings, or if not indicated, at least 72 inches high by 48 inches wide by 36 inches deep, or larger, as required to accommodate equipment and as indicated in UL standards.

C. Material: Exterior and interior enclosure doors, shelves and component enclosures: Fabricate of 14 gauge type 316 stainless steel or 0.125 inch thick type 5052-H32 aluminum.

D. Doors: Stainless steel pan-type construction, with full-length stainless steel piano hinge (for stainless steel or aluminum). Equip exterior door with padlock, heavy-duty locking pistol-grip handles and 3-point latching mechanism of the draw roller type (0.750 inch minimum diameter rollers). Handles shall be 3/4 inch minimum diameter stainless steel. Equip interior doors with flush quarter-turn closure devices. Equip interior and exterior doors with neoprene gaskets.

E. Provide rain shield with 1 inch drip lip for outdoor cabinets to protect against direct sun radiation and rainfall. Design shield to provide 3-1/2 feet of cover front and back and 6 inches of cover on the sides. Design shield shall have a 1-inch open panel door clearance. Shielding material: Type 316 stainless steel or type 5052-H32 aluminum.

F. Nameplates: On the outside of each cabinet's inner door, provide motor data nameplate information for each pump motor; copy all information exactly as shown on each motor nameplate. Provide engraved laminated plastic nameplates; black letters with white background; fasten to outside of cabinet door of each motor starter section with stainless steel screws. Provide nameplates for all devices within panel.

G. In each cabinet section, provide a 120V convenience outlet and a switched 40 watt minimum fluorescent light fixture, with 0 degrees F ballast in each section.

H. Inside and outside of cabinet shall be smooth and free from burrs.

I. If aluminum cabinet, hinges shall be .090 inch thick minimum, aluminum, and shall have .250 inch diameter stainless steel hinge pin. Hinge leaves shall not be exposed externally when door is closed.

J. NEMA 4X enclosures shall have all bolt holes gasketed.

K. A divider of same material and thickness as the cabinet shall be added to

divide electrical components and wiring from instrumentation and pneumatic components and wiring.

PART 3 E X E C U T I O N

3.01 EXAMINATION

A. Verify that surface and job conditions are ready for construction; report unsatisfactory conditions to the City Engineer. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Transport, handle and install products in accordance with manufacturer's instructions.

B. Install on prepared pads. Anchor securely at each corner. Shim and grout as required to form a watertight seal.

C. Install cabinet fronts plumb.

D. Field-cut bottom conduit entrance openings for outdoor cabinets. Seal removable plates with silicone sealant.

E. Install ground rod and equipment ground conductor.

F. Install separate instrument ground lug and ground conductor; connect to common station ground grid.

G. Mount devices to allow removal and reinstallation without backboard removal. Use stainless steel mounting hardware.

H. Except for nameplate fasteners, mounting or other hardware shall not penetrate panel exterior.

I. Exterior panels: Mount with stainless steel anchor bolts and ground to the station ground field. Install and test ground field to provide maximum 5 ohm resistance to ground in accordance with Section 16170 - Grounding and Bonding.

J. Provide door restraints for outer and inner doors to positive lock and hold doors open at 115 degrees minimum.

K. Label all wires with heat shrink markers per Section 16195.

END OF SECTION

SECTION 14520

BELT CONVEYORS (HORIZONTAL-TO-INCLINED)

1. GENERAL

1.1. WORK OF THIS SECTION

A. The Contractor shall furnish, install, and place in satisfactory operation belt conveyors complete with all supports, spare parts, accessories and appurtenances as specified herein, show on the Drawings, and as required for a complete and operable system
B. The equipment shall comply with the requirements of Section___ , Equipment General Provisions
C. All necessary safety equipment and guards to meet OSHA requirements shall be provided
D. The Contractor shall be responsible for coordinating the placement all supports necessary to tie the equipment together and shall have the undivided responsibility for the system's structural integrity

1.2. REFERENCES

A. The following is a list of reference standards:

1. Conveyor Equipment Manufacturers of America (CEMA)
2. American Society for Testing and Materials (ASTM)
3. National Electrical Manufacturers Association (NEMA)
4. American Gear Manufacturers Association (AGMA)
5. American Welding Society (AWS)
6. ANSI B20.1 - Safety Standard for Conveyors and Related Equipment
7. ANSI B15.1 - Safety Standard for Mechanical Power Transmission Apparatus

1.3. SUBMITTALS

A. Provide complete approval submittal manuals as required in Section 01300 – SUBMITTALS in addition to the following:

1. Manuals shall be in a white 3-ring binder, and include tabbed sections defining scope, process calculations, mechanical and structural calculations, catalog cuts, and drawings.

2. Drive details, including calculations and procedures used for selection of drive components, service factor of gear reducer based on absorbed horsepower and installed motor horsepower.

3. Manufacturer's literature, illustrations, specifications, and engineering data including total weight of each unit, structural loads at supports, connection details, and performance data.

4. Drawings shall show dimensions, overall arrangement of equipment and materials of construction.

5. Control diagrams and panel layout.

B. Operations and Maintenance Manuals: Submit complete operation and maintenance manuals in conformance with Section 01720 in addition to the following:

1. Manuals shall be in a white 3-ring binder with tabbed sections to include reinforced 8.5" x 11" paper, 11" x 17" B-size drawings when practical, and individually sleeved D-size drawings.

2. The manual shall include: Equipment Data Pages, Equipment Introduction and Operation, Warranty, Long Term Storage, Troubleshooting, Maintenance and Lubrication, Spare Parts List, Equipment Listing, Catalog Cuts, and Drawings.

3. Field start-up reports as described in paragraph 3.3 (Manufacture Services) shall be submitted after start-up for owner's insertion into approved O&M manual.

1.4. PERFORMANCE AND DESIGN REQUIREMENTS

A. The belt conveyors shall be designed to convey dewatered sludge cake with a bulk density ranging from 45 to 60 pounds per cubic feet.

B. The dewatered sludge cake may consist of digested or undigested biological sludge from the treatment of municipal wastewater or dewatered water treatment plant sludge. The dewatered sludge cake solids content shall range from 10% to 30% total solids, with a typical cake solids content of 20% total solids.

C. The belt conveyors, and all related components supplied under this section shall be designed and rated for continuous duty service (24 – hours per day, 7 – days per week, 365 – days per year) operation.

D. The equipment shall be designed to operate with a capacity of 2.25 m^3/day (1907 ft^3/hr) at a maximum speed of 60 ft/min. Belt width shall be 18 inches.

2. PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

A. The equipment shall be manufactured by Jim Myers & Sons, Inc.(JMS), Charlotte, NC, or pre-qualified equal per paragraph 2.1.D. The referenced supplier is assumed to be pre-qualified.

B. The equipment described by this specification defines minimum equipment requirements as supplied by Jim Myers & Sons, Inc. All costs associated with any deviation from this specification shall be the sole responsibility of the Contractor.

C. The equipment shall be the product of a manufacturer engaged in the design and manufacture of similar equipment in successful operation in similar applications. The manufacturer shall have a minimum of 10 years of United States municipal wastewater experience with 10 installations of the same type of equipment as specified herein with documented successful operation.

D. Pre-qualification requires manufacturers to submit the following 30 days prior to bid:

1. A list of at least 10 previous installations, including contact information, of similar size, design, and complying with the requirements as set forth within this specification.
2. Preliminary drawings and process calculations specific to this project.

E. Equipment shall be manufactured in the USA.

2.2. GENERAL

A. All parts furnished shall be amply designed and constructed for the maximum stresses occurring during fabrication, transportation, erection and continuous operation. All materials for the conveyors and belt cleaning systems shall be new and shall be of the very best quality, entirely suitable for the service to which the units are to be subjected and shall conform to all applicable sections of these specifications.

B. The belt conveyor equipment shall be factory pre-assembled, factory pre-wired, and factory tested to the greatest extent practical.

2.3. EQUIPMENT

A. CONVEYOR BELT

1. Conveyor belting shall be the 24-inches wide and of uniform ply and cover design. Fabric material shall be all polyester carcass. Provide 4-ply belt of cross-rigid construction, but with sufficient number and proper weight so that the maximum tension does not exceed 80% of the manufacturer's allowable tension recommendation. Minimum belt tension rating shall be 220 PIW. Belt shall be designed to withstand maximum operating and starting tensions, both empty and fully loaded, and to bend properly over pulleys without overstressing cover, carcass or splice, Covers shall be moderately oil resistant (MOR), with minimum 1/8 inch cover on carrying side and minimum 1/16 inch cover on bottom.

2. Belting shall be designed to accept mechanical stainless steel splices. Splice shall be recessed and covered.

3. The conveyor shall have 3" high sidewalls vulcanized to the belt to contain the materials and prevent spillage. The sidewalls shall be recessed to provide sidewall stability and allow deflection wheels to transition the conveyor from horizontal to incline and incline to horizontal direction. Sidewall shall be spliced with cold vulcanizing kit and a single stainless steel fastener. Sidewall splice shall be offset six-inches from the conveyor belt splice.

B. IDLERS

1. Idlers shall be CEMA Class C, 5-inch diameter non-metallic rollers. Idler bearings shall be tapered roller type with a minimum B-10 life of 60,000 hours at 50 rpm. Each bearing shall have double seals using a contact seal to exclude dirt and triple-labyrinth seal to retain lubricant. All idlers shall be sealed for life and require no grease fittings. Idlers shall be as manufactured by Exalon, or equal.

2. Carrying idlers shall be of rigid shaft, single-roller type.

2. Carrying idler spacing shall be no greater than 4'-0". In loading areas, defined to extend one foot before and one foot after the actual loading chute dimension, idler spacing shall be 1'-0". Return idler spacing shall be no greater than 10'-0". Calculated belt sag shall be no greater than 2% of idler spacing.

3. All idlers shall be manufactured by Exalon.

4. Idler frames and brackets shall be stainless steel.

C. PULLEYS

1. Drive and tail pulley shall be minimum 12- inch diameter and at least 2-inches wider than the conveyor belt width. The head pulley shall be of the welded steel crown faced drum type with grooved lagging. The lagging shall be minimum 3/8 - inch thick with herringbone groves, and shall be of 50-60 durometer hardness vulcanized rubber. Lagging shall be grooved in a herringbone pattern with quarter inch grooves.

2. Pulley shafts shall be ANSI C1045 steel, with a minimum shaft size of 1-15/16-inches. Drive pulleys shall be keyed to the shafts. Shaft slope at hubs and bearings shall be no greater than 0.0015-inch per inch. The shaft shall be sized such that the maximum combined bending, belt tension, and torsional stresses do not exceed the material yield stress.

3. Pulley shafts shall be supported by roller-bearing pillow blocks. Bearings shall be self-aligning rollers, with a minimum B-10 life of 60,000 hours. For each shaft, one bearing shall be fixed, the other floating to allow for shaft expansion. The fixed

bearing shall be located on the driver side of drive pulley. Bearing adjustment screws shall be provided on each end of bearing base to aid alignment.

4. Pulley shaft bearings at the drive end shall be greased from a single grease fitting located on the most accessible side of the conveyor. Pulley shaft bearings at the tail end shall also be greased from a single grease fitting located on the most accessible side of the conveyor. Stainless steel tubing, mounted on the frame, shall convey grease from the single grease fitting to the bearing on the opposite side of the conveyor.

5. Pulley shall be as manufactured by Conveyor Components Inc. (CCI).

D. TAKE-UPS

1. Take-ups for each conveyor shall provide for a minimum travel of 2% of total conveyor centers, plus sufficient length for splicing of belting.

2. The entire take-up screw assembly shall be Type 304 stainless steel. A brass capstan nut shall be provided on the screw for ease of movement in either direction under load. The assembly shall be as strong in tension as compression.

3. Screw take-ups shall be self-aligning roller bearing units on protected screw frames with an adjustment of at least 18 inches.

E. BELT CLEANERS

1. A belt cleaning scraper shall be furnished for the head section. The belt scraper shall be spring loaded with a 3/8” thick neoprene blade and a UHMW-PE blade backer. The belt cleaning system shall be placed on the underside of the head pulley.

2. Head pulley belt cleaners shall be arranged so that they are easily accessible for service from one side of the conveyor, and do not interfere with drive arrangements and other conveyor features.

F. SPRAY WASH BOX

1. The conveyor shall be provided with a belt spray wash system at the discharge end of the conveyor.

2. The belt spray wash splash guard and trough shall be constructed of 12 gauge minimum thickness Type 304 stainless steel.

3. The system shall be complete with adjustable belt wipers, rollers, spray bars, inspection doors, solenoid valve and controls, and the necessary piping and accessories as required for a satisfactory operating belt spray wash system

4. The spray bar shall be constructed of 1” inside diameter stainless steel pipe and eight equally spaced spray nozzles to provide a uniform spray covering the entire width of the belt.

5. The spray bar shall be connected to a 2’ long 1” diameter flexible steel reinforced neoprene hose with a minimum working pressure of 150 psi. The hose shall be connected to the 1” diameter pipe. The pipe shall include a 1 inch diameter ball valve for flow control to the sprays. The 1” diameter pipe shall be connected to the nearest non-potable water line.

6. The spray bar and all piping shall be properly secured to the frame. Spray bar shall be located under the returning belt and be fully adjustable.

7. The spray wash water from the nozzles shall be completely contained within the wash box and drained vertically to the channel below by a 4” flanged stainless steel pipe.

G. FRAMES AND SUPPORTS

1. All metals, including the conveyor framework, shall be fabricated from ASTM A-36 steel plate and structural shapes. The main structural frame shall be fabricated from structural grade channel sections with a minimum size of 6- inches.
2. All metals, excluding stainless steel components and shafting, shall be hot-dip galvanized with a minimum thickness of 4-7 mils in accordance with requirements of ASTM A123, ASTM A153 and ASTM A386. Damage to hot-dipped galvanized coatings shall be repaired in accordance with requirements of ASTM A780.

3. The frame shall include adequate supports for head and tail section machinery.

4. The frame shall be supported by legs provided at ten feet maximum intervals. The support legs shall include bottom plates for anchorage of the conveyor to the supporting structural component. Support location, support design loadings, and anchorage requirements for each support shall be clearly detailed in the submittals.

5. Anchor bolts shall be minimum 5/8 – inch diameter. Anchor bolts and fasteners shall be type 304 stainless steel adhesive anchors.

H. DECK PLATE

1. The conveyors shall be equipped with a continuous flat deck plate fabricated of minimum #14 gauge stainless steel.

I. GUARDS

1. Stainless steel safety guards, 18- gauge minimum thickness, shall be furnished for all exposed gears, chains, sprockets and flexible couplings. Guards shall be rigidly supported and designed to permit easy removal.

J. DRIP PANS

1. The conveyors shall be equipped with a continuous drip pan fabricated of minimum #16 ga. stainless steel extending not less than two- inches on each side of the return belt and turned up at the edges not less than two-inches.

2. Drip pans shall be fabricated with nested sections and sloped to a drain connection. Drain connection(s) shall be a flanged opening for attachment of two-inch drainage pipe as indicated on the Drawings. Supports for the drip pans shall be stainless steel.

K. SKIRT PLATES

1. Skirt plates shall be a minimum of 7-inches high exclusive of the edging. The skirt plates shall be fabricated of #10 ga. stainless steel and shall be mounted to the conveyor framework in the loading area only using 3/8” thick stainless steel brackets. Each skirt plate shall have a full length, ½” thick x 4” high neoprene edging bolted to it, with provisions for vertical adjustment.

L. DRIVE SYSTEM

1. Drive assembly shall consist of a close-coupled integral gearmotor, with a chain and sprocket drive assembly. Gear housing shall be cast iron, furnishing complete protection under all conditions of service. Gears shall be manufactured and rated for continuous duty in accordance with AGMA Standards, of heat-treated alloy steel. Provide splash type gear lubrication. Gear reducer shall be Class II speed reducer as manufactured by Eurodrive. Chain and sprocket drive ratio not to exceed 3:1.

2. The gear reducer and drive shall be designed to provide an applied torque adequate to start a full loaded belt.

3. The chain drive shall be provided with a stainless steel OSHA guard.

M. INLET AND DISCHARGE CHUTES (OPTIONAL)

1. Transfer chutes shall be provided at all points where belt conveyor is loaded or discharged. The chutes shall be fabricated from a minimum 10 gauge plate steel, adequately stiffened. The design of the chutes shall take into consideration material trajectory and minimization of material buildup. Transfer shall be designed to direct material to the center of downstream device. Openings with tight covers will be provided in the chute as needed for servicing of belt cleaners and other equipment, adjustment of deflectors and observation of material trajectory. Head pulley on interior conveyors carrying solids shall be completely enclosed for odor control, with a strip curtain above the carrying belt, and the return belt and bottom side of the carrying' belt sealed with 1/4-inch 60 durometer rubber clamped in place.

N. SAFETY DEVICES

1. Safety Trip Cords
   a. Each conveyor shall be furnished with emergency trip cords running on both sides of the conveyor and a safety stop switch in compliance with OSHA standards.
   b. Trip cabling shall be 3/16 – inch O.D. fabricated of internal 3/32-inch 7 x 7 strand galvanized aircraft cable and orange colored nylon outer sheathing. Cabling shall be supported by galvanized steel or stainless steel eyebolts every 10 feet. Wired clamps shall be stainless steel.
   c. The switch assembly shall be able to handle up to 200 feet of conveyor length. Safety switch shall be housed in a NEMA 4X enclosure (aluminum, stainless steel or non-metallic) and shall have a DPDT micro-switch and stainless steel external hardware. Emergency trip cord and safety switch shall be Material Control, Inc. model PCD-2S or equal.

2. A zero speed switch shall be directly connected to each tail pulley. The switch shall be housed in a NEMA 4X enclosure, mounted off the side of the conveyor frame with a bolted stainless steel bracket. The switch shall be a Dazic model SA3B1Z1 or equal.

O. HARDWARE

1. All fasteners shall be stainless steel. Zinc plated fasteners shall not be used.

2. All stainless steel bolts shall be assembled using an anti-seize compound.

3. All structural bolts shall be A-325, hot-dip galvanized.

P. FABRICATION.

1. All parts and components shall be factory-assembled in sections convenient for field handling and installation but requiring the minimum amount of work for field assembly. No cutting or welding should be required on either field assembly or erection.

2. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.

3. All assembled parts and components ready for shipment shall be securely bundled, coiled, or crated and adequately protected from damage and corrosion during shipment and storage.

Q. SURFACE PREPARATION

1. Fabricated carbon steel components with the exception of head and tail pulley shafts shall be shop blasted & hot dipped galvanized.

2. Head and tail pulley shafts shall be coated with an anti-rust inhibitor. One coat shall be applied. The anti-rust inhibitor shall be Protect-O-Flex as manufactured by Pro Chem Inc.

3. Drive chain and sprockets shall be coated with open gear lubricant after installation.

4. Drive units, emergency stop switch, and zero speed switch shall include manufacturer's standard wash down duty paint system.

3. EXECUTION

3.1. INSTALLATION

A. The belt conveyor shall be installed in accordance with the manufacturer's written recommendations.

B. LUBRICANTS AND LUBRICATING EQUIPMENT

1. Provide and install necessary quality oils, greases and anti-seize compounds for initial operation of all equipment provided that requires oil, grease or anti-seize.

2. Anti-seize shall be applied to the threads of all stainless steel bolts before assembly at the factory and field assembly.

3.2. WARRANTY

A. The supplier shall guarantee in writing that the equipment furnished is appropriate for the intended service and shall be free of manufacturing and fabrication defects in material and workmanship for a period of 1 year after the equipment is satisfactorily placed in service. If the equipment is not placed in service within 6 months of delivery, the 1 year guarantee period shall commence 6 months after delivery.

3.3. MANUFACTURER'S SERVICES

A. Manufacturer's Field Services: The CONTRACTOR shall provide the following services in addition to any other services specified herein, and required by these Specifications.

1. A factory trained manufacturer's representative shall be provided for a minimum of two (2) trips and a minimum of three (3) eight hour days to provide installation supervision, start-up and field testing services, and O&M training services. The installation services shall be coordinated between the CONTRACTOR and the manufacturer. The start-up and field testing services, and the O&M services shall be coordinated with the ENGINEER.

2. After installation supervision and field testing services by the manufacturer, the CONTRACTOR shall submit to the ENGINEER, a certification letter on the manufacturer's letterhead and signed by the manufacturer certifying that the equipment was installed per the manufacturer's recommendations.
3. The manufacturer shall provide operator training to all required plant personnel.

B. All costs, including travel, lodging, meals and incidentals for manufacturer service shall be included in the CONTRACTOR'S bid

END OF SECTION

Section 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Basic requirements specifically applicable to the work of Division 16 - Electrical Requirements.

B. The Contractor shall furnish equipment, materials, and labor for assembly and installation plus check-out and start-up of the complete electrical system as shown on the Drawings and stipulated in the Specifications.

1.02 REFERENCES

A. As a minimum requirement, the electrical system shall be constructed in accordance with:

1. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), No. 70 - National Electrical Code (NEC).. The contractor shall provide all electrical work / installations based on the latest addition of the NEC.

2. City of Houston Building Code.

3. Other applicable Codes and Standards as referenced in other Master Specifications.

B. Comply with local, county, state and federal regulations and codes in effect as of date of purchase.

C. Equipment of foreign manufacture must meet U.S. codes and standards.

D. Equipment and materials shall conform to requirements of specification and to the criteria provided in data sheets for the project.

1.03 QUALITY ASSURANCE

A. Product Conformance Certificate and Quality Assurance Release. Submit an overall conformance certificate for electrical components signed by the person responsible for product quality. Specifically identify the purchased material or equipment by project name and location, purchase order number, supplements, and item number where applicable, including materials and services provided by others.

Indicate that all requirements have been met and identify any approved deviations.

B. Field Inspection

1. Electrical work shall be inspected and approved by the local code inspectors, the wastewater inspectors, and the Project Manager prior to starting the 7-day test or scheduling training.

2. Contractor shall give a minimum of two days notice to the Inspectors that the installation is ready for inspection and two days notice to the Project Manager.

3. Concealed work shall be inspected and approved by code inspectors and wastewater inspectors before it is covered:

   a) Conduit with stub-ups, underground in duct banks before concrete is poured. Conduit in slabs, walls and ceilings, complete with boxes.

4. Electrical equipment and materials shall be inspected upon arrival by the Project Manager for compliance with specifications.

1.04 SITE CONDITIONS

A. Take the following site conditions into consideration when fabricating, erecting, installing and wiring electrical equipment under this contract:

1. Plant Location _____

   Houston, Texas _____

2. Plant Type and Size

3. Plant Site Elevation

4. Seismic Zone Zone 0 _____

5. Wind Velocity 90 mph _____

6. Temperature, Min./Max.:

- Coldest Winter Month High 60 degrees F Low 41 degrees F
- Warmest Summer Month High 94 degrees F Low 73 degrees F
- Lowest Expected 11 degrees F
- Highest Expected 107 degrees F

7. Rainfall:

   - Annual 45 inches
   - Design 3.4 inches/hour, 8.4 inches/24 hours

8. Design Relative Humidity: 98%

9. Station Barometric Pressure:

   - Average Annual 29.5 inches Hg Absolute.

10. Utility Water Systems: Design Pressure Design Temp.

    - River Water _____PSI _____degrees F
    - Well Water _____PSI _____degrees F
    - City Water _____PSI _____degrees F

11. Electric Power Supply Characteristics (Available to Contractor):

	Voltage	Phase	Hz	Wire	Delta or Wye
1					
2					
3					

PART 2 P R O D U C T S

2.01 COMPONENT DESIGN

A. Components utilized in the construction of the material or equipment shall be of the latest proven design, new and in current production. Do not use obsolete components or components to be phased out of production.

2.02 FACTORY INSPECTION

A. Provide free access with prior notice for the Project Manager at all times to the shop where the material or equipment is being fabricated or tested. Provide reasonable facilities for inspection, witnessing tests, and examining records. Give 7-days notice prior to starting tests which are scheduled for factory inspection.

PART 3 E X E C U T I O N

3.01 INSTALLATION

PREPARATION

A. Verify dimensions and ratings of equipment and materials to ensure proper fit and performance.

3.02 INSTALLATION

A. Install equipment and materials in accordance with the Drawings and manufacturer's written instructions. If field conditions necessitate changes in electrical installation, obtain approval from the City Engineer.

B. Conductor voltage drop shall not exceed 2 percent for feeders and 3 percent for branch circuits.

3.03 DEMONSTRATION

A. Test the electrical system to specification requirements and to demonstrate correct installation and operation of equipment. O & M Manual shall be furnished prior to testing for reference during testing and corrections for final O & M.

B. Before 7-days test, demonstrate the system to the wastewater inspectors and the Project Manager. Show the system to be fully operational. All alarms, safeties, and communication points to central and locally must operate in both full-automatic and back-up modes. Use fresh water in the test medium.

C. Operate the system continuously for a period of 7 days in full automatic, without failure, to qualify as acceptable. "Failure" is considered any problem that requires correction by process control instructions, maintenance personnel, such as: high or low water level, any motor alarm, power failure, phase failure, communication failure, PLC failure, process control software failure, requiring rewriting or transducer failure. This would exclude conditions not under the control of Contractor, such as: evident lightning strikes, 25-year rains, local power utility power failure longer than the specified duration of service. Failures due to uncontrollable situations would allow the 7-day test to continue, as soon as test conditions are restored and the City Engineer is notified.

D. The existing station shall remain in service during this test.

END OF SECTION

Section 16060

ELECTRICAL DEMOLITION

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Electrical demolition.

1.02 REFERENCES

A. Temporary wiring of systems to maintain operation of facilities while undergoing modifications and demolition shall be provided in accordance with:

1. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), No. 70 - National Electrical Code (NEC), Article No. 590 - Temporary Wiring

2. City of Houston Electrical Code.

1.03 SUBMITTALS

A. Annotate existing drawings to sequence the demolition of systems, equipment removal and temporary hook-ups.

B. Schedule with Project Manager for required shut-downs to accommodate system demolition and installation of temporary facilities.

1.04 QUALITY ASSURANCE

A. Verify field measurements and circuiting arrangements are as shown on Drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents. Report discrepancies to City Engineer before disturbing existing installation.

D. By beginning demolition, installer accepts existing conditions and warrants that he will maintain service to equipment and items not scheduled or indicated for removal, and that he will return to the City all items and systems in good operating condition.

PART 2 P R O D U C T S

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual Sections.

2.02 DESIGN AND CONSTRUCTION

A. The temporary electrical wiring and facilities shall be designed and constructed in strict compliance with NEC - Article No. 590 and the City of Houston Electrical Code.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

B. Coordinate utility service outages with utility company to provide continuous service to operating equipment.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, notify City of Houston Utility Operations and get approval. Use personnel experienced in such operations.

D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from the City Engineer at least one week before partially or completely disabling system. Minimize outage duration.

E. Adding Load to Existing Electrical System: Perform a load analysis to assure that the existing power distribution system (MCC, service, conductors, panel, breakers, feeders, branch circuits, etc.) is not overloaded if additional load is added to existing equipment.

F. Existing electrical conduit and wire may not be reused to feed new equipment except by written authorization from the City of Houston.

3.02 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Remove, relocate, and extend existing installations to accommodate new construction.

B. Remove abandoned wiring to source of supply.

C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. This includes all associated support and anchoring systems. Cut conduit flush with walls and floors, and patch surfaces.

D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.

E. Disconnect and remove abandoned panelboards and distribution equipment.

F. Disconnect and remove electrical wire, conduits, devices and equipment serving utilization equipment that has been removed.

G. Repair adjacent construction and finishes damaged during demolition and extension work. Repairs to include matching material type and color.

H. Maintain access to existing installations which remain active. Modify installation or provide access panel as appropriate. Cut abandon conduits in floors or slabs flush to surface, fill with concrete and path to match surface type and color.

I. Extend existing installations using materials and methods as specified for new work.

3.03 DISPOSAL AND SALVAGE

A. Salvage electrical and instrumentation equipment and wiring size four and larger removed from existing facilities for City's reuse.

B. Material and equipment which can be reused or salvaged remains the property of the City of Houston. Equipment to be retained by the City of Houston shall be delivered to a specified location by the Contractor.

C. Materials and equipment which cannot be reused or salvaged will be removed and disposed by the Contractor.

3.04 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

3.05 INSTALLATION

A. Install relocated materials and equipment under the provisions of Section 02220 - Demolition.

B. Electrical installations and materials shall conform to the current issue of the following standard and codes: American National Standards Institute/National Fire Protection Association (ANSI/NFPA), No. 70 - National Electrical Code (NEC), City of Houston Electrical Code, and material and workmanship.

C. All material shall be free of defects and in safe working condition which will meet electrical classification and functional requirements.

D. Testing shall be made during the course of construction or at the completion of the job. These tests shall be made by the electrical contractor. The contractor shall furnish all test equipment.

E. The job will not be complete until work has been inspected and trial startup has been successfully completed.

END OF SECTION

Section 16111

CONDUIT, FITTINGS, AND BODIES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Conduit, fittings, and bodies.

1.02 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI C 80.1 - Rigid Steel Conduit - Zinc Coated.

2. ANSI C 80.4 - Fittings for Rigid Metal Conduit.

B. American Society for Testing and Materials (PVC Coated Conduit)

1. ASTM D149-09 – Standard test method for dielectric breakdown voltage and dielectric strength of solid electrical insulating materials at commercial power frequencies.

2. ASTM D1735-08 – Standard practice for testing water resistance of coatings using water fog apparatus.

3. ASTM D2247-11 – Standard practice for testing water resistance of coatings in 100% relative humidity.

4. ASTM D2240-05 (2010) – Standard test method for rubber property – durometer hardness.

5. ASTM D1308-02 (2007) – Standard test method for effect of household chemicals on clear and pigmented organic finishes.

6. ASTM D638-10 – Standard test method for tensile properties of plastics.

7. ASTM D746-07 – Standard test method for brittleness temperature of plastics and elastomers by impact.

8. ASTM D1151-00 (2006) – Standard practice for effect of moisture and temperature on adhesive bonds.

9. ASTM D870-09 – Standard practice for testing water resistance of coatings using water immersion.

10. ASTM G152-06 – Standard practice for operating open flame carbon arc light apparatus for exposure of non-metallic materials.

11. ASTM G153-04 (2010) – Standard practice for operating enclosed carbon arc light apparatus for exposure of non-metallic materials.

12. ASTM D3359-09e2 – Standard test methods for measuring adhesion by tape test.

13. ASTM D4585-07 – Standard practice for testing water resistance of coatings using controlled condensation.

C. ASTM B571-97 (2008)e1 – Standard practice for qualitative adhesion testing of metallic coatings

D. Federal Specifications:

1. W-C-58 C - Conduit Outlet Boxes, Bodies Aluminum and Malleable Iron.

2. W-C-1094 - Conduit and Conduit Fittings Plastic, Rigid.

3. WW-C-566 C - Flexible Metal Conduit.

4. WW-C-581 D - Coatings on Steel Conduit.

E. National Electrical Manufacturers Association (NEMA):

1. NEMA RN 1 - Polyvinyl-Chloride Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing.

2. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).

3. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

F. National Fire Protection Association (NFPA), ANSI/NFPA 70 - National Electrical Code (NEC).

G. Underwriters' Laboratories (UL):

1. UL 1 - Flexible Metal Electrical Conduit.

2. UL 6 - Rigid Metal Electrical Conduit.

3. UL 514 B - Fittings for Conduit and Outlet Boxes.

4. UL 651 - Schedule 80 Rigid PVC Conduit.

5. UL 651 A - Type EB and A Rigid PVC Conduit and HDPE Conduit.

6. UL 886 - Electrical Outlet Boxes and Fittings for Use in Hazardous Locations.

H. City of Houston Electrical Code.

1.03 SUBMITTALS

A. Make submittals following Section 01330 - Submittal Procedures:

1. Manufacturer's cut sheets, catalog data.

2. Installation, terminating and splicing procedure.

3. Instruction for handling and storage.

4. Dimensions and weight of products.

5. Code compliance certificate.

6. Conformance certificate.

1.04 QUALITY ASSURANCE

A. Rigid steel conduit shall pass the bending, ductility, and thickness of zinc coating test described by ANSI C 80.1.

B. Flexible conduit shall pass the tension, flexibility, impact, and zinc coating test described by UL 1.

C. Nonmetallic conduit and fittings shall pass the test requirements of NEMA TC 2, UL 65and 651 A and Federal Specification W-C-1094 A.

D. The PVC coated conduit must be listed by UL with both the zinc coating and PVC coating each serving as primary coatings by itself under UL6.

1.05 DELIVERY STORAGE AND HANDLING

A. Package conduit in 10-foot bundles maximum with conduit and coupling thread protectors suitable for indoor and outdoor storage. Package fittings in manufacturer's standard quantities and packaging suitable for indoor storage. Package plastic-coated rigid conduit, fittings, and bodies in such a manner as to protect the coating from damage during shipment and storage.

B. Store conduit above ground on racks to prevent corrosion and entrance of debris.

C. Protect plastic conduit from sunlight.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. Rigid Aluminum Conduit:

1. Allied Tube and Conduit.

2. Wheatland Tube Company.

B. PVC Coated Aluminum Conduit:

1. Occidental Coating Company (O-Cal Blue).

2. Robroy Industries, Inc.

3. Perma-Cote.

4. Triangle PWC.

C. PVC Rigid Sch 80 Conduit:

1. Allied Tube & Conduit.

2. Cantex.

3. Osburn Associates, Inc.

D. Conduit Fittings and Bodies:

1. Appleton Electric.

2. Cooper Crouse-Hinds.

3. Hubbell - Killark Manufacturing Company.

4. O-Z/Gedney.

E. Liquidtight Aluminum Flexible Metal Conduit:

1. Southwire.

2. Anaconda Metal Hose Div .

3. ALFLEX.

4. American Flexible Conduit Co., Inc.

2.02 MATERIALS AND EQUIPMENT

A. Design Conditions. Use electrical conduit, fittings, and bodies designed for service in areas as specified in Section 16010 - Basic Electrical Requirements and this section to form a continuous support system for power, control, and instrument cables or any combination thereof.

B. Conduit Raceway:

1. Rigid Aluminum Conduit .

a) Rigid Aluminum conduit shall be extruded from AA 6063 alloy in temper designation T-1 and shall conform to FED Spec WW-C-540C, ANSI C80.5 and UL 6A .

2. PVC Coated Rigid Aluminum Conduit.

a) PVC coated rigid aluminum conduit shall have a minimum 0.040-in thick, polyvinyl chloride coating permanently bonded to rigid aluminum conduit and an internal chemically cured urethane or enamel coating. The ends of all couplings, fittings, etc. shall have a minimum of one pipe diameter in length of PVC overlap.

b) Elbows and couplings shall be PVC coated by the same manufacturer supplying the conduit PVC coating system. Elbows and couplings used with PVC coated conduit shall be furnished with a PVC coating bonded to the aluminum, the same thickness as used on the coated aluminum conduit.

c) Condulets for conduits up to and including 2-1/2", conduit outlet bodies and covers shall be copper-free aluminum, with captive screw-clamp cover, neoprene gasket and stainless steel screws and clamps, Cooper Crouse-Hinds Form 7 with Mark 7 wedge-nut cover, Appleton, or approved equal. For conduits larger than 2-1/2", junction boxes shall be used.

d) Urethane coating shall be a minimum of 2 mil thickness on the interior of the conduit and the interior of fittings, condulets, covers, and bodies.

e) Form 8 fittings shall have an o-ring molded with the coating of their covers. The fittings shall pass a UL observed pressure and vacuum test retaining 25" of vacuum and 17 PSI of pressure for a period of 80 hours.

3. Liquidtight Aluminum Flexible Metal Conduit

a) Liquidtight aluminum flexible metal conduit shall have an interlocked aluminum core, PVC jacket rated for 60 degrees Canada meeting NEC Article 351.

b) Fittings used with liquidtight flexible aluminum conduit shall be copper-free aluminum and shall conform to FEDSPEC AA50552, and UL-514B .

c) Couplings and fittings for use in hazardous areas shall comply with UL 886, NEC Article 501 & 502, and Federal Specification W-C-586 C.

4. PVC Conduit and Fittings:

a) Use PVC conduit, bends, and fittings, which comply with NEMA TC 2, W-C-A, and NBC Article 347-17 for above ground installation. Underground installations refer to 16402. Conduit shall be Schedule 80.

C. Device Boxes:

1. Device boxes, switch, receptacle, etc., shall be copper free cast aluminum, and shall have tapered, threaded, hubs, with integral bushings. Boxes shall have internal grounding screw, and a minimum of two mounting feet. Boxes shall be type FD, Cooper Crouse-Hinds, Appleton or approved equal.

D. Conduit Hubs:

1. Conduit hubs for use on raceway system pull and junction boxes shall be watertight, threaded aluminum, insulated throat, 316 stainless steel grounding screw, as manufactured by T&B H150GRA Series, or approved equal.

E. Grounding Bushings:

1. Grounding bushings shall be insulated lay-in lug grounding bushings with tin-plated copper grounding path. Bushings shall have integrally molded noncombustible phenolic insulated surfaces rated 150°C. Each bushing shall be furnished with a plastic insert cap and grounding lug. The size of the lug shall be sufficient to accommodate the maximum ground wire size required by the NEC for the application. All non-aluminum metallic hardware shall be 316 stainless steel. Bushings shall be O-Z/Gedney Type ABLG, or approved equal.

F. Expansion-Deflection Coupling:

1. Combination expansion-deflection fittings with 3/4 ” axial expansion and contraction movement, 3/4” parallel misalignment movement, and up to 30 degrees of angular movement in any direction. It shall be of copper-free aluminum, with exterior bonding jumper of tinned copper braid and 316 stainless grounding straps, Cooper Crouse-Hinds Model XD as manufactured by the Crouse--Hinds Co., or equal. Nylon tie wraps are not acceptable.

G. Expansion Fittings:

1. Expansion fittings shall be, 8” movement, copper-free aluminum, with exterior bonding jumper of tinned copper braid and 316 stainless grounding straps, Type XJGSA as manufactured by Crouse-Hinds Co., or approved equal, with internal grounding. Nylon tie wraps are not acceptable.

H. Explosion-Proof Seals, Breathers and Drains:

1. Explosion proof fittings shall be designed for Class 1 Division 1, Group D, hazardous locations. Fittings shall be of copper-free aluminum, consist of seals, breathers and drains of type ED, as required for the application. Fittings shall be as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; O.Z./Gedney Co., or equal.

I. Kellums Grips

1. Kellums grips to support cables shall be of 316 stainless steel.

J. Conduit Mounting Equipment:

1. All pull and junction box supports, spacers, conduit support rods, clamps, hangers, channel, nut, bolts, washers, etc. and shall be made of 316 stainless steel. Nylon tie wraps are not acceptable.

K. Conduit Identifications Tagging:

1. Conduit identification plates shall be embossed stainless steel with stainless steel band, permanently secured to the conduit without screws. Nylon tie wraps are not acceptable.

2. Identification plates shall be as manufactured by the Panduit Corp. or equal.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Ensure that the conduit system to be installed is sized properly for the cable and wire requirements.

B. Verify the actual physical conduit route from the conduit plan drawings and prepare the conduit support system.

C. Verify the equipment locations to which the conduit will be connected and determine detail requirements for connections.

3.02 INSTALLATION

A. Install PVC-coated rigid aluminum conduits in all outdoor locations, inside valve vaults and wet wells, lift station dry pits, areas that are not air-conditioned, and in all other corrosive and wet environments. Install PVC-coated conduit in strict accordance with manufacturer's instructions. Use installers certified by the manufacturer.

B. Install rigid aluminum conduits in dry, inside, air-conditioned locations only.

C. Install PVC SCH 80 conduits in reinforced duct banks or encased in concrete slabs. For stub-ups, use PVC coated rigid aluminum elbows as required in Section 16402.

D. Run exposed conduit parallel or perpendicular to walls, ceilings or main structural members. Group multiple conduits together where possible. Conduit shall not interfere with the use of passageways, doorways, overhead

cranes, monorails, equipment removal areas or working areas. In no case shall conduit routing present a safety hazard, trip hazard, or interfere with normal plant operating and maintenance procedures. A minimum overhead clearance of 8 feet shall be maintained in passageways. All conduits installed across walkways shall have concrete or aluminum trip plates installed.

E. Installation and support of conduit shall be from steel or concrete structures in accordance with the standard detail drawings. Furnish necessary conduit straps, clamps, fittings and support for the conduit in accordance with the standard details.

F. Identify conduit at termination points like MCC, light fixtures, control panels, receptacles, panels, and junction boxes.

G. Not more than 3 equivalent 90 degree bends will be permitted between outlets. Provide bonded expansion fittings at building expansion joints.

H. Install conduit runs so that they are mechanically secure, mechanically protected from physical harm, electrically continuous, and neat in appearance. The interiors of conduit shall provide clean, smooth raceways through which conductors may be drawn without damage to the insulation. Make threaded connections wrench tight.

I. Cut conduit square with a power saw or a rotary type conduit cutter designed to leave a flat face. Do not use plumbing pipe cutters for cutting conduit. Ream the cut ends of conduit with a reamer, designed for the purpose to eliminate rough edges and burrs. Threads shall be cut with standard conduit dies providing 3/4-inch taper per foot, allowing the proper length so that joints and terminals may be made up tight and the ends of the conduit not deformed. Keep dies sharp and use a good quality threading oil continuously during the threading operation. Remove metal cuttings and oil from the conduit ends after the threads are cut coat threads with ALUMA-SHIELD or equal before connections are made

J. Use strap wrenches only to tighten joints in plastic coated rigid aluminum conduit. Replace all conduit and fittings with damage to the plastic coating, such as cuts, nicks and threader chuck jaw marks. Use a solvent, or the same patching material to seal around the edges of conduit fitting covers.

K. Make changes in direction of conduit using elbows or fittings. Do not use pull boxes to make direction changes unless specifically designated otherwise.

L. Field fabricated bends shall be free of indentations or elliptical sections. The radius of the bend shall not be less than 6 times the smallest diameter of the raceway.

M. Protect all conduit terminations from mechanical injury. Prevent the entry of moisture and foreign matter into the conduit system by properly capping terminations.

N. Avoid trapped runs of conduit, if possible. When they are necessary, provide drainage using a "tee" condulet equipped with a drain. Conduit is likely to pass through areas with a temperature differential of 20 F or more. Seal penetrations with a proper seal fitting at the wall or barrier between such areas. For conduit passing through walls separating pressurized areas from non-pressurized areas, install sealing fittings at the wall on the non-pressurized side.

O. Fit all conduit crossing building or structure expansion joints with approved expansion fittings, except that fittings will not be required when conduit crossing an expansion joint is supported on trapeze hangers in such a way that at no time will the conduit be under stress due to expansion. Unless otherwise indicated on Drawings, install expansion fittings every 300 feet within a straight conduit run and where conduit crosses building expansion joints, using bonding straps to ensure ground continuity. Bonding strap connections shall be protected by minimum 40 mils PVC coating.

P. Where rigid aluminum conduit terminates in sheet metal enclosures, fit the conduit rigid aluminum threaded hubs. Sheet metal enclosures made of stainless steel or aluminum located outside or in any other wet, damp, or corrosive areas shall be furnished with PVC-coated aluminum threaded hubs. Restrict side penetrations to the lower one third of the enclosure. Where PVC-coated rigid conduit is used, PVC-coated rigid threaded hubs will be used.

Q. Provide Liquid tight Aluminum Flexible Metal conduit where necessary to allow for movement or to localize sound or vibration, at transformers, at motors and any other rotating equipment. Flexible metal conduit shall be used as fixture whips only.

R. Seal all openings or holes where conduits pass through walls or floors. When passing through a firewall or floor, use a fire-rated seal per the typical detail included in the Drawings. Certain walls, as indicated on the drawings, require environmental (air-tight) seals; seal as indicated on the Drawings.

S. Install explosion-proof seals according to N.E.C. requirements and in coordination with NFPA 820, in conduit runs crossing or entering hazardous classified areas (as shown on Drawings). Install type CSBE removable sealing fittings to seal pump cables between wet well and first junction box. If a junction box is not used, install the CSBE seals at the wet well and the control panel.

T. All transitions in PVC-coated aluminum conduit size shall be accomplished with PVC-coated aluminum reducers or manufactured reducing condulets. RE bushings shall not be used.

U. Parallel runs of conduit may be supported by structural steel racks. When two or more racks are arranged one above the other, provide vertical separation of not less than 12 inches between racks, unless otherwise indicated on Drawings. Space conduits on the racks at least enough to provide 1/4-inch clearance between hubs on adjacent conduits at terminations and to allow room for fittings.

V. Fill conduit racks no more than 75 percent of their capacity, providing usable space for future conduit. To ensure this, conduits leaving the rack horizontally shall be offset up or down so that future conduits may be installed in the space remaining. Construct conduit racks to permit access for wire or cable pulling at all pull points, even when future conduits are added to fill the racks.

W. Where conduit racks are supported on rods from beam clamps or by some other non-rigid suspension system, install rigid supports at no more than 50-foot intervals to give lateral stability to the rack.

X. Conduit racks or hangers must in no way interfere with machinery (or its operation), piping, structural members, process equipment, or access to anticipated future equipment. Refer to architectural, structural, equipment layout and piping drawings to ensure that this requirement is met. Label high voltage conduit with the circuit phase-to-phase voltage by means of a firmly attached tag or label of approved design at each conduit termination, on each side of walls or barriers pierced and at intervals not exceeding 200 feet along the entire length of the conduit.

Y. Support conduit sizes 2 inches and larger at spacing’s not exceeding 10 feet and conduit sizes 1-1/2 inches and smaller at spacing’s not exceeding 8 feet.

Z. The means of fastening conduit to supports shall be: by one hole malleable iron conduit straps secured by wood screws to wood and by bolts with expansion anchors to concrete or masonry; by "Korn" clamps or U-bolts to other surfaces. Use "clamp backs" when strapping conduits to walls, column faces, or other such surfaces.

AA. Support conduit runs with conduit clamps, hangers, straps and metal framing channel attached to structural steel members. Conduits of 1-1/2 inch size or less may be supported by one-hole conduit straps on concrete, tile or steel work, but for larger size conduit, 2-hole straps shall be used. Use clamps of galvanized malleable iron for rigid galvanized conduit and stainless steel for PVC-coated conduit. Metal framing channel straps used for PVC-coated conduit shall be type 316 stainless steel.

BB. Install conduits supported form building walls with at least 1/4-inch clearance from the wall to prevent the accumulation of dirt and moisture behind conduit.

CC. All Conduits embedded in concrete lift station deck shall be PVC-coated rigid aluminum.

END OF SECTION

Section 16120

600-VOLT BUILDING WIRE AND CABLE

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Specifications for 600-volt building wire and cable.

1.02 REFERENCES

A. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), NFPA 70 - National Electrical Code (NEC), Article 310 - Conductors for General Wiring

B. Underwriter's Laboratories (UL)

1. UL 83: Thermoplastic Insulated Wires and Cables

2. UL 1063: Machine Tool Wires and Cables

C. American Society for Testing and Materials (ASTM)

1. ASTM B 3: Soft or Annealed Copper Wires

2. ASTM B 8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, Soft

D. Insulated Cable Engineers Association (ICEA), ICEA S-61-402: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-5)

E. City of Houston Electrical Code

1.03 SUBMITTALS

A. Make submittals following Section 01330 - Submittal Procedures.

1. Manufacturer's cut sheets, catalog data

2. Instruction for handling and storage

3. Dimensions and weight

4. Conformance certificate

1.04 QUALITY ASSURANCE

A. Tests Cable shall meet all the requirements of Part 6 of ICEA S-61-402.

B. Conformance Certificate and Quality Assurance Release: Submit a conformance certificate signed by the person responsible for product quality. The certificate shall specifically identify the purchased material or equipment; such as by the project name and location, purchase order number, supplements, and item number where applicable, including materials and services provided by others. The certificate shall indicate that requirements have been met and identify any approved deviations.

1.05 DELIVERY, STORAGE AND HANDLING

A. Ship wire and cable on manufacturer's standard reel sizes unless otherwise specified. Where cut lengths are specified, mark reel footage accordingly. Each reel shall contain one continuous length of cable. Provide impact protection by wood lagging or suitable barrier across the traverse of the reel. Provide moisture protection by using manufacturer's standard procedure or heat shrinkable self-sealing end caps applied to both ends of the cable.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. American Insulated Wire Corporation

B. Southwire Company

C. General Cable Company

D. Superior Essex

E. Rome Cable Company

F. Triangle Wire and Cable, Inc.

2.02 MATERIALS AND EQUIPMENT

A. Design. Provide cable designated as THWN/THHN stranded single conductor type and UL 83 and UL 1063 listed, rated 600 volts and certified for continuous operation at maximum conductor temperature of 90 C in dry locations and 75 C in wet locations in conduit. MTW stranded will be used in control panels.

B. Conductors. Provide conductors which are Class B, concentric stranded, annealed uncoated copper with physical and electrical properties complying with ASTM B 3 and ASTM B 8 and Part 2 of ICEA S-61-402.

C. Insulation.

1. Each conductor shall be PVC insulated and nylon jacketed to meet the requirements of Part 3 of ICEA S-61-402. The insulation thickness shall match the dimensions listed in Table 310.104(A) of the National Electrical Code (NEC) for type THHN/THWN wire.

2. Outdoor conductors installed in conduit exposed to sunlight shall be Type XHHW-2 stranded copper conductors, moisture, and heat resistant cross-linked polyethylene (XLP). Conductors shall meet or exceed UL Standard 44, Federal Specification A-A-59544, and requirements of the National Electrical Code. Type XHHW-2 meets and exceeds all construction requirements of ICEA S-95-658 (NEMA WC 70.

D. Wire Marking

1. Wire marking shall be in accordance with National Electrical Code (NEC) Article 310.120.

2. The printing method used shall be according to (NEC) 310.120(B).

E. The single conductor color coding shall be as follows:

System Voltage	A	B	C	Neutral
120/208 Volt 3Ph/4w	Black	Red	Blue	White
120/240 Volt 3Ph/4w	Black	Orange	Blue	White
277/480 Volt 3Ph/4w	Brown	Purple	Yellow	Grey
Motor Control	1 Black			
	2 Red			
	3 Blue			
Ground	Green			

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Complete the cable raceway systems and underground duct banks before installing cables.

B. Verify sizing of raceways and pullboxes to ensure proper accommodation for the cables according to (NEC) minimum requirements or as specified on drawings.

C. Check the length of the cable raceway system against the length of cable on the selected reel.

D. Clean and swab conduits of foreign matter before cables are pulled.

3.02 INSTALLATION

A. Wiring Methods

1. Use wiring methods indicated on Drawings.

2. In general, use THHN/THWN stranded building wire for lighting, power and control wiring where conductors are enclosed in raceways like in above ground conduit system or in underground duct banks, or inside control panels.

3. Use XHHW-2 stranded building wire in outdoor areas power and control wire is in conduit exposed to direct sunlight. Refer to (NEC) 310.15(B)(3)(a)(5)(c) Exception.

4. Do not use solid conductors.

5. Use conductors not smaller than No. 12 AWG stranded for general lighting circuits.

6. Use conductors not smaller than No. 14 AWG stranded for control circuits, except when part of a multiconductor cable or internal panel wiring.

7. In general, do not splice conductors unless approved by the City Engineer.

8. Splices associated with taps for lighting and control circuits are allowed without approval.

9. Make splices in accessible junction boxes.

B. Single Conductor in Conduit and Ductbank

1. Install cables in accordance with the manufacturer's instructions and the National Electrical Code (NEC), Chapter 3- Wiring Methods and Materials. Do not exceed maximum wire tension, maximum insulation pressure and minimum bending radius.

2. Pull cables into conduits using wire pulling compounds approved by cable manufacturers to reduce friction. Lubricants must not be harmful to the conductor insulation. Mixtures containing soap or detergent shall not be used.

C. Single Conductor in Cable Tray

1. Do not install single conductor building wire and cable in cable tray.

2. For single conductor tray installation, see Section 16122 - 600 Volt Power Cable.

D. Preparation for Termination

1. Make 600-volt power cable terminations and splices with heat shrinkable sleeves and seals.

2. Terminal lugs and connectors for all sizes of conductors shall be crimp-on type.

3. For size 1/0 AWG and larger, crimp-on lugs shall have the long barrel with 2-hole tongues except in places where termination space is limited.

E. Tests

1. In general, test insulation integrity of the wiring system before terminating.

2. Make sure to disconnect sensitive electronic equipment before testing insulation.

3. Use a 600 VDC megohmmeter and perform the wire system insulation test in accordance with the operating instructions.

F. Termination. After the 600-volt wiring system has been tested with satisfactory results, reconnect wire.

END OF SECTION

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Section 16121

600-VOLT CONTROL CABLE

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. 600-volt control cable.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM B 3 - Soft or Annealed Copper Wires.

2. ASTM B 8 - Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, Soft.

3. ASTM B 33 - Tinned Soft or Annealed Copper Wire for Electrical Purposes.

4. ASTM B 174 - Bunch-stranded Copper Conductors for Electrical Conductors.

B. Institute of Electrical and Electronics Engineers (IEEE), IEEE 383-2.5: IEEE Standard for Type Test of Class IE Electric Cables and Field Splices.

C. Insulated Cable Engineers Association (ICEA):

1. ICEA S-61-402 - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-5).

2. ICEA S-66-524 - Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-7).

3. ICEA S-68-516 - Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-8).

D. Underwriters' Laboratories (UL):

1. UL 44 - Rubber Insulated Wires and Cables.

2. UL 83 - Thermoplastic Insulated Wire and Cables.

E. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), No. 70 - National Electrical Code (NEC) , Chapter No.3 - Wiring Methods and Materials, Article 725 - Class 1, Class 2, and Class 3 Remote Control, Signaling, and Power-Limited Circuits.

1.03 SUBMITTALS

A. Make submittals following Section 01330 - Submittal Procedures.

1. Completed engineer's data sheets.

2. Completed manufacturer's data sheets.

3. Manufacturer's cut sheets, catalog data.

4. Installation, terminating and splicing procedure.

5. Instruction for handling and storage.

6. Dimensions and weight.

7. Conformance certificate.

1.04 QUALITY ASSURANCE

A. Tests.

1. Cable shall be tested at the factory to confirm that the cable complies with requirements of Part 6 of ICEA S-61-402, S-66-524 or S-68-516. Refer to data sheet for additional test requirements.

2. Where applicable, the cable shall meet the requirements of the vertical tray flame test as described in IEEE 383-2.5.

1.05 DELIVERY STORAGE AND HANDLING

A. Ship cable on manufacturer's standard reel sizes, unless otherwise specified. Where cut lengths are specified, mark reel footage accordingly. Each reel shall contain one continuous length of cable. Reels shall be of the type specified on the data sheets. Provide impact protection by wood lagging or suitable barrier across the traverse of the reel. Provide moisture protection by manufacturer's standard procedure or heat shrinkable self-sealing end caps applied to both ends of the cable.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. Southwire Company

B. Belden Division, Cooper Industries, Inc.

C. Okonite Company

D. Cablec Continental Cables Company

E. General Cable Company

F. Superior Essex

2.02 MATERIALS AND EQUIPMENT

A. Design. Provide cable with the following design characteristics. The cable shall consist of multiple conductors. The cable assembly shall be UL listed, flame, oil and sunlight resistant, and certified for continuous operation at the temperature specified on the 600-Volt Control Cable Data Sheets in wet or dry locations while installed in underground duct, conduit, or cable tray. The number and size of conductors supplied in each cable shall correspond to the quantities specified on the 600-Volt Control Cable Data Sheets.

B. Conductors. Provide conductors which are concentric or bunch-stranded, annealed tinned copper with physical and electrical properties conforming to ASTM B 3, ASTM B 8 or ASTM B 33 or ASTM B 174 and Part 3 of ICEA S-61-402, S-66-524, or S-68-516 unless otherwise specified on the 600-Volt Control Cable Data Sheets.

C. Insulation. Each conductor shall be insulated as specified on the 600-Volt Control Cable Data Sheets complying to the requirements of Part 3 of ICEA S-61-402, S-66-524 or S-68-516. The average insulation thickness shall not be less than the dimensions shown in Section 3.2, Table 3-1 of ICEA S-61-402, S-66-524 or S-68-516 for 600 volt insulation unless otherwise specified on the 600-Volt Control Cable Data Sheets. The minimum insulation thickness shall not be less than 90 percent of the value given in the table.

D. Drain Wire. Provide drain wire Class B, seven-stranded, tin-coated copper in accordance with ASTM B 3, ASTM B 8, or ASTM B 33 and as specified on the 600-Volt Control Cable Data Sheets.

E. Shielding. Cable shielding shall consist of laminated, nonburning, mylar-backed aluminum tape applied helically around conductors with the aluminum side in continuous contact with the drain wire unless otherwise specified on the 600-Volt Control Cable Data Sheet. The tape shall be wrapped around the conductors with a 25 percent minimum overlap unless otherwise specified on the 600-Volt Control Cable Data Sheets.

F. Jacket.

1. When control cables are to be enclosed in conduit, ducts or in other raceway systems, the cables shall be of the non-metallic type and shall be covered by an overall nonmetallic jacket, as specified on the 600-Volt Control Cable Data Sheets, which complies with the requirements of Section 4.4 of ICEA S-66-524 or S-68-516, Section 4.3 of ICEA S-61-402, or Table 21-5 of Part 21 of UL 83.

2. Multi-conductor cables shall have a jacket thickness which complies with Table 4-7 of Part 4 of ICEA S-66-524, Table 4-5 of Part 4 of ICEA S-68-524, or Table 4-6 of Part 4 of ICEA S-61-402 unless otherwise specified on the 600-Volt Control Cable Data Sheets.

G. Armor. Where control cables are to be exposed, as in cable tray, cable channel or other cable support systems, the cables shall be protected by an interlocked metal tape armor made of galvanized steel which meets the requirements of paragraph 4.5 of ICEA S-68-516 or S-66-524 unless otherwise specified on the 600-Volt Control Cable Data Sheets. An over-all jacket shall be provided as specified in the Data Sheets.

H. Conductor Identification. Identify individual conductors by method as specified on the 600-Volt Control Cable Data Sheets in conformance with Appendix L of ICEA S-66-524, Part 5 of ICEA S-68-516, or Appendix I of ICEA S-61-402.

I. Cable Marking. Print cable marking information on the jacket of each cable at 2-foot intervals. Use a permanent printing method with a color sharply contrasting the jacket color. See the 600-Volt Control Cable Data Sheets for the minimum information required.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. When control wiring requires installation in cable tray and other cable support systems, use the 600-Volt Multiconductor Control Cable.

B. Complete cable raceway systems, underground duct banks, and cable support systems before installing cables.

C. Verify sizing of raceways and pullboxes to ensure proper accommodation for the cables.

D. Check the length of the cable raceway system against the length of cable on the selected reel.

E. Do not install or work on PVC insulated or jacketed cables in temperatures below 32 F.

F. Clean conduits of all foreign matter before cables are pulled in.

G. Provide at least 30 percent spare conductors.

3.02 INSTALLATION

A. Cable in Conduit and Ductbank.

1. Install cables in accordance with the manufacturer's instructions and the National Electrical Code (NEC), Article 725 - Class 1, Class 2, and Class 3 Remote Control, Signaling and Power Limited Circuits. Do not exceed maximum wire tension, maximum insulation pressure and minimum bending radius.

2. Pull cables into conduits using wire pulling compounds approved by cable manufacturers to reduce friction. Lubricants must not be harmful to the conductor insulation or cable jacket. Mixtures containing soap or detergent shall not be used.

B. Cable in Tray

1. Install armored cable in cable tray.

2. 600-Volt Tray rated Control Cable may be installed in cable tray with 600-volt Tray rated power cables.

3. Install cables in trays in a neat and orderly manner. Tie cables to the rungs at approximate 15-foot intervals by use of cable ties.

C. Termination

1. Do not splice conductors unless approved by the Project Manager. For termination use crimp-on type, ring tongue, non-insulated, tin-plated copper lugs.

2. Mark wiring on both ends with circuit numbers or loop tag numbers. Heat shrink wire markers after the ring tongue terminal has been installed. Extend the marker over the crimp-on base of the terminal.

D. Tests

1. Test insulation integrity and conductor continuity before connecting the cables.

2. Use a 500 VDC megohmmeter and perform the cable insulation test in accordance with the operating instructions.

E. Termination. After the 600-volt control cable has been tested with satisfactory results, terminate the cable at both ends to designated terminal points.

END OF SECTION

DATA SHEET 1 of 3

IDENTIFICATION

CLIENT _____ MANUFACTURER _____
PROJECT _____ MODEL NO. _____
JOB NO. _____ SIZE _____
PLANT LOCATION _____ SERIAL NO. _____
ITEM NO. _____ INQUIRY NO _____
SERVICE _____ P.O. NO. _____
NO. ITEMS REQUIRED _____

NOTE: [ ] INDICATES INFORMATION TO BE COMPLETED BY MANUFACTURER

OPERATING DATA

VOLTAGE _____ FREQUENCY _____ AMBIENT TEMP (ºC) _____
INSTALLATION ENVIRONMENT _____

CONSTRUCTION

CONDUCTORS

SIZE (AWG or KCMIL): _____
ARRANGEMENT: _____ SINGLE CONDUCTOR __ OTHER _____
_____ MULTI-CONDUCTOR _____ NO. OF CONDUCTORS
MATERIAL: _____ BARE COPPER _____ TIN-COATED COPPER
_____ SOLID _____ STRANDED
SINGLE CONDUCTOR: _____ JACKETED _____ NON-JACKETED
MULTI-CONDUCTOR _____ JACKETED _____ NON-JACKETED (TRIPLEXED ONLY)
_____ ARMORED _____ ARMORED W/OUTER JACKET
_____ GROUND WIRES IN INTERSTICES: _____ COPPER _____ ALUMINUM
CONDUCTOR CLASS PER _____ ASTM STANDARD
SPECIAL REQUIREMENTS: _____

INSULATION

TYPE: _____ CROSS LINKED POLYETHYLENE _____ CHLOROSULFONATED POLYETHYLENE
_____ POLYVINYL CHLORIDE _____ ETHYLENE-PROPYLENE RUBBER
_____ POLYETHYLENE _____ OTHER _____
THICKNESS (MILS OR MM) _____
COLOR: _____
TEMPERATURE RATING: _____ 60ºC - 75ºC (WET-DRY) _____ 75ºC - 90ºC (WET-DRY)
_____ 90ºC (WET-DRY) _____ OTHER _____
DRAIN WIRE: SIZE _____ STRANDED ____ SOLID _ BARE COPPER _____ TIN-COATED COPPER
SPECIAL REQUIREMENTS: _____

SHIELDING

TYPE SHIELDING: _____ BRAIDED _____ CONDUCTIVE PLASTIC
_____ CONDUCTIVE COTTON _____ SPIRAL-SERVED _____ CORRUGATED
_____ MYLAR FILM - ALUMINUM FOIL _____ POLYESTER FILM-ALUMINUM FOIL
_____ COPPER TAPE _____ OTHER _____
POLYESTER FILM-ALUMINUM LOCATION _____ INSIDE _____ OUTSIDE
_____ PAIR SHIELD ISOLATED
` _____ SEPARATOR _____ FILLED

ITEM NO. _____

DATA SHEET 2 of 3

SHIELD COMBINATION

OVERSHIELD: _____ POLYESTER FILM ALUMINUM
_____ BRAID _____ SERVED _____ OTHER _____

BRAID SHIELD: _____ TYPE STRANDS _____% COVERAGE _____ TINNED
_____ BARE _ COPPER _____ ALUMINUM
_____ OTHER _____

OVERALL TYPE: _____ POLYESTER _____ PAPER . OTHER: _____

JACKET

TYPE: _____ POLYVINYL CHLORIDE _____ POLYETHYLENE
_____ HEAVY DUTY NEOPRENE _____ CHLOROSULFONATED POLYETHYLENE
_____ NYLON _____ OTHER _____

THICKNESS (MILS OR MM) _____
COLOR: _____ BLACK _____ OTHER _____
SPECIAL REQUIREMENTS: _____

ARMORING

TYPE: _____ INTERLOCKED (POSITIVE) _____ OTHER _____
MATERIAL: _____ GALVANIZED STEEL _____ ALUMINUM
_____ OTHER _____
COVERING: _____ POLYVINYL CHLORIDE _____ OTHER _____
COLOR: _____ BLACK _____ OTHER _____
SPECIAL REQUIREMENTS: _____

MARKING

CONDUCTOR IDENTIFICATION

SINGLE CONDUCTOR: _____
MULTI-CONDUCTOR: _____

CABLE MARKING

REQUIRED: _____ MANUFACTURER _____ CONDUCTOR SIZE
_____ NO. OF CONDUCTORS _____ VOLTAGE RATING
_____ UL LABEL _____ NEC TYPE
_____ TEMPERATURE RATING _____ MONTH/YEAR OF MANUFACTURE
_____ INSULATION _____ FOOTAGE MARKERS
_____ OTHER _____

FACTORY TESTING/DOCUMENTATION

_____ PHYSICAL _____ _____ FLAME TESTS (PER IEEE 383 - 2.5)
_____ _____
_____ ELECTRICAL _____ OTHER TESTS _____
_____ MEGGER _____
_____ OTHER _____ _____
_____ _____
_____ _____

ITEM NO._____

600-VOLT CONTROL CABLE

DATA SHEET 3 of 3

QUALITY ASSURANCE

_____ NO ADDITIONAL REQUIREMENTS _____ ATTACHED SPECIFICATION _____

PACKAGING

_____ DOMESTIC _____ EXPORT

SHIPPING

REEL TYPE: _____ RETURNABLE __ NON-RETURNABLE _____ LENGTH PER REEL _____

ADDITIONAL REQUIREMENTS: _____

MANUFACTURER DATA

CABLE DIMENSION (O.D. IN.) _____ SHIPPING TIME _____

CABLE CROSS-SECTIONAL AREA _____ OTHER _____

CABLE WEIGHT (LBS/FT) _____

CABLE MIN BENDING RADIUS _____

TENSILE STRENGTH _____

GROSS WEIGHT/REEL (LBS) _____

TOTAL CUBIC FEET/REEL _____

SHORT CIRCUIT WITHSTAND CURVES _____

CABLE TESTING REQUIREMENTS _____

NOTES

ITEM NO. _____

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Section 16122

600-VOLT POWER CABLE

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. 600-volt power cable.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM).

1. ASTM B 3: Soft or Annealed Copper Wires.

2. ASTM B 8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, Soft.

3. ASTM B 33: Tinned Soft or Annealed Copper Wire for Electrical Purposes.

B. Institute of Electrical and Electronics Engineers (IEEE), IEEE 383-2.5: IEEE Standard for Type Test of Class IE Electric Cables and Field Splices.

C. Insulated Cable Engineers Association (ICEA).

1. ICEA S-61-402: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-5).

2. ICEA S-66-524: Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-7).

3. ICEA S-68-516: Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-8).

D. Underwriters' Laboratories (UL).

1. UL 44: Rubber Insulated Wires and Cables.

2. UL 83: Thermoplastic Insulated Wire and Cables.

E. National Fire Protection Association (NFPA), No. 70 - National Electrical Code (NEC), Chapter No.3 - Wiring Methods and Materials.

F. City of Houston Electrical Code.

1.03 SUBMITTALS

A. Make submittals following Section 01330 - Submittal Procedures:

1. Completed engineer's data sheets

2. Completed manufacturer's data sheets

3. Manufacturer's cut sheets, catalog data

4. Installation, terminating and splicing procedure

5. Instruction for handling and storage

6. Dimensions and weight

7. Conformance certificate.

1.04 QUALITY ASSURANCE

A. Tests.

1. Cable shall be tested at the factory to confirm that the cable complies with requirements of Part 6 of ICEA S-61-402, S-66-524 or S-68-516. Refer to data sheet for additional test requirements.

2. Where applicable, the cable shall meet the requirements of the vertical tray flame test as described in IEEE 383-2.5.

1.05 DELIVERY STORAGE AND HANDLING

A. Ship cable on manufacturer's standard reel sizes unless otherwise specified. Where cut lengths are specified, mark reel footage accordingly. Each reel shall contain one continuous length of cable. Reels shall be of the type specified on the data sheets. Provide impact protection by wood lagging or suitable barrier across the traverse of the reel. Provide moisture protection by manufacturer's standard procedure or heat shrinkable self-sealing end caps applied to both ends of the cable.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. Southwire company

B. Superior Essex

C. General Cable Company

D. Okonite Company

E. Pirelli Cable Corporation

F. Rome Cable Corporation

G. Triangle Wire and Cable, Inc.

2.02 MATERIALS AND EQUIPMENT

A. Design. Provide cable with the following design characteristic. Cable shall be UL 44 or UL 83 listed, rated 600 volts and certified for continuous operation at the temperature as specified on the 600 Volt Power Cable Data Sheets while installed in underground duct, conduit, or cable tray. Cables shall be single-conductor or multi-conductor (with ground) as specified on the data sheets.

B. Conductors. Provide conductors which are Class B, concentric stranded, annealed copper coated, unless otherwise specified on the data sheets, with physical and electrical properties conforming to ASTM B 3, ASTM B 8 or ASTM B 33 and Part 2 of ICEA S-61-402, S-66-524, or S-68-516. The number and size of conductors supplied in each cable shall correspond to the quantities specified on the data sheets.

C. Insulation. Insulate each conductor as specified on the 600 Volt Power Cable Data Sheets to meet the requirements of Part 3 of ICEA S-61-402, S-66-524 or S-68-516. The insulation thickness shall match the dimensions listed in Section 3.2, Table 3-1 of ICEA S-61-402, S-66-524 or S-68-516, as specified on the data sheets.

D. Jacket.

1. When power cables are to be enclosed in conduit, ducts or in other raceway systems, multiconductor power cables shall be of the non-metallic type and shall be covered by an overall nonmetallic jacket as specified on the Data Sheets, which complies with the requirements of Section 4.4 of ICEA S-66-524 or S-68-516, Section 4.3 of ICEA S-61-402, or Table 21-5 of Part 21 of UL 83.

2. Single-conductor cables shall have a jacket thickness which meets the requirements of Table 4-4 of Part 4 of ICEA S-66-524, Table 4-2 of Part 4 of ICEA S-68-516, or Table 4-2 or 4-6 of Part 4 of ICEA S-61-402. Multi-conductor cables shall have a jacket thickness which complies with Table 4-7 of Part 4 of ICEA S-66-524, Table 4-2 of Part 4 of ICEA S-68-516, Table 4-5 of Part 4 of ICEA S-68-516, or Table 4-6 of Part 4 of ICEA S-61-402, unless otherwise specified on the data sheets.

E. Armor. When power cables are to be exposed in a cable tray, cable channel or other cable support systems, the multiconductor power cables shall be protected by an interlocked metal armor made of galvanized steel which meets the requirements of paragraph 4.5 of ICEA S-68-516 or S-66-524 unless otherwise specified on the data sheets. An over-all jacket shall be provided as specified in the data sheets.

F. Cable Marking. Print cable marking information on the overall cable jacket at 2-foot intervals. Use a permanent printing method and color sharply contrasting with the jacket color. Identify individual conductors as specified on the data sheets in conformance with Part 5 of ICEA S-61-402, S-66-524, and S-68-516.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Complete cable raceway systems, underground duct banks, and cable support systems before installing cables.

B. Verify sizing of raceways and pullboxes to ensure proper accommodation for the cables.

C. Check the length of the cable raceway system against the length of cable on the selected reel.

D. Do not install or work on PVC insulated or jacketed cables in temperatures below 32 F.

3.02 INSTALLATION

A. Cable in Conduit and Ductbank.

1. Clean conduits of foreign matter before cables are pulled.

2. Install cables in accordance with the manufacturer's instructions and the National Electrical Code (NEC), Chapter 3 - Wiring Methods and Materials. Do not exceed maximum wire tension, maximum insulation pressure and minimum bending radius.

3. Pull cables into conduits using wire pulling compounds approved by cable manufacturers to reduce friction. Lubricants must not be harmful to the conductor insulation. Mixtures containing soap or detergent shall not be used.

B. Cable in Tray.

1. Install medium voltage (5 kv and 15 kv) and 600V cables in separate trays or separated cables by a barrier in a single tray in accordance with NEC 392.

2. Install cables in trays in a neat and orderly manner. Tie cables to the tray rungs at approximate 15-foot intervals by use of cable ties.

3. The number of multi conductors or cables rated 2000 volts or less shall be according to NEC 392.22.

4. Using cable ties, make a triplex of single conductors used for 3-phase systems. Install in cable tray in accordance with NEC 392.20(D).

C. Preparation for Termination.

1. Make up 600-volt power cable terminations and splices with heat shrinkable sleeves and seals.

2. Use crimp-on terminal lugs and connectors for all sizes of conductors.

3. Use crimp-on lugs with long barrel and 2-hole tongues, except in places where terminations space is limited.

D. Tests.

1. Before connecting the cables, test insulation integrity.

2. Use a 500 VDC megohmmeter and perform the cable insulation test in accordance with the operating instructions.

E. Termination.

1. After the 600-volt cable has been tested with satisfactory results, terminate the cable at both ends to designated terminal points.

2. Tighten connection bolts with a torque wrench to specified torque levels.

END OF SECTION

DATA SHEET 1 of 3

IDENTIFICATION

CLIENT _____ MANUFACTURER _____
PROJECT _____ MODEL NO. _____
JOB NO. _____ SIZE _____
PLANT LOCATION _____ SERIAL NO. _____
ITEM NO. _____ INQUIRY NO. _____
SERVICE _____ P.O. NO. _____
QUANTITY REQUIRED _____

OPERATING DATA

VOLTAGE _____ FREQUENCY _____ AMBIENT TEMP (ºC) _____
INSTALLATION ENVIRONMENT _____

CONSTRUCTION

CONDUCTORS

SIZE (AWG or MCM): _____
ARRANGEMENT: _____ SINGLE CONDUCTOR OTHER _____
_____ MULTI-CONDUCTOR _____ NO. OF CONDUCTORS
MATERIAL: _____ COPPER _____ ALUMINUM _____ TINNED COPPER
_____ JACKETED _____ NON-JACKETED
_____ GROUND WIRES IN INTERSTICES: _____ COPPER _____ ALUMINUM
ASTM STANDARD: _____
SPECIAL REQUIREMENTS: _____

INSULATION

TYPE: ____CROSS-LINKED-THERMOSETTING-POLYETHYLENE ___CHLOROSULFONATED POLYETHYLENE
____ POLYVINYL CHLORIDE _____ ETHYLENE-PROPYLENE RUBBER
____ POLYETHYLENE _____OTHER _____
COLOR: _____
TEMPERATURE RATING: _____ 60ºC - 75ºC (WET-DRY) _____75ºC - 90ºC (WET-DRY)
_____ 90ºC (WET-DRY) _____ OTHER _____
INSULATING RATING: _____ 100% _____ 133% _____ 173% _____ OTHER _____
ICEA STANDARD: _____
SPECIAL REQUIREMENTS: _____

JACKET

TYPE: _____ POLYVINYL CHLORIDE _____ POLYETHYLENE
_____ HEAVY DUTY NEOPRENE _____ CHLOROSULFONATED POLYETHYLENE
_____ NYLON _____ OTHER: _____
_____
COLOR: _____ BLACK _____ OTHER: _____
ICEA STANDARD: _____
SPECIAL REQUIREMENTS: _____

ITEM NO. _____

DATA SHEET 2 of 3

ARMORING

TYPE: _____ INTERLOCKED (POSITIVE) _____ OTHER _____
MATERIAL: _____ GALVANIZED STEEL _____ ALUMINUM
_____ OTHER _____
COVERING: _____ POLYVINYL CHLORIDE _____ OTHER _____
COLOR: _____ BLACK _____ OTHER _____
ICEA STANDARD: _____
SPECIAL REQUIREMENTS: _____

MARKING

CONDUCTOR IDENTIFICATION

SINGLE CONDUCTOR: _____
MULTI-CONDUCTOR: _____

CABLE MARKING

REQUIRED: _____ MANUFACTURER _____ CONDUCTOR SIZE
_____ NO. OF CONDUCTORS _____ VOLTAGE RATING
_____ UL LABEL _____ NEC TYPE
_____ TEMPERATURE RATING _____ MONTH/YEAR MANUFACTURE
_____ OTHER _____

TESTING

_____ PHYSICAL _____ _____ FLAME TESTS (PER IEEE 383 - 2.5)
_____ _____
_____ ELECTRICAL _____ OTHER TESTS _____
_____ MEGGER _____
_____ OTHER _____ _____
_____ _____
_____ _____

QUALITY ASSURANCE

_____ NO ADDITIONAL REQUIREMENTS _____ ATTACHED SPECIFICATION _____

PACKAGING

_____ DOMESTIC _____ EXPORT

SHIPPING

REEL TYPE: _____ RETURNABLE _____ NON-RETURNABLE _____ LENGTH PER REEL _____
_____
_____
_____
_____
ADDITIONAL REQUIREMENTS: _____

ITEM NO. _____

600-VOLT POWER CABLE

DATA SHEET 3 of 3

MANUFACTURER DATA

CABLE DIMENSION (O.D. IN.) _____ SHIPPING TIME _____

CABLE CROSS-SECTIONAL AREA _____ OTHER _____

CABLE WEIGHT (LBS/FT) _____

CABLE MIN BENDING RADIUS _____

TENSILE STRENGTH _____

GROSS WEIGHT/REEL (LBS) _____

TOTAL CUBIC FEET/REEL _____

SHORT CIRCUIT WITHSTAND CURVES _____

NOTES

ITEM NO. _____

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Section 16125

THERMOCOUPLE EXTENSION CABLE

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Specifications for thermocouple extension cable.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM).

1. ASTM B3: Specification for Soft or Annealed Copper Wire.

2. ASTM B8: Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, Soft.

3. ASTM B33: Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.

B. American National Standards Institute (ANSI), ANSI MC96.1: Temperature Measurement Thermocouples.

C. Institute of Electrical and Electronics Engineers (IEEE), IEEE 383-2.5: IEEE Standard for Type Test of Class IE Electric Cables and Field Splices.

D. Insulated Cable Engineers Association (ICEA).

1. ICEA S-61-402: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-5).

2. ICEA S-66-524: Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-5).

3. ICEA S-68-516: Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-8).

4. American National Standards Institute/National Fire Protection NEC), Article 725, Class 1, Class 2, and Class 3 Remote-Controls, (Signaling, and Power-Limited Circuits).

5. Underwriters' Laboratories (UL), UL Subject 13: Listing Mark and Follow-up Inspection.

1.03 SUBMITTALS

A. Submit under the provisions of Section 01330 the following:

1. Completed engineer's data sheets from this specification or manufacturer's data sheets, cut sheets and catalog data.

2. Installation, terminating and splicing procedure (including bend radius and pulling tension data).

3. Instruction for handling and storage.

4. Dimensions and weight.

1.04 QUALITY ASSURANCE

A. Tests.

1. Cable shall be tested at the factory to confirm that the cable complies with requirements of this specification. Perform manufacturer's standard test and those listed in UL Subject 13.

2. Perform any additional tests specified on the Thermocouple Extension Cable Data Sheets.

3. Where applicable, the cable shall meet the requirements of the vertical tray flame test as described in IEEE 383-2.5.

4. Manufacturer shall perform any additional test and inspection required to ensure that cable meets requirements specified on the Thermocouple Extension Cable Data Sheets.

1.05 DELIVERY, STORAGE AND HANDLING

A. Ship cable on manufacturer's standard reel sizes unless otherwise specified. Where cut lengths are specified, mark reel footage accordingly. Each reel shall contain one continuous length of cable. Reels shall be of the type specified on the data sheets. Provide impact protection by wood lagging or suitable barrier across the traverse of the reel. Provide moisture protection by manufacturer's standard procedure or heat shrinkable self-sealing end caps applied to both ends of the cable.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. Alpha Wire Corporation

B. Belden Div., Cooper Industries, Inc.

C. Cablec Continental Cables Company

D. General Cable Company

E. Manhattan Electric Cable Corporation

F. Okonite Company

2.02 MATERIALS AND EQUIPMENT

A. Design. Provide cable with the following design characteristics. Cable is used to connect field-mounted thermocouples to temperature monitoring and recording devices. The cable assembly shall consist of individually insulated conductors covered by an overall jacket. The cable is intended for circuits in accordance with Article 725 of the National Electric Code and the Thermocouple Extension Cable Data Sheets. Install thermocouple extension cable in underground duct, conduit, or cable tray. The type of conductors, the number of pairs, and other requirements of each cable shall be specified on the Thermocouple Extension Cable Data Sheets.

B. Construction. Provide conductors made from metals matching the characteristics of the thermocouple and with wire size as specified on the Thermocouple Extension Cable Data Sheets. Select conductor with a calibrated tolerance which is within the standard or special limits of error defined in ANSI MC96.1 and as specified on the Thermocouple Extension Cable Data Sheets.

C. Insulation. The primary insulation of each conductor is specified on the Thermocouple Extension Cable Data Sheets. The physical and electrical properties of the insulation shall comply with the requirements of UL Subject 13.

D. Drain Wire. Provide drain wire which is Class B, seven-stranded or solid; and bare or tin-coated copper in accordance with ASTM B3, B8 or B33, and as specified on the Thermocouple Extension Cable Data Sheets.

E. Shielding. Provide shielding consisting of laminated, nonburning, mylar-backed aluminum tape applied helically around a twisted pair of

conductors with the aluminum side in continuous contact with the drain wire unless otherwise specified on the Thermocouple Extension Cable Data Sheets.

F. Wrap the tape around the conductors with a 25 percent minimum overlap unless otherwise specified on the Thermocouple Extension Cable Data Sheets.

G. Jacket. The jacket used to cover single and multi-pair cables is specified on the Thermocouple Extension Cable Data Sheets. The physical and electrical properties of the jacket shall comply with the applicable requirements of UL Subject 13. The jacket thickness shall match the dimensions shown in Table 10 of UL Subject 13.

H. Single Pair Cables. Each pair shall consist of two individually insulated conductors with a drain wire, wrapped by a shield and covered by an overall jacket as specified on the Thermocouple Extension Cable Data Sheets.

I. Multi-Pair Cables. Multi-pair cables shall consist of the required number of electrically isolated, shielded, twisted, insulated pairs which are bundled together and covered by an overall shield and jacket as specified on the Thermocouple Extension Cable Data Sheets.

J. Armor or Barrier. Where requested, use thermocouple extension cables protected by an interlocked metal tape armor coating made of galvanized steel, which meets the requirements of paragraph 4.5 of ICEA S-68-516 or S-66-524 unless otherwise specified on the Thermocouple Extension Cable Data Sheets.

K. Conductor Identification. Use individual conductors in each cable which are color coded in accordance with Table 6 of ANSI MC96.1, and as specified on the Thermocouple Extension Cable Data Sheets.

L. Cable Marking. Print cable marking information on the jacket of each cable at 2-foot intervals. Use a permanent printing method with a color sharply contrasting the jacket color. See the Thermocouple Extension Cable Data Sheets for the minimum information required.

PART 3 E X E C U T I O N

3.01 PREPARATION

3.02 Complete cable raceway systems, underground duct banks and cable support systems before installing cables.

A. Verify sizing of raceways and pullboxes to ensure proper accommodation for the cables.

B. Check the length of the cable raceway system against the length of cable on the selected reel.

C. Do not install or work on PVC insulated or jacketed cables in temperatures below 32 degrees F.

D. Clean conduits of foreign matter before cables are pulled.

3.03 INSTALLATION

A. Cable in Conduit and Duct Bank

1. Install cables in accordance with the manufacturer's instructions and NEC Article 725 - Class 1, Class 2, and Class 3 Remote-Control, Signaling and Power-Limited Circuit. Do not exceed maximum wire tension, maximum insulation pressure and minimum bending radius.

2. Pull cables into conduits using adequate lubrication to reduce friction. Lubricants must not be harmful to the conductor insulation.

3. Conduits carrying low level signal cables shall be PVC-coated rigid steel.

4. Use thermocouple leads that are continuous from instrument to thermocouple. Do not splice extension cable. Where junctions are unavoidable, make connections only on terminal blocks enclosed in suitable boxes. Generally, use such boxes only in installation involving a large number of thermocouples where multiconductor cable is applicable. Take care in locating such boxes in areas that have comparatively stable ambient temperature conditions. Avoid hot locations.

5. Do not install thermocouple leads in the same conduit or pull box with any other wiring.

6. Make the connection between thermocouple lead and rigid conduit by running cable in a flexible conduit forming a drip loop to prevent excessive moisture from entering the conduit system.

B. Cable in Tray. Install thermocouple extension cable in cable tray only when the tray is dedicated for this type cables and cables are approved for tray installation.

C. Termination

1. Do not splice conductors.

2. For shielded thermocouple cable, terminate the shield and ground it at one end only, preferably at the control panel end.

3. If splicing is required, maintain shield continuity by jumpering the ground shield across connection point where it is broken at junction boxes, or other splice points. Insulate these points from ground.

4. Mark wiring on both ends with circuit numbers or loop tag numbers. Heat shrink wire markers after the ring or fork terminal has been installed. Extend the marker over the crimp or base of the terminal.

END OF SECTION

THERMOCOUPLE EXTENSION CABLE

DATA SHEET 1 of 4

IDENTIFICATION

CLIENT _____ MANUFACTURER _____
PROJECT _____ MODEL NO. _____
JOB NO. _____ SIZE _____
PLANT/LOCATION _____ SERIAL NO. _____
ITEM NO. _____ INQUIRY NO. _____
SERVICE _____ P.O. NO. _____
QUANTITY REQUIRED _____

NOTE: [ ] INDICATES INFORMATION TO BE COMPLETED BY SELLER

ENVIRONMENTAL CONDITIONS

TEMPERATURE RANGE: MAX _____ºC MIN _____ ºC
INSTALLATION: _____ ENCLOSED _____ OUTDOORS _____ INDOORS
_____ UNDERGROUND UNDERWATER_____
EXPOSURE: _____ MOISTURE _____ DIRT _____ OZONE
_____ RADIATION ____CHEMICALS:(PLEASE LIST) _____
SOILS: (PLEASE LIST) _____ELECTROSTATIC INTERFERENCE _____
ELECTROMAGNETIC INTERFERENCE DISTURBANCES _____RODENTS _____
OTHER: _____

PHYSICAL REQUIREMENTS

FLEXIBILITY: _____ VERY FLEXIBLE _____ FLEXIBLE _____ NOT CRITICAL
RESISTANCE TO: _____ ABRASION _____ IMPACT _____ CRUSH
_____ DEFORMATION _____ CUT THROUGH _____ COLD FLOW
TERMINATION METHOD: _____
ADDITIONAL REQUIREMENTS: _____

ELECTRICAL REQUIREMENTS

_____ CROSS TALK (ISOLATION IN DB AT FREQ)
_____ DC RESISTANCE (OHMS/1000 FT)
_____ VOLTAGE BREAKDOWN (VOLTS/MILL)
_____ INSULATION RESISTANCE (MEGOHMS/1000 FT)
ADDITIONAL REQUIREMENTS: _____

_____ CLASS I _____ CLASS II _____ CLASS III
_____ 600 VOLT _____ 150 VOLT _____ 300 VOLT
ADDITIONAL REQUIREMENTS: _____

DATA SHEET 2 of 4

TYPE

DESIGN TEMPERATURE SCALE: _____ CELSIUS _____ FAHRENHEIT

_____ JX _____ KX _____ TX _____ EX

_____ SX _____ RX _____ BX

_____ OTHER _____

CONSTRUCTION

CONDUCTORS

SIZE (AWG): _____

_____ COPPER _____ STRANDED _____ SOLID

_____ LIMITS OF ERROR_____

ADDITIONAL REQUIREMENTS: _____

INSULATION

RUBBER:_____ SBR _____ NATURAL _____ SYNTHETIC ___ BUTYL_____ POLYBUTADIENE

_____ NEOPRENE _____ NBR _____ EPR/EPT ___CHLOROSULFONATED POLYETHYLENE _____ SILICONE

PLASTIC: _____ PVC _____ LOW-DENSITY POLYETHYLENE _____CELLULAR POLYETHYLENE

_____ TEFLON

_____ HIGH-DENSITY POLYETHYLENE _____ POLYPROPYLENE _____ POLYURETHANE

_____ NYLON _____ OTHER: _____

VOLTAGE RATING: _____ AC _____ DC WALLTHICKNESS _____

NUMBER OF CONDUCTORS: _____ NUMBER OF PAIRS: _____

NUMBER OF TRIADS: _____

LAY LENGTH PER INCH OF PAIRS: _____ LAY _____ TWIST-COATED

DRAIN WIRE: _____ SIZE _____ STRANDED _____ SOLID _____ BARE COPPER _____ TIN-COATED COPPER

COLOR _____

TEMPERATURE RATING: _____ 60º - 75ºC (WET-DRY) _____75ºC - 90ºC (WET-DRY)

_____ 90ºC (WET-DRY) _____105ºC

OTHER: _____

SPECIAL REQUIREMENTS: _____

SHIELDING

TYPE SHIELDING: _____ BRAIDED _____ CONDUCTIVE PLASTIC

_____ CONDUCTIVE COTTON _____ SPIRAL-SERVED

_____ MYLAR FILM-ALUMINUM FOIL _____POLYESTER FILM-ALUMINUM FOIL

_____ OTHER: _____

POLYESTER FILM-ALUMINUM LOCATION _____ INSIDE _____ OUTSIDE_____ PAIR SHIELD ISOLATED

_____ SEPARATOR _____ FILTER

SHIELD COMBINATION

OVERSHIELD: _____ POLYESTER FILM-ALUMINUM

_____ BRAID _____SERVED

_____OTHER: _____

THERMOCOUPLE EXTENSION CABLE

DATA SHEET 3 of 4

SHIELD COMBINATION (CONT)

BRAID SHIELD: _____ TYPE STRANDS _____% COVERAGE __ TINNED
_____ BARE _____COPPER _____ ALUMINUM
OVERALL TYPE: _____ POLYESTER _____ PAPER _____ OTHER: _____
_____
SHIELD OVERLAP _____%
_____
_____

JACKET

TYPE: _____ POLYVINYL CHLORIDE _____ POLYETHYLENE
_____ HEAVY DUTY NEOPRENE _____ CHLOROSULFONATED POLYETHYLENE
_____ KAPTON _____ TEFLON
_____ NYLON _____ OTHER: _____
_____
_____
THICKNESS (MILS OR MM) _____
COLOR: _____ BLACK _____ OTHER:_____
SPECIAL REQUIREMENTS: _____
_____
_____

ARMOR OR BARRIER

TYPE: _____ INTERLOCKED (POSITIVE) OTHER: _____
_____ SERVED ARMOR _____ BONDED BARRIER
MATERIAL: _____ GALVANIZED STEEL _____ ALUMINUM
_____ OTHER: _____
COVERING: _____ POLYVINYL CHLORIDE _____ OTHER: _____
COLOR: _____ BLACK _____ OTHER: _____
SPECIAL REQUIREMENTS: _____
_____
_____

MARKING

CONDUCTOR IDENTIFICATION

SINGLE-CONDUCTOR: _____
MULTI-CONDUCTOR: _____
_____

CABLE MARKING

REQUIRED: _____ MANUFACTURER _____ CONDUCTOR SIZE
_____ NO. OF CONDUCTORS _____ VOLTAGE RATING
_____ UL LABEL _____ NEC TYPE
_____ TEMPERATURE RATING _____ MONTH/YEAR OF MANUFACTURE
_____ OTHER: _____
_____

FACTORY TESTING/DOCUMENTATION

_____ PHYSICAL _____ FLAME TESTS (SPECIFY STANDARDS)_____
_____
_____ ELECTRICAL _____ OTHER TESTS:_____
_____ MEGGER
_____ OTHER:_____
_____
_____

DATA SHEET 4 of 4

QUALITY ASSURANCE

_____ NO ADDITIONAL REQUIREMENTS _____ ATTACHED SPECIFICATION _____

PACKAGING

_____ DOMESTIC _____ EXPORT

SHIPPING

REEL TYPE: _____ RETURNABLE _____ NON-RETURNABLE _____ LENGTH PER REEL _____

ADDITIONAL REQUIREMENTS: _____

MANUFACTURER DATA

CABLE DIMENSION (O.D. IN.) _____ SHIPPING TIME _____
CABLE CROSS-SECTIONAL AREA _____ OTHER _____
CABLE WEIGHT (LBS/FT) _____
CABLE MIN BENDING RADIUS _____
TENSILE STRENGTH _____
GROSS WEIGHT/REEL (LBS) _____
TOTAL CUBIC FEET/REEL _____
SHORT CIRCUIT WITHSTAND CURVES _____
CABLE TESTING REQUIREMENTS _____

NOTES

Section 16126

INSTRUMENTATION CABLE

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Specifications for instrumentation cable.

1.02 REFERENCES CODES AND STANDARDS

A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. NFPA 70 – National Electrical Code (NEC)

2. NEMA WC-5 – Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

3. ANSI/TIA/EIA 606A – Standard for telecommunications Infrastructure.

1.03 SUBMITTALS

A. Shop Drawings

1. Submit catalog data of all wire and cable, connectors and accessories, specified under this Section with all selections, options and exceptions clearly indicated.

B. Certified Tests

1. Submit a test report of all installed wire insulation tests.

C. Operation and Maintenance Manuals

1. Submit Operation and Maintenance Manuals containing installation and maintenance instructions for splice and termination kits.

1.04 QUALITY ASSURANCE

A. The general construction of the wire, cables and the insulation material used shall be similar to that used for cable of the same size and rating

in continuous production for at least 15 years and successfully operating in the field in substantial quantities.

B. Wire and cable with a manufacture date of greater than twelve (12) months previous will not be acceptable.

C. Wire and cable shall be in new condition, with the manufacturer's packaging intact, stored indoors since manufacture, and shall not have been subjected to the weather. Date of manufacture shall be clearly visible on each reel.

D. The manufacturer of these materials shall have produced similar electrical materials for a minimum period of five (5) years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.05 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, the Contractor shall have successfully completed all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, or equipment which failed any factory tests, will not be permitted.

B. Check for reels not completely restrained, reels with interlocking flanges or broken flanges, damaged reel covering or any other indication of damage. Do not drop reels from any height.

C. Unload reels using a sling and spreader bar. Roll reels in the direction of the arrows shown on the reel and on surfaces free of obstructions that could damage the wire and cable.

D. Store cable on a solid, well drained location. Cover cable reels with plastic sheeting or tarpaulin. Do not lay reels flat.

PART 2 P R O D U C T S

2.01 MANUFACTURERS

A. Alpha Wire Corporation

B. Belden Division, Cooper Industries, Inc.

C. Continental Cables Company

D. General Cable Company

E. Okonite Company

2.02 MATERIALS AND EQUIPMENT

A. Cables for 4 20 ma, R.T.D., potentiometer and similar signals shall be PLTC rated and shall be:

1. Single pair cable:

Conductors: 2 #16 stranded, tinned and twisted on 2 in lay
Insulation: PVC with 600 volt, 90 degrees C rating
Shield: 100 percent mylar tape with drain wire
Jacket: PVC with manufacturer's identification
Misc: UL1685 listed for underground wet location use
Manufacturers: Okonite, Belden or approved equal

2. Three conductor (triad) cable:

Conductors: 3 #16 stranded, tinned and twisted on 2 in lay
Insulation: PVC with 600 volt, 90 degrees C rating
Shield: 100 percent mylar tape with drain wire
Jacket: PVC with manufacturer's identification
Misc: UL1685 listed for underground wet location use
Manufacturers: Okonite, Belden or approved equal

3. Multiple pair cables (where shown on the Drawings:

Conductor: Multiple pairs, #16 stranded, tinned and twisted on a 2 in lay
Insulation: PVC with 600 volt, 90 degrees C rating
Shield: Individual pairs shielded with 100 percent mylar tape and drain wire
Jacket: PVC with manufacturer's identification
Misc: UL1685 listed for underground wet location use
Manufacturers: Okonite, Belden or approved equal

2.03 COMMUNICATION CABLES

A. Cables for Ethernet and RS485 shall be rated and shall be:

1. Category 5e above Grade shielded Cable

Conductors: 4 bonded pair 24AWG Bare Copper
Insulation: Polyolefin

Shield: 100 percent aluminum foil polyester tape with drain wire
Jacket: PVC with 600 volt rated and manufacturer's identification
Misc.: UL21047 and UL1666 listed for indoor and dry locations use
Manufacturers: Belden 7957A or approved equal

2. Category 5e above Grade un-shielded Cable

Conductors: 4 bonded pair 24AWG Bare Copper
Insulation: Polyolefin
Jacket: PVC with 300 volt rated and manufacturer's identification
NEC CMR
Misc.: UL1666 listed for indoor and dry locations use
Manufacturers: Belden 7923A or approved equal

3. Category 6 above Grade -shielded Cable

Conductors: 4 bonded pair 23AWG Bare Copper
Insulation: Polypropylene
Shield: 100 percent aluminum foil polyester tape with drain wire
Jacket: PVC with 600 volt rated and manufacturer's identification
Transmission Standards: Category 6 - TIA 568.C.2
NEC CMR
Flame Test Method: UL1666 Vertical Riser listed for indoor and dry locations use
Manufacturers: Belden 7953A or approved equal

4. Category 6 above Grade un-shielded Cable

Conductors: 4 bonded pair 23AWG Bare Copper
Insulation: Polyolefin
Jacket: PVC with 300 volt rated and manufacturer's identification
Transmission Standards: Category 6 - TIA 568.C.2
Nominal Velocity of Propagation: 72 %
Flame Test Method: UL1666 Vertical Riser listed for indoor and dry locations use
Manufacturers: Belden 7940A or approved equal

5. Category 5e below Grade shielded Cable

Conductors: 4 pair 24AWG Bare Copper
Insulation: Polyolefin
Shield: 100 percent aluminum foil polyester tape with drain wire

Jacket: LLPE (Linear Low Density Polyethylene) with 300 volt rated and manufacturer's identification
Misc.: NEMA WC-63.1, listed for outdoor and wet locations use
Manufacturers: Belden 7937A or approved equal

6. 485 Communications Cable

Conductors: 1 pair 24AWG Tinned Copper
Insulation: Polyethylene
Shield: 100 percent aluminum foil polyester tape with tinned copper drain wire
Jacket: PVC with 300 volt rated and manufacturer's identification
Misc.: UL2919 listed for indoor and dry locations use
Manufacturers: Belden 9841 or approved equal

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Complete cable raceway systems, underground duct banks and cable support systems before installing cables.

B. Verify sizing of raceways and pullboxes to ensure proper accommodation for the cables.

C. Check the length of the cable raceway system against the length of cable on the selected reel.

D. Do not install or work on PVC insulated or jacketed cables in temperatures below 32 degrees F.

E. Clean and swab conduits of foreign matter before cables are pulled.

F. Provide at least 30 percent spare conductors or pairs.

3.02 INSTALLATION

A. Cable in Conduit and Ductbank

1. Install cables in accordance with the manufacturer's instructions and NEC Article 725 - Class 1, Class 2, and Class 3 Remote Control, Signaling and Power Limited Circuits. Do not exceed maximum wire tension, maximum insulation pressure and minimum bending radius.

2. Instrumentation cables shall be installed in raceways as specified. Unless specifically shown on the Drawings, all instrumentation circuits

shall be installed as single shielded twisted pair cables or single shielded twisted triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever three wire circuits are required.

3. Terminal blocks shall be provided at all instrument cable junction boxes, and all circuits shall be identified at such junctions.

4. Shielded instrumentation wire, coaxial cable, data highway cable, discrete I/O, multiple conductor cable, and fiber optic cables shall be run without splices between instruments, terminal boxes, or panels. The shield shall be continuous for the entire run.

5. Pull cables into conduits using adequate lubrication to reduce friction. Lubricants must not be harmful to the conductor insulation or cable jacket.

6. Conduits carrying low level signal cables shall be PVC-coated rigid steel.

B. Cable in Tray. Install instrument and signal cable in cable tray only when the tray is dedicated for this type cable and cables are approved for tray installation.

C. Termination

1. Do not splice conductors. For termination use crimp-on type ring tongue non-insulated tin plated copper lugs.

2. For shielded control cable, terminate the shield and ground it at one end only, preferably at the control panel end for instrument and communication cable and at the supply end for electronic power cables.

3. Splices of Instrumentation conductors will not be permitted between terminal points. Terminations shall be made with connectors as specified. The shield of pair shielded and triad shielded shall be terminated on terminal strips.

4. Mark wiring on both ends with circuit numbers or loop tag numbers. Heat shrink wire markers after the ring tongue terminal has been installed. Extend the marker over the crimp or base of the terminal.

D. Tests

1. Before connecting the cables, test insulation integrity and conductor continuity.

2. Use a 500 VDC megohmmeter and perform the cable insulation test in accordance with the operating instructions.

E. Termination: After instrumentation cable installation and conductor termination by the instrumentation and control supplier, perform tests to ensure that instrumentation cable shields are isolated from ground, except at the grounding point in the instrumentation control panel. Remove all improper grounds.

END OF SECTION

DATA SHEET 1 of 4

IDENTIFICATION

CLIENT _____ MANUFACTURER _____
PROJECT _____ MODEL NO. _____
JOB NO. _____ SIZE _____
PLANT/LOCATION _____ SERIAL NO. _____
ITEM NO. _____ INQUIRY NO. _____
SERVICE _____ P.O. NO. _____
QUANTITY REQUIRED _____

NOTE: [ ] INDICATES INFORMATION TO BE COMPLETED BY MANUFACTURER

ENVIRONMENTAL CONDITIONS

TEMPERATURE RANGE: MAX _____ ºC, MIN _____ ºC
INSTALLATION: _____ ENCLOSED _____ OUTDOORS _____ INDOORS_____
_____ UNDERGROUND _____ UNDERWATER_____
EXPOSURE: _____ MOISTURE _____ DIRT _____ OZONE_____
_____ RADIATION _____ CHEMICALS:(PLEASE LIST) _____
SOILS: (PLEASE LIST) _____ ELECTROSTATIC INTERFERENCE _____
ELECTROMAGNETIC INTERFERENCE DISTURBANCES _____ RODENTS _____
OTHER: _____

PHYSICAL REQUIREMENTS

FLEXIBILITY: _____ VERY FLEXIBLE _____ FLEXIBLE _____ NOT CRITICAL
RESISTANCE TO: _____ ABRASION _____ IMPACT _____ CRUSH
_____ DEFORMATION _____ CUT THROUGH COLD FLOW
TERMINATION METHOD: _____

STRIPPABILITY: _____ MANUAL
_____ AUTOMATIC EQUIPMENT TYPE _____

ELECTRICAL REQUIREMENTS

_____ FREQUENCY (HZ) _____ CROSS TALK (ISOLATION IN DB AT FREQ)
_____ CURRENT (MILLIAMP) _____ DC RESISTANCE (OHMS/1000 FT)
_____ CAPACITANCE (PFD) _____ VOLTAGE BREAKDOWN (VOLTS/MILL)
_____ ATTENUATION (DB/100 FT) _____ INSULATION RESISTANCE (MEGOHMS/1000 FT)
ADDITIONAL REQUIREMENTS: _____

ITEM NO. _____

DATA SHEET 2 of 4

CONSTRUCTION

CONDUCTORS

SIZE (AWG): ____

_____ COPPER _____ STEEL _____ TINNED

_____ BARE _____ SOLID _____ COPPER COATED

_____ STRANDED _____ SILVER COATED

NUMBER OF CONDUCTORS: _____ NUMBER OF PAIRS _____

NUMBER OF TRIADS _____

ADDITIONAL REQUIREMENTS: _____

INSULATION

RUBBER: _____ SBR _____ NATURAL _____ SYNTHETIC _____ BUTYL POLYBUTADIENE

_____ NEOPRENE _____ NBR _____ EPR/EPT

_____ CHLORSULFONATED POLYETHYLENE _____ SILICONE

PLASTIC: _____ PVC ____ LOW-DENSITY POLYETHYLENE _____ CELLULAR POLYETHYLENE ____ TEFLON

_____ HIGH-DENSITY POLYETHYLENE _____ POLYPROPYLENE _____ POLYURETHANE

_____ NYLON _____ OTHER: _____

VOLTAGE RATING: _____ AC _____ DC WALL THICKNESS _____

LAY LENGTH PER INCH OF PAIRS: _____ LAY _____ TWIST

DRAIN WIRE: _____ SIZE _____ STRANDED __ SOLID _____ BARE COPPER _____ TIN-COATED COPPER

COLOR _____

TEMPERATURE RATING: _____ 60º - 75ºC (WET-DRY) __ 75ºC - 90ºC (WET-DRY)

_____ 90ºC (WET-DRY) _____ OTHER: _____

SPECIAL REQUIREMENTS: _____

SHIELDING

TYPE SHIELDING: _____ BRAIDED _____ CONDUCTIVE PLASTIC

_____ CONDUCTIVE COTTON _____ SPIRAL-SERVED

_____ MYLAR FILM-ALUMINUM FOIL __ POLYESTER FILM-ALUMINUM FOIL

_____ OTHER: _____

POLYESTER FILM-ALUMINUM LOCATION: _____ INSIDE _____ OUTSIDE _____ PAIR SHIELD ISOLATED

_____ SEPARATOR _____ FILTER

SHIELD COMBINATION

OVERSHIELD: _____ POLYESTER FILM-ALUMINUM __ BRAID _____ SERVED

_____ OTHER: _____

BRAID SHIELD: _____ TYPE STRANDS _____% COVERAGE __ TINNED

_____ BARE _____ COPPER _____ ALUMINUM

OVERALL TYPE: _____ POLYESTER _____ PAPER ___ OTHER: ____

JACKET

TYPE: _____ POLYVINYL CHLORIDE _____ POLYETHYLENE

_____ HEAVY DUTY NEOPRENE _____ CHLOROSULFONATED POLYETHYLENE

_____ NYLON _____ OTHER: _____

ITEM NO. _____

DATA SHEET 3 of 4

JACKET (Cont)

THICKNESS (MILS OR MM) _____

COLOR: _____ BLACK _____ OTHER: _____

SPECIAL REQUIREMENTS: _____

ARMORING

TYPE: _____ INTERLOCKED (POSITIVE) OTHER: _____

MATERIAL: _____ GALVANIZED STEEL _____ ALUMINUM _____

_____ OTHER: _____

COVERING: _____ POLYVINYL CHLORIDE _____ OTHER: _____

COLOR: _____ BLACK _____ OTHER: _____

SPECIAL REQUIREMENTS: _____

MARKING

CONDUCTOR IDENTIFICATION

SINGLE-CONDUCTOR: _____

MULTI-CONDUCTOR: _____

CABLE MARKING

REQUIRED: _____ MANUFACTURER _____ CONDUCTOR SIZE

_____ NO. OF CONDUCTORS _____ VOLTAGE RATING

_____ UL LABEL _____ NEC TYPE

_____ TEMPERATURE RATING _____ MONTH/YEAR OF MANUFACTURE

_____ OTHER: _____

FACTORY TESTING/DOCUMENTATION

_____ PHYSICAL _____ _____ FLAME TESTS (SPECIFY STANDARDS) _____

_____ ELECTRICAL _____ OTHER TESTS: _____

_____ MEGGER

_____ OTHER: _____ _____

_____ _____

_____ _____

QUALITY ASSURANCE

_____ NO ADDITIONAL REQUIREMENTS _____ ATTACHED SPECIFICATION _____

PACKAGING

_____ DOMESTIC _____ EXPORT

SHIPPING

REEL TYPE: ____ RETURNABLE __ NON-RETURNABLE _____ LENGTH PER REEL _____

ADDITIONAL REQUIREMENTS: _____

ITEM NO. _____

INSTRUMENTATION CABLE

DATA SHEET 4 of 4

1. [ ] **MANUFACTURER DATA**
2. CABLE DIMENSION (O.D. IN.) _____ SHIPPING TIME _____
3. CABLE CROSS-SECTIONAL AREA _____ OTHER _
4. CABLE WEIGHT (LBS/FT) _____
5. CABLE MIN BENDING RADIUS _____
6. TENSILE STRENGTH _____
7. GROSS WEIGHT/REEL (LBS) _____
8. TOTAL CUBIC FEET/REEL _____
9. SHORT CIRCUIT WITHSTAND CURVES _____
10. CABLE TESTING REQUIREMENTS _____
11.
12. **NOTES**
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Section 16131

DEVICE, PULL AND JUNCTION BOXES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Specifications for device, pull, and junction boxes.

1.02 REFERENCES

A. All products and components shown on the Drawings and listed in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. NFPA 70 – National Electrical Code (NEC)

2. NFPA 70E – Standard For Electrical Safety in the Workplace

3. UL 6A – Electrical Rigid Metal Conduit

4. ANSI C80.5 – Electrical Rigid Aluminum Conduit

5. UL 514B – Outlet Bodies

B. All equipment components and completed assemblies specified in this Section of the Specifications shall bear the appropriate label of Underwriters Laboratories (UL).

1.03 SUBMITTALS

A. Submit the following under provisions of Section 01330 – Submittal Procedures:

1. Manufacturer's cut sheets, catalog data

2. Instruction for handling and storage

3. Installation instructions

4. Dimensions and weights

1.04 QUALITY ASSURANCE

A. The manufacturer of these materials shall have produced similar electrical materials and equipment for a minimum period of five (5) years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly. All assemblies shall be of the same manufacturer.

C. The Contractor's installer of materials specified herein shall have a minimum of five (5) years' experience in the installation of each type of material. Proof of experience shall be submitted, upon request of the Owner/Engineer, prior to installation.

1.05 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, the Contractor shall have successfully completed all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, or equipment which failed any factory tests, will not be permitted.

B. Materials shall be handled and stored in accordance with manufacturer's instructions.

C. Materials shall not be stored exposed to sunlight. Such materials shall be completely covered.

D. Materials showing signs of, previous or jobsite, exposure will be rejected.

1.06 WARRANTY

A. Prior to jobsite delivery, the Contractor shall have successfully completed all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, or equipment which failed any factory tests, will not be permitted.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. Sheet Metal Boxes

1. Hoffman Industrial Products

2. Pauluhn Electric Manufacturing Company

3. Hennessy

4. Tanco

5. Tejas

6. Circle A.W.

B. Cast Device Boxes

1. Appleton Electric Company

2. Crouse-Hinds, Division of Cooper Industries

3. Killark Electric Manufacturing Company

2.02 MATERIALS AND EQUIPMENT

A. Sheet Metal Boxes

1. Provide UL-approved junction boxes and pull boxes manufactured from stainless steel sheet metal and meeting requirements of NEMA 4X for corrosive and wet area, NEMA 250 and NEC Article 314.

2. Provide boxes with a stainless steel continuous hinge, closure hasps and all- stainless steel hardware. Junction boxes shall be mounted so the door opens to the right or to the left.

3. Furnish the door with neoprene gasket and provision for padlock.

B. Device Boxes

1. Boxes specified herein, including terminal boxes, junction boxes and pull boxes, are for use with raceway systems only, but include switch, receptacle and lighting housings. Boxes used for housing electrical and instrumentation equipment, other than terminal boxes, shall be as described elsewhere in these Specifications. All raceway boxes shall be provided with a common ground point and UL rated.

2. Classified Areas, NEMA 7/4X (Class 1, Division 1, Groups A, B, C, and D, or as defined in NFPA 70). Boxes shall be constructed as follows:

a) Copper free cast aluminum body and cover

b) Stainless steel hinges

c) Watertight neoprene gasket

d) Stainless steel cover bolts

e) Manufacturers

1) Cooper Crouse Hinds Type EJB, Style C

2) Appleton Electric Type AJBEW

3) Approved Equal

C. Device Boxes

1. Provide UL-approved boxes designed and manufactured to house electrical devices like receptacles and switches, and in conformance with NEMA FB1 and NEC Article 314.

2. Supply boxes that are hot-dip galvanized or cast iron suitable for corrosive and wet atmosphere.

D. Hardware

1. Mounting Hardware: Stainless steel

2. Conduit Connectors: Watertight as manufactured by Myers Hubs, or equal.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Review the drawings and determine how many boxes of each kind are required and check if supplied quantity is sufficient.

3.02 INSTALLATION

A. Boxes described in this specification shall be used both in dry and wet, corrosive areas, both inside and outside locations.

B. Install boxes in accordance with NEC Article 314 in locations indicated on the Drawings. Junction boxes shall be mounted so the door opens to the right or to the left.

C. Install junction and pull boxes in readily accessible places to facilitate wire pulls, maintenance and repair. Junction boxes shall be sized for the number and size of conduits that enter the junction box.

D. Plug unused conduit openings.

E. Make conduit connections to sheet metal boxes with watertight conduit connectors.

F. Label boxes with phenolic nameplates as required in Section 16195.

END OF SECTION

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Section 16140

WIRING DEVICES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Specifications for wiring devices including:

1. Receptacles.

2. Wall switches.

3. Wall plates and cover plates.

1.02 REFERENCES

A. American National Standards Institute/National Electrical Manufacturers Association (ANSI/NEMA):

1. NEMA WD1 - General Purpose Wiring Devices.

2. NEMA WD6 - Dimensional Requirements.

B. Federal Specifications (WC-596F).

C. American National Standards Institute/National Fire Protection Association (NFPA):

1. NFPA No. 70 - National Electrical Code (NEC), Articles 210 Branch Circuits, 250 Grounding and 410, Paragraphs 56, 57 and 58.

1.03 SUBMITTALS

A. Submit the following under provisions of Section 01330 – Submittal Procedures:

1. Product Data: Manufacturer's product literature and specifications including dimensions, weights, certifications and instructions for handling, storage and installation.

1.04 DELIVERY, STORAGE AND HANDLING

A. Pack and crate devices to permit ease of handling and protect from damage during shipping, handling and storage.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. Bryant Electric

B. Crouse-Hinds, Arrow Hart Division

C. Hubbel Inc. Wiring Devices Division

D. Leviton Manufacturing Company

E. Pass & Seymour/Legrand.

2.02 MATERIALS AND EQUIPMENT

A. Standards: Conform to NEMA WD1 for general requirements and NEMA WD6 for dimensional requirements.

B. Manufacture devices to heavy-duty industrial specification grade with brown nylon bodies (orange for isolated-ground receptacles) back and side wiring provisions and green-colored grounding screws.

C. Receptacles:

1. Duplex-type receptacles: Rated 20 amps at 120 volts.

2. Contacts: Brass or phosphor bronze.

3. Receptacle grounding system: Extend to the mounting strap unless isolated ground is indicated or required.

4. GFI or GFCI (ground fault circuit interrupter) receptacles: Provide feed-through type with test and reset button.

D. Wall Switches:

1. Toggle switches: Singel pole, 20 Amp, 120/277 Volt - Cooper, Catalog No. 2221V, similar to Hubbell, Inc.; Pass & Seymour, Inc. or equal.

2. Double pole, 20 Amp, 120/277 Volt - Cooper, Catalog No. 2222V, similar by Hubbell, Inc.; Pass & Seymour, Inc. or equal.

3. Three way, 20 Amp, 120/277 Volt - Cooper, Catalog No. 2223V, similar by Hubbell, Inc.; Pass & Seymour, Inc. or equal.

E. Cover Plates:

1. In outdoor, corrosive and wet areas, provide cover plates of heavy duty plastic, gasketed with hinged covers that remain waterproof while still in use and stainless steel hardware.

2. All other plates: Type 316 stainless steel.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Verify that device boxes are correctly placed.

B. Verify that the correct quantity, size and type of wires are pulled to each device box.

C. Verify that wiring has been checked at both ends.

D. Prepare wire ends for connection to devices.

E. Inspect each wiring device for defects.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install devices plumb and level.

C. Install switches with OFF position down.

D. Install receptacles with grounding pole on top.

E. Connect wiring device grounding terminal to outlet box with bonding jumper.

F. Connect wiring devices by wrapping conductors clockwise around screw terminals.

G. Install cover plates on switch, receptacle and blank outlets in finished areas.

H. Energize and test devices for proper operation.

END OF SECTION

Section 16160

CABINETS AND ENCLOSURES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Specifications for cabinets and enclosures for housing of control panels and motor controls.

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA).

1. 250 - Enclosures for Electrical Equipment (1000 volts maximum).

a) NEMA 3 - Enclosures for outdoor use primarily to provide a degree of protection against wind-blown dust, rain, and sleet; undamaged by formation of ice on the enclosure.

b) NEMA 12 - Enclosures for indoor use primarily to provide a degree of protection against dust, falling dirt, and dripping non-corrosive liquids.

c) Provide NEMA 4X 316 Stainless Steel enclosures for outdoor and wet locations or as specified on drawings.

B. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), NFPA 70 - National Electrical Code (NEC), Article 312 - Cabinets, Cutout Box, and Meter Socket Enclosures.

C. Underwriters Laboratories (UL), UL 50 - Safety for Cabinets and Boxes.

1.03 SUBMITTALS

A. Submit the following under provisions of Section 01330 – Submittal Procedures:

1. Manufacturer's cut sheets and catalog data

2. Instruction for handling and storage

3. Installation instructions

4. Dimensions and weights

1.04 DELIVERY, STORAGE AND HANDLING

A. Have cabinets and enclosures packed and crated to permit ease of handling and to provide protection from damage during shipping, handling and storage.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. The EMF Company

B. Hennessey Products, Inc.

C. Hoffman Industrial Products

D. Pauluhn Electric Manufacturing Company

E. Weigman Company

F. Rose Enclosure

G. N.E.M.A. Enclosure Mfg. Co.

H. Rittal

2.02 MATERIALS AND EQUIPMENT

A. Sheet Metal Boxes

1. Provide enclosures manufactured in accordance with NEMA 250 and NEC Article 312. Fabricate outdoor NEMA 3 panels from 0.125- inch thick type 5052 H32 aluminum or 14 gauge, 316 stainless steel for installation in areas that are not air conditioned. NEMA 12 indoor panels for installation in air conditioned areas shall be painted steel.

2. Dimensions and special features are shown on the Drawings.

3. Construct outdoor enclosures with continuously welded seams ground smooth.

4. Additional material thickness and bracing requirements shall be determined by the manufacturer to provide the strength required

by the standard listed. The bracing shall be provided in such a way as to minimize the protrusion into the wiring and the equipment spaces.

5. Install the door with a stainless steel continuous hinge, stainless steel padlock handle with gasket and stainless steel hardware. Junction boxes shall be mounted so the door opens to the right or to the left.

6. Furnish the door with oil-resistant neoprene gasket attached with oil-resistant adhesive and held in place with aluminum retaining strips.

7. Use a single, 3/4-inch minimum, door handle that provides a 3-point latching through latch rods with rollers. Provide rollers with at least 3/4-inch diameter.
8. Gasketed overlapping doors may be used instead of a center post.

9. Provide heavy duty lifting eyes of suitable material.

10. Fabricate the enclosure with a stud-mounted panel inside. Make panels from 12-gauge steel painted with white enamel finish.

11. Equip both NEMA 12 and NEMA 3 enclosures with thermostatically controlled space heaters and corrosion inhibitors. Provide heaters rated for 240V for 120V operation.

12. Weld mounting feet to the enclosure if called for on the Drawing.

13. Include a high impact plastic data pocket in the enclosure.

14. Provide ground connections on the enclosures to enable grounding of the enclosure with a No. 2 AWG conductor.

15. Equip free-standing outdoor cabinets with inner and outer door restraint bars to prevent door swing during windy conditions.

16. Supply indoor enclosures with filtered passive air intake and exhaust openings, 4-inch square in the side near the top and near the bottom of the adjacent side panel.

B. Hardware

1. Mounting Hardware: Stainless steel

2. Conduit Connectors: Watertight as manufactured by Myers Hubs, or equal.

2.03 TESTING

A. Test cabinets and enclosures in accordance with UL 50 so unit qualifies for a UL label.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Review Drawings and determine how many enclosures of each kind are required and check if supplied quantity is sufficient.

B. Check the mounting pads or foundations for proper mounting dimensions and features, including grounding conductor stub-up.

3.02 INSTALLATION

A. Use enclosures described in this specification only above grade.

B. Install enclosures in accordance with NEC Article 312 in locations as indicated on the Drawings.

C. Install enclosures in readily accessible locations to facilitate general operations, wire pulls, maintenance and repair.

D. Plug unused conduit openings.

E. Make conduit connections to the enclosures with watertight conduit connectors.

F. Identify all components in cabinets with phenolic nameplates as required in Section 16195.

G. Use pre-printed tubular heat-shrink type wire and cable markers to label each end of all conductors.

END OF SECTION

Section 16161

PANELBOARDS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Specifications for panelboards.

1.02 REFERENCES

A. American National Standards Institute/National Electrical Manufacturers Association (ANSI/NEMA)

1. NEMA AB1: Molded Case Circuit Breakers

2. NEMA PB1: Panelboards

3. NEMA PB1.1: Instruction for Safe Installation Operation and Maintenance of Panelboards rated 600 volts or less.

4. NEMA PB1.2: Application Guide for Ground-fault Protective Devices for Equipment

5. UL 67: Panelboards

6. UL 50: Cabinets and Boxes

7. Fed. Spec W-P-115C

B. Federal Specifications, FS W-C-375A: Circuit Breakers, Molded Case, Branch Circuit and Service.

C. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), NFPA No. 70 - National Electrical Code (NEC), Article 408 - Switchboards and Panelboards.

D. Underwriters Laboratory

1. UL 67: Panelboards

2. UL 50: Cabinets and Boxes

1.03 SUBMITTALS

A. Submit the following under provisions of Section 01330 – Submittal Procedures:

1. Manufacturer's cut sheets and catalog data

2. Breaker arrangement

3. Breaker characteristic curves

4. Instruction for handling and storage

5. Installation instructions

6. Dimensions and weights

1.04 DELIVERY, STORAGE AND HANDLING

A. Have panelboards packed and crated to permit ease of handling and to provide protection from damage during shipping, handling and storage.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. Sheet Metal Boxes

1. Eaton Cutler Hammer

2. General Electric

3. Siemens

4. Schneider Electric

2.02 MATERIALS AND EQUIPMENT

A. Basic Requirements

1. Use panelboards manufactured and tested in accordance with NEMA PB 1.

2. Provide circuit breakers of industrial grade, manufactured and tested in accordance with NEMA AB 1 and Federal Specification FS W-C-375.

3. Perform a load analysis to assure the panel rating is not overloaded when new loads are added to existing panels.

B. Rating

1. Voltage rating, current rating, number of phases, number of wires and number of poles are indicated on Drawings.

2. Branch circuit breaker interrupting capacity shall be minimum 10,000 ampere RMS symmetrical for 208V; 25,000 ampere RMS symmetrical for 480V.

C. Circuit Breakers: Molded case, bolt-on thermal magnetic type with number of poles and trip ratings as shown on the Drawings. Provide ground fault interrupters with trip rating where shown on the Drawings.

D. Bus System

1. Bus Bars: 98 percent conductivity copper. Provide a solid neutral bar in 4-wire panelboards. Include ground bus in all panels. Provide split-bus panels where shown on Drawings.

2. Main: Circuit breaker or main lugs only as indicated on the Drawings or as required to meet the current interrupting ratings.

E. Box and Trim

1. Construction: Code grade steel, ample gutter space, flush door, flush snap latch and lock.

2. Trim: Surface or flush as required. Enclose panelboards located outdoors, in other wet and corrosive areas, or in non-air conditioned areas in NEMA 4X weatherproof stainless steel enclosures. Enclose indoor panelboards installed in air conditioned areas in a NEMA 1 enclosure with manufacturer's standard gray enamel finish.

3. Directory: Typed card, with glass cover in frame on back of door giving the circuit numbers and the area or equipment served.

F. Conduit Connectors: Watertight as manufactured by Myers Hubs, or equal.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Review Drawings to verify that panelboards are correct for the application.

3.02 INSTALLATION

A. Install the panelboard in accordance with NEMA PB 1.1 and NEC Article 408.

B. Mount panelboards 6'-0" (to top of cabinet) above finished floor or grade. In wet and corrosive areas, including outdoor locations, install panel enclosures on spacers to provide approximately 1/4-inch between back of cabinet and mounting surface. Mounting hardware shall be type 316 stainless steel.

C. In wet and corrosive areas, including outdoor locations, connect conduit to the bottom of enclosure and to the lower 30 percent of the sides using watertight connectors.

END OF SECTION

Section 16165

DISCONNECT SWITCHES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Specifications for disconnect switches including:

1. Fusible disconnect switches

2. Non-fusible disconnect switches

3. Circuit breaker type disconnect switches

4. Fuses

5. Circuit breakers

1.02 REFERENCES

A. American National Standards Institute/National Electrical Manufacturers Association (ANSI/NEMA)

1. NEMA AB1: Molded Case Circuit Breakers

2. NEMA KS1: Enclosed Switches

B. Underwriters Laboratories (UL)

1. UL 98: Standard for safety enclosed switches and Dead Front Switches

2. UL 198C: High Interrupting Capacity Fuses, Current Limiting type

3. UL 198E: Class R Fuses

C. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), NFPA No. 70 - National Electrical Code (NEC), Chapter 4.

1.03 SUBMITTALS

A. Submit the following under provisions of Section 01330 – Submittal Procedures:

1. Manufacturer's cut sheets and catalog data

2. Switch internal arrangement

3. Breaker or fuse characteristic curves

4. Instructions for handling and storage

5. Installation instructions

6. Dimensions and weights

1.04 DELIVERY, STORAGE AND HANDLING

A. Have disconnect switches packed and crated to permit ease of handling and to provide protection from damage during shipping, handling and storage.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. Disconnect Switches and Circuit Breakers:

1. Eaton/ Cutler Hammer

2. General Electric

3. Siemens Energy and Automation

4. Schneider Electric

B. Fuses

1. Bussman Division, Eaton/ Cooper Industries

2. Gould Shawmut

3. Littlefuse Incorporated

2.02 MATERIALS AND EQUIPMENT

A. Disconnect Switches

1. Characteristics: Horsepower rated, 600-volt, heavy-duty type with an interlocked door, positive quick-make, quick-break mechanism and visible blades.

2. Use switches and components designed, manufactured and tested in accordance with NEMA AB1, NEMA KS1, UL 98, and NEC Chapter 4.

3. Enclose switch in a NEMA 12 type enclosure for indoor, air-conditioned applications and NEMA 4X (type 316 stainless steel) in outdoor locations, non-air-conditioned areas, or other wet or corrosive areas.

4. Provide switches with provisions for padlocking the operating lever in OFF position and door in closed position.

5. Select switches having the number of poles and general size conforming to the Drawings.

6. Conform to fusible, non-fusible or circuit breaker type switch requirements as shown on Drawings and required by the NEC, or one-line diagrams.

7. Provide an auxiliary contact, shown on the Drawings.

8. Select fuses or circuit breakers with current interrupting duty as calculated for the points of switch application or as indicated on the Drawings or one-line diagrams.

B. Fuses. Unless otherwise noted on Drawings, for fuses used in disconnect switches, provide the dual-element, time-delay type with the maximum interrupting rating of 200,000 amperes, conforming to the NEC.

C. Circuit Breakers. When circuit breakers are used in disconnect switches, provide the thermal-magnetic type with current interruption ratings as required at the point of application.

D. Conduit Connectors: Watertight as manufactured by Myers Hubs, or equal.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Review the Drawings and verify that the disconnect switches are correct for the applications.

B. Make sure that the correct fuses or breakers are being used regarding size and short circuit interrupting capability.

C. Prepare adhesive labels on the inside door of each switch indicating UL fuse class and size or breaker type and size for replacement.

3.02 INSTALLATION

A. Install the disconnect switches in accordance with and NEC Chapter 4. Disconnect switches shall be mounted in sight of or within 25’ of motors and rotating equipment.

B. Mount switches 6'-6" (to top of cabinet) above finished floor or grade.

C. In wet and corrosive areas, including outdoor locations, install switches on spacers to provide a space of approximate 1/4-inch between the back of cabinet and the mounting surface.

D. In wet and corrosive areas, including outdoor locations, connect conduit to the bottom of enclosure and to the lower 30 percent of the sides using watertight connectors.

E. Disconnect shall be labeled as required in Section 16195.

END OF SECTION

Section 16170

GROUNDING AND BONDING

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Grounding electrodes and conductors

B. Equipment grounding conductors

C. Bonding

D. Power system grounding

E. Communication system grounding

F. Electrical equipment and raceway grounding and bonding

G. Control equipment grounding

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM B3: Soft or Annealed Copper Wires

2. ASTM B8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, Soft

3. ASTM B33: Tinned Soft or Annealed Copper Wire for Electrical Purposes

B. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE 142-82: Recommended Practice for Grounding of Industrial and Commercial Power Systems

2. IEEE 383-2.5: IEEE Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations.

C. Underwriters' Laboratories (UL)

1. UL 83: Thermoplastic Insulated Wire and Cables

2. UL 467: Grounding and Bonding Equipment

D. National Fire Protection Association (NFPA), NFPA No. 70 - National Electrical Code (NEC), Article No. 250 - Grounding.

1.03 SUBMITTALS

A. Submit the following under the provisions of Section 01330 – Submittal Procedures:

1. Manufacturer's cut sheets and catalog data

2. Installation, terminating and splicing procedure

3. Instruction for handling and storage

4. Dimensions and weight

1.04 QUALITY ASSURANCE

A. Tests

1. Use insulated cable conforming to requirements of the vertical tray flame test as described in IEEE 383-2.5.

2. Test grounding system in the field in accordance with procedures outlined in Part 3 - Execution.

1.05 DELIVERY, STORAGE AND HANDLING

A. Ship grounding cable on manufacturer's standard reel sizes unless otherwise specified. Where cut lengths are specified, mark reel footage accordingly. Each reel shall contain one continuous length of cable. Provide impact protection by wood lagging or suitable barrier across the traverse of the reel. Pack and crate other materials specified to withstand normal abuse during shipping, handling and storage.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. Cable

1. Southwire company
2. Superior Essex
3. General Cable Company
4. Okonite Company
5. Pirelli Cable Corporation
6. Rome Cable Corporation
7. Triangle Wire and Cable, Inc.

B. Ground Rods and Connectors:

1. Blackburn
2. Copperweld
3. Thomas & Betts

C. Exothermic Connections:

1. Burndy Corporation (Therm-O-Weld)
2. Erico Products (Cadweld)

D. Grounding Connectors:

1. Burndy Corporation
2. O.Z. Gedney
3. Thomas & Betts

2.02 MATERIALS AND EQUIPMENT

A. Design. Provide grounding cable and materials with the following characteristics:

1. Use a grounding system designed in accordance with NEC Article No. 250 - Grounding, and the IEEE 142-82 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

B. Materials

1. Use grounding conductors, tin plated bare or insulated, which are manufactured and tested in accordance with applicable standards ASTM B3, ASTM B8 and ASTM B33.

2. Provide a main ground loop of No. 4/0 AWG, Class C stranded, bare copper cable. Small groups of isolated equipment may be grounded by a No. 2 AWG minimum insulated conductor connected to the main loop. Generally, taps shall be sized as follows:

   a) Main ground loop or grid #4/0 minimum

   b) Switchgear, motor control centers and power transformers #4/0

   c) Motors 200 hp and above #4/0

   d) Power panels - AC and DC #2/0

   e) Control panels and consoles #2

   f) Building columns #4/0

   g) Fencing posts #2/0

3. Where single conductor insulated grounding conductors are called for, use 600-volt insulation. Use ground conductors identified with green insulation or green tape marking.

4. Supply identifying ribbon which is PVC tape, 3 inches wide, red color, permanently imprinted with "CAUTION BURIED ELECTRIC LINE BELOW" in black letters as specified in Section 16195, Electrical Identification.

5. Utilize tin plated flexible copper braid across hinged chain link or fence gates to bond the movable portion to the grounded fence post.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Complete site preparation and soil compaction before trenching and driving ground rods for the underground grid.

B. Verify from Drawings the exact location of stub-up points for grounding of equipment, fences and building or steel structures.

3.02 CONSTRUCTION CRITERIA

A. The main ground loop at a depth of at least 30 inches below earth surface. Connect the ground loop to ground rods and to tap connections to form a complete system as indicated on the electrical Drawings. The Contractor shall give special attention to the grounding of service equipment, structures and fences to comply with the NEC, local authorities and the serving utility company.

B. Electrical equipment, buildings, tanks, and other structures and equipment shall be grounded as indicated on the Drawings. Where ground rods are required, the rods shall be 10 feet long, 3/4 inch diameter, copper-clad steel ground rods. Rods shall be driven vertically, and the top of the rods shall be a minimum of 18 inches below finished grade, or as specified on the Drawings. Ground wells will be provided for all driven rods.

C. Local pushbutton and selector switch stations, two-wire control devices, disconnect switches, lighting transformers, panelboards, operator panels, benchboards, and the enclosures of other electrical apparatus shall be grounded through and equipment grounding conductor run with the power supply or control circuit conductors or shall be grounded as shown on the Drawings.

D. Ground medium voltage motors, in addition to the grounding conductors in the motor feeder cable, with a separate No. 4/0 AWG cable to motor frame.

E. Motors having power supplied by multiconductor cable shall be grounded by a separate grounding conductor in the cable and where supplied by single conductor cable in conduit by a grounding conductor pulled in the conduit. Connect ground conductors to the ground bus in the motor control center and to the ground terminal provided in the motor conduit box.

F. Do not ground the insulated bearing pedestals of large motors.

G. Connect ladder-type cable trays to the grounding electrode system.

H. Install a warning ribbon approximately 12 inches below finished grade directly above the ground grid.

I. Connect fence posts of chain link and metal fences to the main ground loop at least every 50 feet. Install bonding straps to gates.

3.03 INSTALLATION

A. Equipment Grounding

1. Make grounding connections to surfaces which are dry and cleaned of paint, rust, oxides, scales, grease and dirt to ensure good conductivity. Clean copper and galvanized steel to remove oxide before making welds or connections.

2. Use the exothermic welding process for below-grade grounding connections, except at ground rods. Use mechanical connectors or thermal connections for above-grade grounding connections as shown on the Drawings.

3. Make grounding connections to electrical equipment, vessels, mechanical equipment and ground rods in accordance with the Drawings.

4. Ground tanks and vessels by making connections to integral structural supports or to existing grounding lugs or pads, and not to the body of the tank or vessel.

5. Leave ground connections to equipment visible for inspection. Protect them with PVC non-metallic conduit as indicated on the Drawings.

6. Make connections to motor frames and ground buses with lugs attached to the equipment by means of bolts. Do not use motor anchor bolts or equipment housing for fastening lugs of grounding cable.

7. Where the wiring for lighting systems consists of single conductor cables in conduit, provide each conduit with an equipment grounding conductor. Use a grounding conductor with green colored insulation and ground equipment in the lighting system.

B. Raceway and Support Systems Grounding

1. Install raceway, cable rack or tray and conduit so that it is bonded together and permanently grounded to the equipment ground bus, according to the Drawings. Connection to conduit may be grounding bushing or ground clamp.

2. Install raceway at low voltage motor control centers or other low voltage control equipment so that it is bonded and grounded,

except that any conduit which is effectively grounded to the sheet metal enclosure by bonding bushing or hubs need not be otherwise bonded.

3. Where a grounding conductor is run in or on a cable tray, bonds the grounding conductor to each section of cable tray with a cable tray ground clamp.

4. Where only grounding conductor is installed in a metal conduit, bond both ends of the conduit to the grounding conductor.

5. Provide flexible "jumpers" around raceway expansion joints. Use copper bonding straps for steel conduit. Install jumpers across cable tray joints which have been parted to allow for expansion and any hinged cable tray connections.

C. Fences and Gates. Ground fences, fence posts and gates to the underground grid as shown on the Drawings.

D. Power System Grounding

1. Solidly ground the secondary neutral of the main power supply transformer either to the ground grid or through an impedance. See Drawings for details.

2. Solidly ground the neutral of lighting, instrument and control transformers.

E. Cable Armor and Shields

1. For shielded control cable, terminate and ground the shield at one end only, preferably at the control panel end for instrument and communication cable and at the supply end for electronic power cables. Maintain shield continuity by jumpering the ground shield across connection point where it is broken at junction boxes, or other splice points. Insulate these points from ground.

2. Connect the ground wire in power cable assemblies at each terminal point to a ground bus, if available, or to the equipment enclosure. Do not carry these ground wires through a "doughnut" current transformer (CT) used for ground fault relaying; do carry ground leads from stress cones through CTs. Ground power cable armor and shield at each terminal point.

F. Test Wells

1. Provide access (test wells) for testing the ground grid system at one or several ground rod locations. Make test wells of a pipe surrounding the rod and connections with a cover placed on top at grade level. See Drawings for details.

2. Install a test well at the service entrance pole to serve as the service entrance grounding electrode.

G. Test

1. Perform ground resistance tests after underground installation and connections to building steel are complete, unless otherwise noted on applicable Drawings.

2. Make tests at each ground test well using a "fall of potential" test method. Each ground test well shall not exceed a maximum resistance of 5 ohms. Where measured values exceed this figure, install additional ground rods as required to reduce the resistance to the specified limit.

H. Inspection. Inspection of the grounding system by the Project Manager and the local Code Inspector must take place before the grid trenches are backfilled.

END OF SECTION

SECTION 16171

LOW VOLTAGE ELECTRIC MOTOR

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Specification for low voltage motors. See Specification 11311, Submersible Wastewater Pumps, for motors integral with submersible wastewater pumps.

1.02 RELATED WORK

A. Specification Section 16195, Electrical Identification.

1.03 REFERENCES

A. American National Standards Institute/Anti-Friction Bearing Manufacturers Association (ANSI/AFBMA): Load Ratings and Fatigue Life for Ball Bearings.

B. American National Standards Institute/national Electrical Manufacturers Association (ANSI/NEMA): MG 1 - Motors and Generators.

C. American National Standards Institute/National Fire Protection Association (ANSI/NFPA): NFPA 70 - National Electrical Code (NEC).

D. American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)

1. IEEE112 - Standard Test Procedure for Polyphase Induction Motors and Generators

2. IEEE114 - Standard Test Procedure for Single-Phase Induction Motors

E. American National Standards Institute/Underwriters Laboratories, Inc. (ANSI/UL)

1. UL547 - Thermal Protectors for Motors

2. UL674 - Electric Motors and Generators for Use in Hazardous Locations, Class I Groups C and D, Class II Groups E, F and G

F. Institute of Electrical and Electronics Engineers (IEEE)

1. 85 – 1973 Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery

2. 43 – 2000 Recommended Practice for Testing Insulation Resistance of Rotating Machinery

G. American Society of Heating, Refrigerating, and Air-conditioning Engineers, Inc. / Illumination Engineering Society of North America (ASHRAE / IES): 90.1-1989, Table 5.1 - Minimum Acceptable Nominal Full-load Motor Efficiencies for Single Speed Polyphase Motors.

1.04 SUBMITTALS

A. Submit the following under the provisions of Section 01330 – Submittal Procedures:

1. Outline drawings

2. Complete motor data

3. Assembly drawings

4. Anchor bolt location drawings

5. Electrical schematics and wiring diagrams

6. Equipment performance curves and data

7. Bill of installation/assembly materials

8. Equipment weights

9. Catalog data

10. Assembly/disassembly sizes and weights

11. Operating instructions

12. Maintenance and lubrication recommendations

13. Recommended spare parts for startup including prices

14. Special maintenance tool requirements

15. Recommended spare parts list for one year operation

16. Quality control procedures

17. Nondestructive test procedures

18. Acceptance test procedure

19. Surface preparation and painting procedure

20. Shipping, handling, and storage procedures

21. Installation/erection procedure

22. Code compliance certificate

23. Electrical equipment heat run test records

24. Nameplate data

25. Performance/acceptance test report

26. Code data reports

1.05 QUALITY ASSURANCE

A. Tests

1. Inspect and test motors in accordance with specified NEMA standards. Test polyphase motors to the requirements of ANSI/IEEE 112. Test single phase motors to the requirements of ANSI/IEEE 114- 2001. See data sheets for other standard test requirements that may be specified.

1.06 DELIVERY, STORAGE AND HANDLING

A. Prepare each unit for the type and mode of shipment specified. The preparation shall be suitable for at least six months of outdoor storage from time of shipment requiring no disassembly prior to operation (except for bearing and seal inspections).

B. Provide instructions as necessary to preserve the integrity of the storage preparation after the equipment arrives at the jobsite.

C. Coat exterior machined surfaces with a suitable rust preventative.

D. After drained and cleaned, coat internal areas of bearings and auxiliary equipment in oil lubrication systems fabricated from carbon steel with a suitable oil-soluble rust preventative.

E. Provide threaded openings with steel caps or solid-shank steel plugs. Do not use nonmetallic plugs or caps.

F. When sleeve bearings are furnished, block the rotor to prevent axial and radial movement.

G. When space heaters are furnished, make heater leads accessible without disturbing the shipping package. Tag the leads for identification.

PART 2 P R O D U C T S

2.01 MANUFACTURERS

A. General Electric.

B. Reliance Electric.

C. Siemens.

D. Toshiba.

E. U.S. Motors.

2.02 DESIGN

A. This specification defines the minimum requirements for low-voltage, random-wound, squirrel-cage, induction motors in the NEMA frame sizes for classified electrical hazardous and non-classified area service.

B. Use this specification for the selection and purchase of induction motors purchased separately or furnished with driven equipment as a package.

C. This specification, along with the reference documents make up the requirements for motors up to and including 200 hp. Use driven equipment specifications to supplement this specification and identify special project requirements.

D. Motors purchased with this specification will drive pumps, compressors, fans, agitators, conveyors and other similar equipment. Motors will be installed in a plant environment that may include high humidity, storms, salt-laden air, insects, plant life, fungus, rodents as well as traces of petroleum and/or chemicals.

E. Motors shall perform satisfactorily for the application.

F. Motors, electrical components and installation shall be suitable for the hazardous area classification (class, group, and division) and shall meet the requirements of ANSI/UL 674 and the NEC.

G. Make motors suitable for operation in an outdoor corrosive and wet environment.

H. When motors are furnished with the driven equipment as a package, motors shall also meet the requirements of the driven equipment specification.

I. Design motors for operation at a temperature of up to 40º/104ºF ambient and at an elevation of up to 1000 m/3300 ft above sea level.

2.03 PERFORMANCE REQUIREMENTS

A. Confirm motors have ample capacity to supply the maximum output demanded by the driven equipment and have a speed-torque-current characteristic appropriate to the driven equipment.

B. Confirm motors ability to overcome starting load inertia and accelerate the load to rated speed within 15 seconds at 80 percent of rated nameplate voltage, without exceeding the motor time-temperature damage curve.

C. Design and construct motors for continuous full load duty, and for continuous or intermittent operation under any extreme environmental condition.

D. Three-phase induction motors shall be ANSI/NEMA MG 1 Design B. Motors driving high-torque loads may be NEMA Design C or D, providing so stated in the proposal.

E. Single-phase fractional horsepower motors shall be NEMA Design N.

F. The single speed, polyphase motors shall have efficiencies as shown in ASHRAE/IES Standard 90.1 - 1989, Table 5-1 and ANSI/NEMA MG-1-1998 Table 12-10. Provide motors commonly referred to as “Premium Efficiency” in the Industry.

2.04 ENCLOSURES AND FRAMES

A. Provide motors with NEMA totally enclosed, fan-cooled (TEFC) enclosures.

B. Motors frames, enclosures, terminal boxes, fan cover guards and air passages shall be cast iron or heavy fabricated steel of such design or proportions as to hold all motor components rigidly in proper position, and shall meet all NEMA requirements. End bells shall be cast iron. Steel sheet or plate used shall have a thickness of at least 1/8 in. Fans, breathers, drains, screens, covers and hardware shall be corrosion-resistant materials. Fractional horsepower motors may have rolled steel stator frame and cast iron brackets with integral mounting feet.

C. Make motor enclosure fans low inertia, nonsparking type, and suitable for bidirectional rotation and mount on hub with stainless steel bolts.

D. Furnish each enclosure with a stainless steel automatic breather/drain located at the low point of the enclosure.

E. Motor frame and enclosure shall have provisions for grounding to the main grounding system. Drill and tap rear foot on horizontal motors and the flange base on vertical motors on the junction box side for a service post ground connector.

F. Provide motors weighing more than 300 lbs. with lifting eyebolts, rings or lugs capable of supporting the weight of the motor.

2.05 ELECTRICAL REQUIREMENTS

A. Design motor for 60 Hz power at the nominal operating voltages listed below.

1. 115/230V, single-phase (3/4 hp and smaller).

2. 460V, three-phase (one horsepower and larger).

B. Induction motors shall be random-wound, squirrel-cage rated for continuous duty and suitable for across-the-line starting, at rated voltage.

C. Determine motor horsepower, speed, torque and special operating requirements from the requirements of the driven equipment.

D. Use copper for motor windings and terminal leads. Aluminum is not an allowable material for any portion of the motor other than die-cast rotor (fabricated aluminum rotors are not acceptable). Copper rotors shall not be fabricated using brazing maler and any copper alloy must contain less than two percent phosphorous.

E. Provide three-phase single speed motors with three leads.

F. For two-speed motors provide two windings.

G. Motors shall have a 1.15 service factor (SF) rating.

H. Motor insulation shall be a minimum of Class F epoxy nonhygroscopic material with temperature rise limited to Class B design rise of 90°C by resistance method at 1.15 SF.

I. Motors shall operate successfully under running conditions at rated load with variation in voltage and frequency up to the limits set by ANSI/NEMA MG 1-12.44.

J. Motors shall be suitable for the number of full-voltage starts as required by ANSI/NEMA MG 1-12.50 as a minimum.

2.06 TERMINAL BOXES

A. Make motor terminal boxes weatherproof and with threaded conduit entrances with water-resistant seals between boxes and motor frame. Design the line-terminal box to allow box to be rotated in four 90 degree steps for bottom, side or top entry of conduit or cable. The main terminal box location shall be determined by the Contractor. Locate terminal box for space heaters (when supplied) on the same side as the line terminal box.

B. Size the line terminal box so that feeder cables can be connected to motor leads for terminals without damage to the cable or the leads. Oversize the terminal box to exceed the minimum volumes shown in the NEC Section 430-12 and provide adequate space to mount and enclose all devices mounted within.

C. Furnish the line terminal box with suitable compression ring-type, permanently numbered, cable connectors for incoming bolted-cable connections and one clamp-type ground terminal lug of sufficient size to contain a conductor the same size as motor leads.

D. Wire accessory leads to a terminal board in a terminal box or boxes separate from the line leads. Supply separate terminal boxes for the leads for space heaters, and temperature detectors, current transformers, and other similar accessories, when supplied.

2.07 ELECTRICAL ACCESSORIES

A. Arrange space heaters to provide optimum uniform heating of the stator winding and prevent condensation in the motor at ambient temperature when motor is not in operation. Space heaters shall be rated 240 V but shall be connected for operation at 115V. Space heaters shall have maximum sheath temperature of 150°C and shall be approved for the specified hazardous area classification.

B. Provide winding thermal protection, when required, in accordance with ANSI/UL 547 and consisting of differential heat sensing devices embedded in each motor winding. The devices shall be sensitive to both over temperature and rate of temperature rise.

2.08 BEARINGS AND LUBRICATION

A. Grease or oil-lubricated anti-friction ball or roller bearings are preferred within the application limits. Sleeve-type bearings may be acceptable when recommended by the manufacturer for a particular application. Sealed grease-lubricated bearings are acceptable only for fractional horsepower motors in noncritical service.

B. Motors shall have proper bearing insulation to prevent circulation of shaft currents and resulting damage. Provide also insulating means for any oil-supply connections and monitoring equipment to prevent electrical bypassing of the bearing insulation.

C. Bearings for all direct--connected and belted service motors shall have an L_{10} rating life in accordance with ANSI/AFBMA 9, of at least 40,000 hours.

D. Size bearing housing for grease-lubricated bearings adequately to minimize need for frequent lubrication. Design bearing housing to prevent loss of grease from the bearing cavity and to prevent entry of foreign material into the bearings. Provide housing for grease-lubricated bearings with two plugged openings accessible from the exterior of the motor, one for receiving a pressure grease fitting, and the other to serve as a drain and vent during greasing.

E. Provide oil-lubricated bearing housings a reservoir of sufficient depth, to serve as a settling chamber for foreign materials, with a drain plug, and vents as required, accessible from the exterior of the motor. Furnish oil-lubricated motors with a constant oil-level sight gauge mounted on the motor housing and marked with running- and stopped-oil levels.

F. Provide motors with suitable seals to prevent moisture from entering through the shaft openings. For applications where hoses and water are used for cleanup, provide an Inpro/Seal isolator (labyrinth seal) on the shaft end of the motor.

G. For in-line pumps, special high thrust bearings are required for drive motors, except for pumps where the thrust bearings are provided as an integral part of the pump.

2.09 ADDITIONAL REQUIREMENTS FOR VERTICAL MOTORS (NOT REQUIRED)

A. Solid shaft vertical motors are acceptable for all applications except when the connection to the driven equipment consists of sectional driven shaft which may unscrew and lengthen in the event of reversal of direction.

B. Hollow-shaft vertical motors are acceptable for all applications when the thrust is in the direction to engage the coupling.

C. Hollow-shaft vertical motors coupled to a sectional drive shaft with screwed joints shall have special couplings described as follows:

1. Provide motors, except the explosion proof type, with self-releasing couplings designed to disconnect motor from driven equipment and permit lengthening of drive shaft upon reversal of rotation.

2. Provide explosion proof motors with non-reversing couplings of spark-resisting construction, designed to prevent reverse rotation.

D. Design vertical motor thrust bearings conservatively to carry maximum axial thrusts (up and down) imposed by driven equipment.

E. Vertical motors shall preferably have oil-lubricated, top and bottom bearings.

F. Vertical motor bases shall be NEMA Type P.

G. Provide vertical motors with a positive, non-reversing, corrosion-resistant ("anti-ratchet") mechanism.

H. Provide vertical motors with fan-end splash shields.

2.10 SLIDING BASE AND SOLE PLATE REQUIREMENTS (NOT REQUIRED)

A. Motors for adjustable belt and chain drives, 1 hp larger, shall be provided with slide rails, or a double-screw adjusting heavy duty sliding based. Fractional horsepower motors shall have slotted holes.

Fabricate sliding base from heavy steel to withstand vibration and corrosive environment and paint it the same color with the same paint system as the motor.

B. Mating surfaces shall be ± 0.0002 in./ft and finished to 250 microinches, and shall be protected during shipping.

C. Motors without sliding bases and that will not be directly mounted on equipment bases shall be equipped with sole plates. Sole plates shall be set into Owner's foundation and the motor shall be mounted onto the plate.

2.11 ROTOR BALANCING AND VIBRATION

A. Balance motor rotors dynamically according to NEMA standards. Depositing weld metal, solder and the like on the rotor to effect a balance will not be acceptable. Remove parent metal to achieve balance without affecting the structural strength of the rotor. Chiseling or sawing parent metal is prohibited.

B. Measure vibration in all directions with the motor running uncoupled at no load, normal voltage and frequency, and at each speed of the operating range. Motor vibration shall not exceed the total amplitude, peak-to-peak values given in ANSI/NEMA MG 1-12.05A as measured in accordance with ANSI/NEMA MG 1-12.07.

2.12 NAMEPLATES

A. Fasten motor stainless steel nameplates securely to the motor with stainless steel screws. Nameplates shall include as a minimum the information required by ANSI/NEMA MG 1-16.61.

2.13 FINISH

A. Motors shall be primed and finished using the motor manufacturer's standard epoxy painting system.

B. Cover internal surfaces, e.g., shaft, rotor, stator, and other similar components, with a corrosion-resistant coating of epoxy or equal material for increased life.

2.14 NOISE LEVELS

A. Determine motor noise level in accordance with IEEE 85. Levels or noise generated by a motor shall not exceed 85 dbA at a distance of 1 m/3.3 ft.

B. Noise level requirements may be also covered by a separate noise requirements specification included with the driven equipment specification.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Verify dimensions of motor foundation with sole plates or slide rails in place.

3.02 INSTALLATION

A. Install the motor in accordance with the Manufacturer's published instructions using the necessary tools and instrument to ensure proper fit and alignment with the driven machine.

B. Before coupling up with the driven machine, the following work should be performed.

1. Test the motor winding insulation resistance in accordance with IEEE 43.

2. Terminate cables to the motor leads.

3. Energize motor momentarily to check rotation.

4. Check shaft of driven machine to ensure free movement.

C. Couple motor up with driven machine.

D. Record motor nameplate data.

3.02 IDENTIFICATION

A. See Specification 16195.

END OF SECTION

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Section 16195

ELECTRICAL IDENTIFICATION

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Specification for electrical identification including:

1. Nameplates and labels

2. Wire and cable markers

3. Conduit markers

4. Cable tray markers

5. Underground warning tape

6. Warning labels

1.02 REFERENCES

A. American National Standards Institute/National Fire Protection Association (ANSI/NFPA)

1. No. 70 - National Electrical Code (NEC)

a) Article 110 - Requirements for Electrical Installation

b) Article 430 - Transformers and Transformer Vaults

B. City of Houston Building Code

C. Other applicable Codes and Standards as referenced in other Sections.

D. Underwriters Laboratories. U.L. Standards No. 224 - Extruded Insulated Tubing

1.03 SUBMITTALS

A. Submit the following under the provisions of Section 01330 Submittal Procedure:

1. Manufacturer's cut sheets and catalog data

2. Description of materials used

3. Label or nameplate dimensions

4. Engraving or imprint legends

5. Instruction for handling and storage

6. Installation instructions

1.04 DELIVERY, STORAGE AND HANDLING

A. Pack materials to permit ease of handling and to provide protection from damage during shipping, handling and storage.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. Almetek Industries Incorporated

B. Brady U.S.A. Incorporated

C. Ideal Electric Company

D. Raychem Corporation

E. 3M Electrical Products Division

F. Thomas & Bett

G. Tyton Corporation

2.02 MATERIALS AND EQUIPMENT

A. Nameplates and Labels

1. Provide an identification tag for each item of electrical and instrumentation equipment showing its item number and service or application. Use the description shown on the electrical Drawings.

2. For nameplates, use 3-ply phenolic material engraved to show black lettering on a white background. Size the nameplates approximately 1 inch wide and 3 inches long for 3 lines of 3/16 inch - 16 letters with a 0.8 condensed factor.

3. Generally, provide large pieces of equipment with engraved nameplates; provide additional nameplates at pushbuttons and other local devices; as detailed. Provide identification for all other electrical and instrumentation equipment, devices, or enclosures, such as MCC's, panelboards, disconnect switches, capacitors, relays, and dedicated receptacles not furnished with readily noticeable tag, nameplates, or other means of identification. Provide fault current nameplate per NEC requirements.

4. Install nameplates on the front cover of transformers stating the transformer service location number or identification number, the panelboard or device served, and main breaker feeding the transformer (MCC No. and compartment), and the drawing number on which the transformer schematic is shown.

5. Furnish equipment, such as motor starters, safety switches, welding receptacles and circuit breakers, with 1" x 3" plastic nameplates stating description of item served.

6. Provide nameplates for motors giving the driven equipment description, the service location number, and the MCC number with compartment number when applicable. Nameplates will normally be mounted adjacent to the motor at the motor pushbutton when one is furnished.

7. Install nameplates on the outside and inside of doors to circuit breaker panelboards (i.e., lighting, instrument or receptacle panels). State the panelboard name, the drawing number on which the panelboard schedule shows, and the main breaker feeding the panel (MCC No. and compartment).

8. Type panelboard directories and insert them inside the panelboard doors. Text shall be 12pt- Arial font.

9. Place a large nameplate no less than 3"x5" on control panels, relay panels, junction boxes, or enclosures with electrical devices mounted inside or on the outside of the enclosure indicating the purpose of the cabinet.

10. Provide a nameplate on MCC motor starter doors duplicating motor nameplate data.

B. Wire and Cable Markers

1. Use pre-printed tubular heat-shrink type wire and cable markers at each end of all conductors.

2. Select markers manufactured so that the heat-shrink process makes the imprint permanent and solvent-resistant.

3. Use markers that are self-extinguishing, conforming to U.L. Standard No. 224 for print performance, heat shock, and flammability.

4. Provide marker material that is flexible, radiation cross-linked polyolefin with 3 to 1 shrink ratio, rated 600 volts, and white in color.

C. Conduit Markers

1. Provide conduit markers made of stainless steel tags approximately 2 inches x 1 inch x 19 gage.

2. Stamp the caption on the tag and have it black filled.

3. Punch tags for tie fasteners. Fasten tags to the conduits with stainless steel braided wire.

D. Cable Tray Markers

1. For high visibility and contrast, use cable tray markers that are yellow with black legend.

2. Use markers made of vinyl impregnated cloth, suitable for exposure to corrosive, wet, and abrasive environment.

3. Make markers of pre-cut individual letters or numbers with pressure sensitive adhesive backing.

4. Size legend characters to 4 inches high on a total marker height of approximately 5 inches, suitable for applying to 6-inch side rails of a cable tray.

E. Underground Warning Tape

1. Provide warning tape made of 4 mil thick polyolefin film, 3 inches wide, suitable for direct burial and resistant to alkalis, acids, and other common soil substances.

2. Use red tape with black legend printed in permanent ink.

F. Warning Labels

1. Place OSHA safety labels on enclosures and boxes 100 cubic

inches or more containing electrical equipment or terminations.

2. Provide OSHA color codes for the labels. Use labels made from 4 mil vinyl with pressure sensitive adhesive backing.

3. The warning label caption is DANGER - 480 VOLTS or as indicated on the drawings.

4. Size labels either 5 inches x 3-1/2 inches or 10 inches x 7 inches, as indicated on the Drawings.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Degrease and clean surfaces where adhesive labels will be applied.

B. Drill holes for nameplates to be fastened with stainless screws.

C. Prepare the cable ends for termination and conductor markings.

D. Identify conduits at terminating points and select tags accordingly.

3.02 INSTALLATION

A. Install nameplates and labels in accordance with the manufacturer's instructions and the Drawings.

B. Apply wire and cable markers in accordance with manufacturer's instructions using a heat gun with properly sized nozzle for the application. Tag the wires at both ends with the same notation.

C. Tag conduits at junction boxes, pull boxes, and at other termination points.

D. Identify cable trays at the time of installation with the alphanumeric number shown on the Drawings. Label cable trays on the outside rail. Place the tray identifier at each point where the tray designation changes and at 200 foot intervals in between, but not less than two per run.

E. Identify underground conduits, cables, or duct banks using the underground warning tape. The underground grounding grid, including the laterals. Also use underground warning tape. Install one tape per trench at 12 inches below grade or as indicated on the Drawings. For wide trenches or duct banks, install one warning tape per 24 inch width.

F. Apply the 5 inches by 3-1/2 inches warning labels to disconnect switches, panelboards, terminal boxes, and similar devices in accordance with manufacturer's instruction and the Drawings. Apply the 10 inches x 7 inches warning labels to larger control panel enclosures, motor control centers, and to entrance doors to buildings containing electrical power and control equipment.

END OF SECTION

SECTION 16290

SURGE PROTECTION DEVICES

PART 1 G E N E R A L

1.01 SCOPE OF WORK

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install surge protective devices (SPDs) in the MCC/power panel, control panels and field devices.

2. Provide surge protection devices to protect field instruments and equipment from the effects of transient surges caused by lightning and other electrical sources.

3. SPDs shall be installed at the following locations:

a) On 480 VAC power and neutral connections at the MCC or power panels.

b) On 120 VAC, 60Hz power connections to control panels.

c) On all analog signals at the control panel. Include surge protection at 24 VDC loop powered field instruments for wiring distances greater than 75 feet from the control panel. Include surge protection on all four-wire, 120 VAC field instruments.

d) On all discrete signals that have portions of interconnecting wiring located outside of protected buildings.

e) On all copper data lines that have portions of interconnecting wiring located outside of protected buildings

B. Related Sections:

1. Section 17320: Control Panels and Enclosures.

2. Division 16: Electrical.

1.02 QUALITY ASSURANCE

A. Standards, Codes and Regulations:

1. Surge protective devices and the installation and interconnection of the devices shall comply with applicable provisions of the following standards, codes and regulations:

   a) National Fire Protection Association 79, Annex “D” Standards, (NFPA).

   b) National Electrical Code, (NEC).

   c) National Electrical Manufacturer's Association Standards, (NEMA).

   d) UL 1449 Third Edition, Standard for Safety Surge Protective Devices (SPDs).

   e) UL 497B, Protectors for Data Communications and Fire-Alarm circuits.

   f) International Electro Technical Commission (IEC).

   g) Institute of Electrical and Electronics Engineers (IEEE).

   h) State and Local code requirements.

   i) Where any conflict arises between codes or standards, the more stringent requirement shall apply.

PART 2 P R O D U C T S

2.01 SPD - GENERAL

A. Connect and ground in accordance with surge protection device manufacturer’s instructions. SPDs shall use a separate path to building ground; the equipment safety ground is not to be used as a transient ground path.

B. SPDs shall be installed as close as practical to the protected equipment, panel, or switchboards to minimize connecting wire lead lengths.

C. All control panel SPDs shall be DIN-rail mountable and capable of being monitored by direct visual means and have remote indication for fault indication to a local monitoring and control system.

D. All control panel SPDs shall be pluggable for easy removal to facilitate testing to ensure proper protection levels. Removal shall not disrupt operation of protected circuits.

E. MOV based suppression products rated for use above 110 VAC, 60Hz, 95 percent humidity, shall incorporate a thermally sensitive device to remove the metal oxide varistor (MOV) from service should the event of severe overheating occur.

F. The surge protection devices shall be used as the interface terminal blocks when applicable.

2.02 SPD - 480 VAC POWER

A. General: Provide surge protection for 3-phase 480 VAC wye power connections. Include circuit breaker in series with each device to facilitate device removal and testing.

B. Features:

1. Suppression: Metal oxide varistors (MOVs) and gas-filled surge arresters.

2. Protection level Up (core-neutral): ≤ 1.6 kV.

3. Protection level Up (core-ground): ≤ 1.75 kV.

4. Protection level Up (neutral-ground): ≤1.5 kV.

5. Nominal discharge surge current (8/20 µs): 20 kA.

6. Maximum discharge surge current (8/20 µs): 40 kA.

7. Response time (core-neutral): ≤ 25 ns.

8. Response time (core-ground): ≤ 100 ns.

9. Operating temperature of -40 ºC to 80 ºC.

C. Product and manufacturer:

1. Phoenix Contact, VAL-MS 320/3+1.

2. Erico, TDS350TT277

3. Dehn, DG MU 3PY 480 4W+G

4. Or approved equal.

2.03 SPD - 120 VAC POWER

A. General: Provide modular, pluggable surge protective device of the incoming power feed to the control panel.

B. Features:

1. Suppression: Metal oxide varistors (MOVs) and gas-filled surge arresters.

2. Maximum Continuous Operating Voltage: 150V.

3. Nominal load current In: 26 A.

4. Protection level Up (L-N): 620 V.

5. Protection level Up (L-PE): 850 V.

6. Protection level Up (N-PE): 850 V.

7. Nominal discharge surge current (8/20 µs): 2.5 kA.

8. Response time: < 25 ns (L-N)

9. Operating temperature of -40 ºC to 85 ºC.

C. Product and manufacturer:

1. Phoenix Contact, MAINS-PLUGTRAB PT 2-PE/S-120AC-ST.

2. Erico, TDS1301TR150

3. Dehn, DR M 2P 150

4. Or approved equal.

2.04 SPD – 24 VDC ANALOG – CONTROL PANEL

A. General: Surge protection device (SPD) at the control panel for 24 VDC power connections to field instruments. SPD shall be pluggable, modular and able to be tested.

B. Features:

1. Suppression: Gas-filled surge arrester and silicon avalanche diode.

2. Maximum Continuous Operating Voltage: 28 VDC.

3. Nominal current In: 450 mA.

4. Protection level Up (core-core): ≤ 70 V (1 kV/500 A).

5. Protection level Up (core-ground): ≤ 450 V (1 kV/5 kA).

6. Resistance per path: 2.2 ohms.

7. Nominal discharge surge current (8/20 µs): 10 kA.

8. Total surge current (8/20 µs): 20 kA.

9. Response time (core-core): ≤ 1 ns

10. Response time (core-ground): ≤ 100 ns

11. Capable of being monitored by head-end module and LED indicators for status.

12. Operating temperature of -40 ºC to 85 ºC.

C. Monitoring Module Features:

1. Communicate status and provide power to SPD LEDs via TBUS connector on DIN rail.

2. Nominal Operating Voltage: 28 VDC (20 VDC – 30 VDC).

3. Provide two NC contacts for status of overload and performance limit reached of connected SPDs.

4. Capable of monitoring status of 28 SPDs.

5. Provide ON/OFF switch for SPD LED lights.

D. Product and manufacturer:

1. Phoenix Contact, MCR-PLUGTRAB PT 1x2-24DC-ST.

2. Erico, UTB30SP

3. Dehn, BXT ML4 BE 24

4. Or approved equal.

2.05 SPD – DISCRETE SURGE PROTECTION – 24 VDC

A. General: Surge protection at the control panel for 24 VDC discrete signal connections. SPD shall be pluggable, modular and able to be tested.

B. Features:

1. Suppression: Gas-filled surge arrester and silicon avalanche diode.

2. Maximum Continuous Operating Voltage: 28 VDC.

3. Nominal current In: 300 mA.

4. Protection level Up (core-ground): ≤ 60 V (1 kV/500 A)

5. Resistance in series: 4.7 ohms.

6. Nominal discharge surge current (8/20 µs): 10 kA.

7. Total surge current (8/20 µs): 20 kA.

8. Response time (core-ground): ≤ 1 ns

9. Operating temperature of -40 ºC to 85 ºC.

10. Capable of being monitored by head-end module and LED indicators for status.

C. Monitoring Module Features:

1. Communicate status and provide power to SPD LEDs via TBUS connector on DIN rail.

2. Nominal Operating Voltage: 28 VDC (20 VDC – 30 VDC).

3. Provide two NC contacts for status of overload and performance limit reached of connected SPDs.

4. Capable of monitoring status of 28 SPDs.

5. Provide ON/OFF switch for SPD LED lights.

D. Product and manufacturer:

1. Phoenix Contact, MCR-PLUGTRAB PT 2x1-24DC-ST

2. Erico, UTB30SP

3. Dehn, BXT ML4 BD 24

4. Or approved equal.

2.06 SPD – DISCRETE SURGE PROTECTION – 120 VAC

A. General: Surge protection at the control panel for 120 VAC discrete signal connections. SPD shall be pluggable, modular and able to be tested.

B. Features:

1. Suppression: Metal oxide varistors.

2. Maximum Continuous Operating Voltage: 150 VAC.

3. Nominal current In: 26 amps.

4. Protection level Up (Core-ground): ≤ 550 V.

5. Nominal discharge surge current (8/20 µs): 2.5 kA.

6. Total surge current (8/20 µs): 5 kA.

7. Response time (core-ground): ≤ 25 ns

8. Operating temperature of -40 ºC to 85 ºC.

C. Product and manufacturer:

1. Phoenix Contact, MCR-PLUGTRAB PT 2x1VA-120AC-ST.

2. Erico, UTB110DP

3. Dehn, BXT ML4 BE 180

4. Or approved equal.

2.07 SPD – 24 VDC POWER/ANALOG – FIELD DEVICE

A. General: Surge protection at the field device for 24 VDC power connections.

B. Features:

1. Suppression: Gas-filled surge arrester and silicon avalanche diode.

2. Maximum Continuous Operating Voltage: 36 VDC.

3. Nominal current In: 450 mA.

4. Protection level Up (core-core): ≤65 V.

5. Protection level Up (core-ground): ≤ 1.2 kV (C2- 10 kV/5 kA).

6. Nominal discharge surge current (8/20 µs) (core-ground): 10 kA.

7. Total surge current (8/20 µs): 20 kA.

8. Core to core response time: < 1 ns.

9. Core to ground response time: < 100 ns

10. Operating temperature of -25 ºC to 80 ºC.

11. Material and mounting: High grade steel with ½ inch NPT.

C. Product and manufacturer:

1. Phoenix Contact, SURGETRAB, S-PT-EX-24DC.

2. Erico, RTP3034

3. Dehn, BXT ML4 BE 36

4. Or approved equal.

2.08 SPD – 120 VAC POWER/24 VDC SIGNAL – FIELD DEVICE

A. General: Surge protection at the field device to protect the 120 VAC power and 24 VDC analog signal. Surge protection to be provided in a NEMA 4X enclosure.

B. 120 VAC Power Surge Features:

1. Suppression: Metal oxide varistors (MOVs) and gas-filled surge arresters.

2. Maximum Continuous Operating Voltage: 150V.

3. Nominal load current In: 26 A.

4. Protection level Up (L-N): 620 V.

5. Protection level Up (L-PE): 850 V.

6. Protection level Up (N-PE): 850 V.

7. Nominal discharge surge current (8/20 µs): 2.5 kA.

8. Response time: < 25 ns (L-N)

9. Operating temperature of -40 ºC to 85 ºC.

C. 24 VDC Signal Surge Features:

1. Suppression: Gas-filled surge arrester and silicon avalanche diode.

2. Maximum Continuous Operating Voltage: 28 VDC.

3. Nominal current In: 450 mA.

4. Protection level Up (core-core): ≤ 70 V.

5. Protection level Up (core-ground): ≤ 450 V.

6. Resistance per path: 2.2 ohms.

7. Nominal discharge surge current (8/20 µs): 10 kA.

8. Total surge current (8/20 µs): 20 kA.

9. Response time (core-core): ≤1 ns

10. Response time (core-ground): ≤ 100 ns

11. Operating temperature of -40 ºC to 85 ºC.

D. Product and manufacturer:

1. Phoenix Contact, BOXTRAB – BXT-N4X 4-WIRE.

2. Erico, MWE and TDS1301TR150

3. Dehn, 999.990-01

4. Or approved equal.

2.09 SPD – DATA SURGE PROTECTION - ETHERNET

A. General: Surge protection to protect CAT-5/6 Ethernet data signal. Provide attachment plug for DIN-rail mounting. Connection method to device by RJ45 plug.

B. Features:

1. Suppression: Gas-filled surge arrester and diodes.

2. Maximum Continuous Operating Voltage (core-ground): ≤ 180 VDC.

3. Nominal current In: ≤ 1.5 A.

4. Protection level Up (core-core): ≤ 9 V (1 kV/25A)

5. Protection level Up (core-core): ≤ 100 V (1 kV/25A - PoE)

6. Protection level Up (core-earth): ≤ 600 V.

7. Nominal discharge surge current (8/20 µs) (core-ground): 2 kA, per signal pair.

8. Total surge current (8/20 µs): 10 kA.

9. Response time (core-core): ≤ 1 ns.

10. Response time (core-ground): ≤ 100 ns

11. Operating temperature of -40 ºC to 70 ºC.

C. Product and manufacturer:

1. Phoenix Contact, DT-LAN-CAT.6.

2. Erico, LANRJ45C6

3. Dehn, DPA M CLE RJ45B 48

4. Or approved equal.

2.010 SPD – DATA SURGE PROTECTION – RS-485

A. General: Surge protection to protect RS-485 connection. Provide attachment plug for DIN-rail mounting. Connection method to device by 9-position D-SUB connector.

B. Features:

1. Suppression: Gas-filled surge arrester and diodes.

2. Maximum Continuous Operating Voltage: 12 VDC.

3. Nominal current In: ≤ 380 mA.

4. Protection level Up (core-core): ≤ 40 V (5 kA)

5. Protection level Up (core-ground): ≤ 750 V (5 kA).

6. Resistance in series: 3.3 ohms.

7. Nominal discharge surge current (8/20 µs) (core-ground): ≤ 5 kA.

8. Total surge current (8/20 µs): 10 kA.

9. Response time (core-core): ≤ 100 ns.

10. Response time (core-ground): ≤ 100 ns

11. Operating temperature of -40 ºC to 85 ºC.

C. Product and manufacturer:

1. Phoenix Contact, DT-UFB-485/BS.

2. Erico, DEPRS42299D

3. Dehn, BXT ML4 BD HF 5

4. Or approved equal.

2.011 SPD – DEVICE TESTER

A. General: Provide device tester for pluggable surge protective devices in convenient carrying case.

B. Features:

1. Barcode scanner or keypad for entering information on SPD.

2. Operating Voltage: 100 – 240 VAC.

3. Provide all test sockets for SPDs used on the project.

4. Provides documentation of test results.

C. Product and manufacturer:

1. Phoenix Contact, CHECKMASTER.

2. Erico, MGA TESTER

3. Dehn, DRC LC M3+

4. Or approved equal.

2.012 SPARE PARTS

A. Provide the following control system network component spare parts:

1. One per five of each type of surge protective device; minimum of one of each type of surge protective device.

PART 3 E X E C U T I O N

3.01 INSTALLATION

A. The installation shall follow the SPD manufacturer's recommended installation practices and comply with all applicable codes.

B. Coordinate the installation of the surge protection device with the installation of the equipment being protected. The surge protection device shall be installed as close as practical to or within the equipment being protected.

C. Conductor length between suppressor and connection point shall be as short and as straight as possible.

D. Upon completion of installation, provide the services of a factory-certified local service technician to perform start-up testing. Record test results and compare to factory testing to confirm proper operation of equipment. Submit test results with operation and maintenance manuals.

END OF SECTION

SECTION 16401

ELECTRIC SERVICE

PART 1 GENERAL

1.01 CONDITIONS

A. This specification is issued for this specific project only. Reproduction of this document for any other purpose is prohibited.

1.02 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code

B. Utility company standards.

1.03 SYSTEM DESCRIPTION

A. System Characteristics: Three phase, four-wire, 60 Hertz as indicated on Drawings.

B. Service Entrance: Overhead or Underground as indicated on Drawings.

1.04 SUBMITTALS

A. Submit Utility Company prepared drawings.

B. With each submittal, include a copy of the applicable specification(s) page(s) for the item submitted and mark “Complies” or “Non-Compliance” or “Exception” adjacent to the applicable paragraph. Identify applicable drawing sheet number and specification section on front of each submittal cover.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with Utility Company written requirements.

B. Maintain one copy of each document on site.

1.06 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Local codes and regulations.

C. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.07 PAYMENT

A. Unless otherwise stated in the Special Conditions or in the Proposal, no separate payment will be made for the work covered by this section of the specifications and all costs in connection therewith shall be included in related items or work listed in the Proposal.

PART 2 PRODUCTS

2.01 UTILITY METERS

A. Consult with Electric Utility regarding service entrance requirements and metering equipment.

B. Provide and install metering equipment and empty conduit for metering conductors to meet standards and requirements of Electric Utility.

2.02 METERING TRANSFORMER CABINET

A. Size: 24 x 36 x 12 inches minimum or as required by utility company for transformers provided.

B. Included bus bars and provisions for padlocking and sealing per utility company requirements.

2.03 OVERHEAD SERVICE RACK (NOT APPLICABLE)

A. Manufacturers:

1. O.Z. Gedney

2. Killark Electric Mfg. 6

3. Cooper Industries

2.04 PAD MOUNTED TRANSFORMER

A. Install concrete pad, primary and secondary duct banks, safety bollard, metering, etc. complete per Power Company requirements.

2.05 CONDUITS

A. Incase all underground conduits in 3” red concrete.

B. Install warning tape 12” below finished grade. Refer to 16402.3.02.O. and 16195.2.02.E

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Make arrangements with Utility Company to obtain permanent electric service to the project and to verify service information specified and shown on drawings.

B. Coordinate location of Utility Company’s facilities to ensure proper access is available.

C. Include deviations required by Electric Utility from contract documents to comply with Electric Utility standards and requirements.

3.02 APPLICATION FOR ELECTRIC SERVICE

A. Obtain required forms from Electric Utility.

B. Assist Owner in completion of forms and deliver completed forms to Electric Utility.

C. Coordinate schedule for installation of electric service with Electric Utility.

D. Notify Utility Company, within 30 days of project start date, that permanent service will be required for this project. Specify date required and location of project.

3.03 INSTALLATION

A. Install service as required by Utility Company and as indicated on drawings.

END OF SECTION

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Section 16402

UNDERGROUND DUCT BANKS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Underground electrical duct banks.

1.02 REFERENCES

A. National Fire Protection Association (NFPA): No. 70 - National Electrical Code (NEC) Appendix B.

1.03 SUBMITTALS

A. Catalog cut sheets of the ducts and spacers.

1.04 DELIVERY, STORAGE AND HANDLING

A. Have duct spacers and associated hardware packed and crated to avoid damage during shipment and handling.

B. Clearly mark packages or crates stating that the material is for electrical duct banks only.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. Thomas and Betts.

B. Underground Devices Inc.

C. Walker Division, Butler Manufacturing Company.

2.02 MATERIALS AND EQUIPMENT

A. Conduit. Construct ducts using schedule 80 rigid PVC conduit. Refer to Section 16111 - Conduit, Fittings and Bodies.

B. Spacers. Secure conduit with non-magnetic, universal, interlocking-type spacers for both horizontal and vertical duct arrangements.

C. Concrete. Use steel reinforced, red concrete as duct encasement. Refer to Section 03100 Concrete Formwork.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Verify from Drawings and field survey that the location of ductbanks does not interfere with any existing or new underground facilities.

B. Verify that materials are on site in proper condition and that sufficient quantity is on hand for the work.

C. Verify that trenches are in the correct places and prepared with sufficient depth and width to accommodate the duct banks, reinforcing rod, and concrete.

D. Be prepared for inspection of the duct banks before reinforcing rod is installed.

E. Before pouring concrete, verify that the ducts are free of debris and properly installed in the support and spacer systems and that the ducts are properly fitted together and firmly held in place by the hold down hardware.

F. Provide 24-hour notice to Project Manager, Wastewater Inspectors and the Local Code Inspector for cover-up inspection before pouring electrical conduit ductbanks.

3.02 INSTALLATION

A. Use the size and types of conduit as indicated on the Drawings for the various duct banks required for the project.

B. Make duct bank installations and penetrations through foundation walls watertight.

C. Assemble duct banks using non-magnetic saddles, spacers and separators. Position separators to provide 2-inch minimum concrete separation between the outer surfaces of the conduits.

D. Provide a 3-inch minimum concrete covering on both sides, top and bottom of concrete envelopes around conduits. Add red dye at the rate of 10 pounds per cubic yard to concrete used for envelopes for easy identification during subsequent excavation.

E. Firmly fix ducts in place during pouring of concrete. Carefully spade and vibrate the concrete to ensure filling of spaces between ducts.

F. Make bends with sweeps of radius not less than 6 times the smallest diameter of the raceway.

G. Make a transition from non-metallic to PVC-coated metallic rigid aluminum conduit where duct banks enter structures or turn upward for continuation above grade.

H. Make bends of 30 degrees or more using PVC coated metallic rigid aluminum conduit.

I. Reinforce duct banks throughout, where indicated on the Drawings.

1. Unless otherwise noted on the Drawings, reinforce with No. 5 longitudinal steel bars placed at each corner and along each face at a maximum parallel spacing of 12 inches on centers, and No. 5 tie-bars transversely placed at 18-inch maximum longitudinal intervals.

2. Maintain a maximum clearance of 2 inches from bars to the edge of the concrete encasement.

J. Where ducts enter structures such as handholes, manholes, pullboxes, or buildings, terminate the ducts in suitable end bells, insulated L-bushings, Meyers hubs or couplings on steel conduits. Tag conduit entering pull boxes with stamped, stainless steel tags. Identify as designated in cable and conduit schedule.

K. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material, or other materials which can damage or contribute to corrosion of ducts or prevent adequate compaction of fill.

L. Install a tinned bare stranded #4/0 AWG copper duct bank ground in each duct bank envelope. Make ground electrically continuous throughout the entire duct bank system. Connect ground to switchgear and MCC ground buses and to steel conduit extensions of the underground duct system.

M. After completion of the duct bank and prior to pulling cable, pull a mandrel, not less than 12 inches long and with a cross section approximately one-fourth inch less than the inside cross section of the duct, through each duct. Then pull a rag swab or sponge through to remove any particles of earth, sand or gravel that may have been left in the duct. Repull the rag or sponge swab until the swab emerges clean.

N. Use hemp rope to pull conductors into PVC conduit. Do not use nylon or wire cable for this purpose.

O. Install a warning ribbon approximately 12 inches below finished grade over underground duct banks. Refer to Section 16195 - Electrical Identification.

P. For manholes and pull boxes below grade, install wire racks to support cables properly around the perimeter and keep them dry.

Q. For manholes and pull boxes below grade, construct a french drain, or other drainage as detailed on the Drawings.

END OF SECTION

Section 16410

LOW VOLTAGE POWER FACTOR CORRECTION CAPACITORS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Specifications for low voltage power factor correction capacitors.

1.02 REFERENCES

A. American National Standards Institute/National Electrical Manufacturers Association (ANSI/NEMA)

1. NEMA CP-1: Shunt Capacitors

2. NEMA ICS-2: Industrial Control Devices, Controllers and Assemblies

B. American National Standards Institute/National Fire Protection Association (ANSI/NFPA): NFPA No. 70 - National Electrical Code (NEC) Article 460 - Capacitors.

C. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE): Standard No. 18 - Standard for Shunt Power Capacitors.

D. Underwriters Laboratories, Inc. (UL): UL 810 - Capacitors.

E. Power factor correction system shall comply with CenterPoint standard for harmonic distortion.

1.03 SUBMITTALS

A. Submit the following under provisions of Section 01330 – Submittal Procedures:

1. Mounting dimensions and instructions

2. Equipment weights

3. Catalog data

4. Electrical schematics and wiring diagrams for control devices

5. Operating instructions for controls

1.04 QUALITY ASSURANCE

A. Tests

1. Perform tests in accordance with ANSI/NEMA CP-1. Each capacitor shall be subjected to manufacturing testing as described in ANSI/UL 810. Have test or inspections performed and evaluated by qualified personnel. Document deficiencies observed during the testing process and correct them prior to shipment.

2. Tests required include: short-time over voltage test, capacitance test, leak test and dissipation factor test.

3. Run a functional test on factory assembled automatic units.

1.05 DELIVERY, STORAGE AND HANDLING

A. Have capacitors packed and crated to permit ease of handling and to provide protection from damage during shipping, handling and storage.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. ABB Power T&D Company, Inc.

B. ASC Industries

C. Eaton/ Cutler Hammer.

D. General Electric Company

E. Schneider Electric

2.02 MATERIALS AND EQUIPMENT

A. Capacitor Requirements

1. The capacitors shall provide power factor correction for individual motors 20 horsepower and above in the system by connecting each capacitor to the load side of the respective motor starter, or automatically switching capacitor banks on and off in accordance with the need for reactive power. See Drawings and one-line diagrams for details.

2. Use capacitors meeting the requirements stipulated in NEMA CP-1 and IEEE Standard No. 18.

3. The capacitor total losses shall not exceed 0.5 W per kVAR.

4. Select capacitors with permanently connected discharge resistors in full compliance with NEC Article 460-6(a) and (b).
5. Use capacitors which are the fused, fixed-type with multiple cells with dry-type dielectric enclosed in an anti-corrosion unpainted enclosure.

6. When individual motor circuits are equipped with power factor correction capacitors, connect the capacitors to the circuit between the contactor and the overload relay so as not to affect the true value of the motor current going through the overload relay heater coils.

7. Provide necessary anti-corrosion mounting brackets and hardware with the capacitors.

8. When called for on the one-line diagrams, provide the power factor correction by an automatic capacitor bank.

9. Connect the capacitor bank to the main power supply bus immediately down-stream from the ammeter and voltmeter in the motor control center.

10. Select individual capacitors as described for the individual motor power factor correction capacitor.

11. Use a capacitor bank with a modular design to allow for expansion by adding capacitor units and control devices.

12. Mount capacitors and control system in an enclosure suitable for the environment and as specified in Section 16160 - Cabinets and Enclosures.

    a) If installed outside, provide a NEMA 3 gasketed enclosure.

    b) If installed inside a building, provide a NEMA 12 enclosure.

    c) Mount capacitors on wall above indoor motor control centers.

    d) If a motor control center is part of the plant design, install controls for the automatic power factor correction capacitors in a motor control center section.

B. Automatic Power Factor Control: Where specified, provide controls to permit an operator to select a target power factor adjustable to any

value between 0.95 leading and 0.80 lagging. The controls continuously sense the power factor on the circuit being corrected and, when it differs from the target setting for more than 10 seconds, operate a contactor to switch a capacitor bank into or out of the circuit. Contactors are opened or closed as required to bring the corrected circuit power factor closer to the target setting. Only one capacitor bank is switched at a time.

C. Controls. The controls for the automatic power factor correction shall comply with NEMA ICS-2 with quantities, ratings, mounting provisions and sensing, and power connections as shown on the one-line diagrams. System features and components shall include:

1. Basic control system: solid-state microprocessor-based.

2. Three-pole 600-volt rated contactors for repetitive high-inrush-switching duty presented by capacitor loading.

3. Fuses or circuit breakers for protection of wiring, contactors and capacitors.

4. Air-core-type inductors mechanically braced to withstand the maximum fault current available at the point of application may be installed in the capacitor circuit to limit switching surges to within contactor ratings.

5. Indicating lights designating energized capacitor banks.

6. The power bus, when required, shall be tin plated copper and braced for available fault current.

7. Interlock enclosure doors to de-energize capacitors when doors are opened.

8. A switchboard type power factor meter with 0.5 lagging to 0.5 leading and plus or minus one percent accuracy.

9. A main circuit breaker operable from outside the enclosure which can de-energize the entire system inside the enclosure. Arrange breaker for pad-locking.

10. Capacitor failure alarm relay with one form C contact for connection by City.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Factory Assembled Unit. Verify dimensions of the housekeeping pad and the embedded leveling channels and conduit stub-ups if applicable.

B. Individual Capacitor for Each Motor. Verify dimensions of the capacitor mounting rack to ensure proper fit and accessibility for wiring and maintenance.

C. Controls in Motor Control Center - Capacitors separately mounted. Verify content of Motor Control Center section to ensure correct power and control devices and wiring.

3.02 INSTALLATION

A. Install equipment and wire up in accordance with the manufacturer's published instructions.

B. Torque bus bar bolts and cable connections to manufacturer's recommendations and tighten nuts and bolts on steel enclosures to ensure structural integrity.

C. Locate capacitors to allow adequate ventilation around the enclosures.

END OF SECTION

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Section 16461

DRY-TYPE TRANSFORMERS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Specifications for dry-type transformers for the following applications:

1. Motor drive isolation

2. Shielded isolation

3. Non-linear loads

4. General purpose

1.02 REFERENCES

A. American National Standards Institute/National Electrical Manufacturers Association (ANSI/NEMA)

1. ANSI No. C89.2: Transformers

2. NEMA ST 1: Specialty Transformers

3. NEMA ST-20: Dry-Type Transformers for General Applications

B. Underwriters Laboratories (UL): UL 506 - Standard for Safety Specialty Transformers.

C. American National Standards Institute/National Fire Protection Association ANSI/NFPA): NFPA No. 70 -National Electrical Code (NEC); Article 450 - Transformers and Transformer Vaults.

1.03 SUBMITTALS

A. Submit the following under provisions of Section 01330 – Submittal Procedures:

1. Outline dimensions, support points and unit weight.

2. Electrical characteristics, including impedance and tap configuration.

3. Insulation type, rated temperature rise, and total insulation system.

4. Test reports are required for equivalent of supplied transformers 300 KVA and above, indicating losses at 25, 50, 75 and 100 percent rated load and sound levels.

5. Connection diagrams.

6. Catalog data.

7. Operation and maintenance data.

1.04 QUALITY ASSURANCE

A. Tests. Run manufacturer's test on transformers in accordance with Underwriters Laboratories (U.L.) Standard No. UL-506.

1.05 DELIVERY, STORAGE AND HANDLING

A. Have transformers individually packed and crated to permit ease of handling and to provide protection from damage during shipping, handling and storage.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. ACME Transformer

B. Eaton/ Cutler Hammer

C. General Electric

D. Hevi-Duty

E. Schneider Electric

2.02 MATERIALS AND EQUIPMENT

A. Use dry-type transformers for lighting system or other general purpose applications, motor drive isolation, shielded isolation and non-linear load requirements.

B. Provide transformers with copper windings.

C. Select transformers designed and constructed in accordance with NEMA ST-1, NEMA ST-20 and the NEC Article 450.

D. For applications up to 30 KVA, use transformers that are encapsulated, non-ventilated type with 115 degree C temperature rise and 185 degree C insulation class.

E. Provide transformers with full capacity winding taps a minimum of two 2-1/2 percent above and two 2-1/2 percent below normal voltage.

F. For applications of 30KVA and above use transformers that are the drip-proof ventilated type for indoor mounting only.

G. Use transformers with sound levels in accordance with NEMA ST-20.

H. Basic impulse level (BIL) shall be 10KV for transformers less than 300 KVA, 30KV for transformers 300KVA and larger.

I. Ground core and coil assembly to enclosure by means of a visible flexible copper strap.

J. Provide transformers with lifting eye bolts or brackets.

K. Provide transformer nameplates of stainless steel, marked in accordance with NEC Article 450-11. Fasten nameplate to the transformers with stainless steel screws or rivets.

L. Refer to the one-line diagram or the Drawings for transformer size, volt and wire configuration.

M. Special purpose transformers shall be as follows:

1. Motor drive isolation transformers: designed for 3-phase SCR controlled, variable speed motor voltages with bracing to withstand stresses associated with motor drives.

2. Shielded isolation transformers shall be designed for power inputs to microprocessors and computers that require additional protection from electrical disturbances with the use of grounded electrostatic shielding.

3. Non-linear transformers shall be designed to withstand the heating effects caused by harmonics resulting from non-linear, non-sinusoidal loads. Use K-rated transformers for non-linear loads.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Verify dimensions of housekeeping pads or other support structures to ensure proper fit.

B. Verify raceway and wiring drawings that are prepared for the transformers and check them against the manufacturer's information.

C. Verify that the protective devices planned for the transformers are in accordance with NEC Article 450.

3.02 INSTALLATION

A. Install transformers plumb and level and in accordance with manufacturer's instructions and the NEC Article 450.

B. Use flexible conduit for connection to transformer case. Make conduit connections to side panel of enclosure.

C. Mount transformers on isolation pads as required to isolate transformer noise from the buildings structure.

D. Wire transformer primary and secondary in accordance with the nameplate instructions and the designated voltages as shown on the one-line diagram.

END OF SECTION

Section 16480

MOTOR CONTROL CENTER

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Specification for low voltage motor control center (MCC).

1.02 REFERENCES

A. American National Standards Institute/National Electrical Manufacturers Association (ANSI/NEMA)

1. ICS 1: General Standards for Industrial Control and Systems

2. ICS 2: Industrial Control Devices, Controllers and Assemblies

3. ICS 4: Terminal Blocks for Industrial Use

B. American National Standards Institute/Underwriters Laboratories, Inc. (ANSI/UL)

1. 467: UL Standard for Safety, Grounding and Bonding Equipment

2. 489: UL Standard for Safety, Molded-Case Circuit Breakers and Circuit-Breaker Enclosures

3. 506: UL Standard for Safety, Specialty Transformers

4. 845: UL Standard for Safety, Motor Control Centers

C. American National Standards Institute/National Fire Protection Association (ANSI/NFPA): 70 National Electrical Code (NEC).

1.03 SUBMITTALS

A. Submit the following under the provisions of Section 01330 – Submittal Procedures:

1. Outline drawings with elevations

2. Equipment arrangement drawings

3. Anchor bolt location drawings

4. Electrical schematics and wiring diagrams

5. Current, potential, and power transformer curves

6. Electrical fuse/circuit breaker characteristic

7. Equipment performance curves and data

8. Bill of installation/assembly materials

9. Equipment weights

10. Completed manufacturer's data sheets

11. Catalog data

12. Assembly/disassembly sizes and weights

13. Nameplate data

14. Performance/acceptance test report

15. Operation and maintenance data

1.04 QUALITY ASSURANCE

A. Tests. Perform tests in accordance with ANSI/NEMA ICS 2-322.22. Test each MCC as described in ANSI/UL 845. Make available upon request certified temperature and short-circuit test data, and a certificate of circuit breaker conformance with ANSI C37.16. Have tests and inspections performed and evaluated by qualified personnel. Document and correct deficiencies observed during the testing process prior to shipment.

1.05 DELIVERY, STORAGE AND HANDLING

A. Upon completion of the manufacture and assembly of the MCC and before crating for shipment, have parts that are disassembled match marked to facilitate installation in the field. Pack and crate parts in such a way to permit ease of handling.

B. Equip MCC shipping sections with lifting facilities so that may be easily unloaded and handled, either by crane or forklift.

C. Do not exceed 120 inches in length for shipping sections. Have equipment packed, crated, and rigidly braced to protect it from damage during shipment, handling, and outdoor storage. Make provision to energize the space heater of each shipping section during storage at

the jobsite. Make a connection point readily available without uncrating the equipment and clearly tag each shipping section to locate the connection and identify the electrical service required.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. Allen-Bradley

B. Eaton/ Cutler Hammer

C. Powell Electrical

D. Siemens

E. Schneider Electric

2.02 MATERIALS AND EQUIPMENT

F. Design. Provide an MCC with the following design characteristics:

1. The MCC construction and wiring shall be NEMA Class I, Type B as specified in ANSI/NEMA ICS-2-322.08 and ICS-2-322.10. Provide an MCC designed for 3-phase, 60 Hz, 480-Volt service with main horizontal and vertical bus ampacities and short circuit bracing as specified on the one-line diagram. Provide NEMA Class IIB wiring for interconnection wiring as specified on drawings.
2. Furnish an MCC designed to operate in service conditions described in NEMA ICS 1 and as shown on the one-line diagram.

3. Supply motor starters suitable for full voltage starting unless otherwise noted on the one-line diagram.

4. Construct the MCC of one or more vertical sections bolted together to form a free standing assembly, designed to permit future additions, changes, or regrouping of units.

5. Provide motor control units of the combination type, consisting of a motor circuit protector (MCP), a magnetic starter and a control power transformer. Size the MCP and starter in accordance with manufacturer's recommendation for the starter and motor size indicated on the one-line diagram.

6. When power factor correction capacitor is called for, connect its wiring to the line side of the overload relay with a set of fuses, a circuit breaker, or other acceptable means to serve as overload protection for the wiring and capacitor.

7. Manufacture main breaker (if used) and feeder breakers of the molded case, thermal-magnetic type to be mounted and wired in accordance with ANSI/UL 489.

8. If called for on the one-line-diagram, locate the lighting panelboard, transformer and transformer feeder breaker in the same vertical section. Supply a transformer with 115 degrees C temperature rise, installed in accordance with ANSI/UL 506.

G. Construction. Construct the MCC of self-supporting and fully enclosed metal clad section for mounting of motor starters, circuit breakers and necessary accessories including bus bars, control transformers, control switches, ground bus, and control wiring, as specified in this section and shown on the one-line diagram.

H. Enclosures

1. Construct each MCC enclosure to be fully metal enclosed, dead front, free standing, and NEMA 12 suitable for indoor service as defined in ANSI/UL 845 or NEMA 3R suitable for outdoor installation when indicated on the one-line diagram. Fabricate enclosure of sheet steel not less than 14 gauge with rear and end covers not less than 16 gauge; with adequate strength to withstand stresses imposed by short circuit current, shipping, handling, installation, and operation, without distortion or damage.
2. Construct frames of the enclosure structure with continuous steel barriers, extending from the front to the rear of each compartment for the controller units, buses and power cables.

3. Provide enclosures of suitable size for reduced voltage starting auto transformers and associated wiring, if required.

I. Vertical Sections

1. Make the structure 20 inches deep. Nominal vertical section dimensions are 20 inches wide by 90 inches high. Design each vertical section to accommodate not more than six NEMA Size 1 combination motor control units mounted one above the other in front-mounted arrangement.

2. Provided horizontal wiring space at the top and the bottom of each vertical section, which will line up with adjacent sections to

form continuous raceways through the entire length of the MCC. In addition, in standard sections include vertical wireways with hinged doors for unit wiring. Provide grommets at points wiring must cross cut-outs.

3. Use section structure designed for top or bottom cable entry as indicated on the one-line diagram. Provide adequate ventilation and heating facilities for each section to keep the maximum temperature rise and humidity within the acceptable limits.

J. Incoming Feed

1. Terminate incoming feeder cables in a main breaker or main lugs. Use top feed to main breakers whether either top or bottom MCC cable entry is specified.

2. The MCC will be fed from one 480V source, unless otherwise stated. Provide the necessary space for adequate bending radius and spreading room to properly train and terminate the cables specified on the Drawings. Where large (350 MCM and above) or parallel cables are used as feeders, provide a separate termination compartment alongside the main breaker for cable entry.

3. Provide a separate compartment with a hinged front access door and suitable space for terminations for incoming cables. Provide compression type lugs in the quantity shown on the diagram. Allow space for a cable bending radius not less than ten times the diameter of the cable. The cable size is shown on the one-line diagram. Install current transformers and phase monitor coils in this compartment on fixed horizontal mounting brackets. Do not loosely place coils around feeder cables.

4. Furnish surge protection devices as specified in Section 16290 - Primary Instrumentation Devices, located downstream from the main breaker or lugs. Mount surge arresters in an isolated, completely enclosed cubicle.

5. When shown on the one-line diagram, install a voltmeter and an ampere-meter with switches in the incoming feed section. Provide meters of the switchboard type with one percent accuracy, 4-1/2 inch diameter face with a minimum of 240 degree direct reading scale. A single electronic meter may be used in lieu of electro-mechanical meters.

K. Combination Starter Unit

1. Provide a standard combination motor starter unit which consists of a motor circuit protector (MCP), a magnetic motor starter, and an overload relay. Install starter and circuit protective device and control power transformer in a plug-in unit. The ratings of the components are shown on the one-line diagram.

2. Provide motor starters conforming to NEMA standards for the horsepower of the motors with which they are to be used and which are suitable for full voltage, across-the-line starting. Select starters with pickup and dropout voltages of not greater than 85 percent and 60 percent of rated voltage, respectively. Do not use a starter smaller than NEMA Size 1.

3. For NEMA size 4 and larger, provide vacuum-type contactors.

4. Select overload relays designed so that any attempt for reset immediately after operation cannot result in damage to the unit. Provide running protection for the motor and all other series components, based upon the tripping characteristics of the overload relay.

5. Utilize motor management relays of the solid state type with adjustable overload, phase unbalance and phase failure sensitivity. Refer to speciation 16662.

6. Starters shall have a minimum of one NC and one NO auxiliary contacts in addition to the seal-in contact.

7. Have reversing contactors and 2-speed starters both mechanically and electrically interlocked to prevent both contactors from being engaged at one time.

8. Provide an MCP of the magnetic type with a fault interrupting capability suitable for the complete starter unit.

9. Provide each combination starter unit with its own control power transformer with Class B insulation and 120 volt secondary.
10. Place fuses on the secondary side of control power transformers with one dual element fuse. Have control transformers separately fused on the primary side with two dual element fuses.

11. Unless otherwise called for on the one-line diagram, the minimum rating of the control power transformer shall have the capacity to operate all connected loads including motor space heaters. The minimum for the various sizes of starters, shall be as follows:

NEMA Size 1	150 VA
NEMA Size 2	150 VA
NEMA Size 3	250 VA
NEMA Size 4	500 VA

12. Connect the control power transformer so that it is de-energized when the circuit breaker is opened.

L. Reduced Voltage Starters

1. If reduced voltage starters are specified, provide the closed transition auto-transformer type.

2. Construct each reduced voltage auto-transformer starter unit with a molded-case circuit breaker in combination with a closed transition type auto-transformer starter with 50 percent, 65 percent, and 80 percent taps. Set the starter on the 65 percent tap. The starter shall have three phase overload relays and shall be ambient temperature compensated with manual reset. Include a thermal switch wired to protect the auto-transformer from overheating. Control timing of the starting period by an adjustable accelerating relay.

3. Provide heavy duty, NEMA type, autotransformers sized for a minimum of 125 percent of the motor load.

M. Terminal Blocks

1. Provide terminal blocks conforming to NEMA/ANSI ICS 4 type rated 600 volts, with screw type terminals to accommodate non-insulated ring tongue wire lugs for No. 18 through No. 10 size wire for field connection.

2. Use a sufficient number of terminal blocks so circuits for 480-volt and 120-volt service can be wired to a separate group of terminal blocks, making power and control circuit readily identified for safety during maintenance.

3. Wire all auxiliary contacts to terminal blocks.

N. Units

1. Equip each unit compartment with barriers to isolate it from adjacent devices in the control center and prevent communication of faults from one compartment to another.

2. All full voltage starter units through NEMA Size 5 and all feeder breakers through 400 Amp shall be of the draw-out push in/ pull out type. Draw-out provisions shall include a positive guide rail system and stab shrouds to absolutely ensure alignment of stabs with the vertical bus. Draw-out units shall have a tin-plated stab assembly for connection to the vertical bus. No wiring to these stabs shall extend outside of the draw-out unit.

3. Install an individual front door on each unit compartment. Make each door interlocking with the circuit disconnect so that the door may not be opened while the circuit disconnect is in a closed position. Provide a means for overriding this interlock.

4. Use padlocking arrangements that permit locking circuit disconnect in the open position with a minimum of three padlocks when the door is closed.

5. Arrange components so that removal of a starter or breaker unit does not require removal of its door, or the removal of an adjacent unit.

6. Place unit wiring diagrams in the print pocket on the inside of each unit door.

7. Furnish units designated as future or spare complete with guide rails, separator bars, doors, and operating hardware required to permit completion of the unit by the addition of a combination starter or feeder breaker unit.

8. For any unused space that is not suitable for the addition of a plug-in unit, fabricate and install a plain bolted sheet metal cover.

9. Identify electrical components, such as relays, breakers, terminal strips, and starters, with laminated nameplates as required in Section 16195.

O. Buses and Connections

1. Extend the main horizontal copper bus across the assembly to form a complete continuous bus. Support it in at least two places in each vertical section using glass-reinforced, polyester-type insulators which are impervious to moisture and adverse atmospheric conditions.

2. Fabricate buses from tin plated copper bars. Use buses designed to operate at individual rate full load current without exceeding a 50 degrees C temperature rise at 40 degrees C ambient temperature as defined in ANSI/UL 845. The

continuous current rating of the main and branch buses shall be as stated on the one-line diagram.

3. Bolt connections to main and branch buses. Make joints and contact surfaces free of burrs and irregularities.

4. Provide tin-plated, compression-type cable connectors (NEMA 2-hole) for each bus bar in the main feed cubicle. Select connectors of adequate size and quantity for the feeder cables.

5. Make provision for extension in both directions for future sections.

6. Install both main and branch buses so they are phased in the order A-B-C from front-to-rear, top-to-bottom, and left-to-right as viewed from the front of the MCC.

7. Have a copper ground bus extend the full length of the MCC near the bottom, with provision for extension into future sections. It shall be amp rated at a minimum of 25 percent of horizontal power bus. Provide compression lugs on each end of the ground bus for connection of the grounding copper conductor. Permanently ground the non-current carrying metal parts of equipment within each MCC through the ground bus in accordance with ANSI/UL 467. Terminate ground cables to the ground bus by means of the connectors.

8. The vertical bus shall be completely isolated and insulated by means of a labyrinth design barrier. It shall effectively isolate the vertical buses to prevent any fault-generated gases to pass from one phase to another. The vertical bus shall include a shutter mechanism that will allow the unit stabs to engage the vertical bus every 6 inches and provide complete isolation of the vertical bus when a unit is removed. Provide one shutter mechanism for all future spaces and covers for the balance of openings.

P. Wireways

1. Provide each section with horizontal wiring space at both the top and bottom. Make wiring spaces line up with adjacent sections to form a continuous wireway for the entire length of the MCC.

2. In addition, provide each section with a wireway space at least 4 inches wide between the units and side unit wiring. Secure the wireway with a tight fitting hinged access door of formed sheet metal. Furnish wire straps in the vertical wireway to group

individual conductors. Tie wires securely in place for a neat, orderly installation.

3. Completely enclose both horizontal and vertical wireways and isolate them from exposure to any live parts.

4. Use control wiring that is a minimum No. 14-AWG copper, 600 volts, tin plated, Type TA, TBS or SIS as defined in ANSI C37.30.6.
5. For current transformer wiring, use No. 10 AWG copper which is otherwise, the same as control wiring.

6. Power and control cables may enter the MCC only at bottom. Provide suitable opening in bottom of MCC for cable entry. Collect power and control cables neatly in separate bundles.

7. Make wires continuous between terminals and other connections, without splices.

8. Identify wiring at both ends with same number, machine printed on heat shrink type sleeves as specified in Section 16195 - Electrical Identification.

Q. Control Devices

1. Provide heavy duty oil tight pushbuttons, selector switches and indicating lights as specified on drawings.

2. Provide indicating lights which are push-to-test LED type with transformer and 100,000 hour lamp life.

R. Space Heaters: Install thermostat controlled electric space heaters to prevent condensation of moisture in the control centers. The rated voltage of these heaters shall be double the voltage applied. Make thermostats adjustable, and set to cut out when the temperature rises to an ambient of 30 degrees C (240 volt rated space heaters operated on 120 volt which power is derived from a local panelboard).

S. Nameplates

1. Use engraved phenolic with black lettering and white background for nameplates on individual units as well as the main nameplate for the assembly.

2. Make MCC compartment nameplates 1" x 3" with approximately 1/4 inch high lettering. Make MCC main nameplates 8" x 2" with 1 inch high lettering. Secure nameplates with self-tapping stainless steel metal screws.

3. Provide a blank nameplate for spare compartments.

4. Word nameplate captions as indicated on the one-line diagram.

5. Label all components in the MCC with phenolic nameplates as required in Section 16195.

T. Markings – Hazard Warnings

1. Manufacturer shall provide Manufacturer's Markings as specified in NEC 110.16.

2. Manufacturer shall provide Field-Applied Hazard Markings according to NEC 110.21(B).

U. Finish

1. Thoroughly clean the inside and outside of the MCC of foreign matter, excessive oxide, scale, weld spatter, and flux. Repair fabricating scars and rough edges by welding and grinding before painting, followed by heat treatment, if required by the governing code or standard.

2. Give a finish coat of manufacturer's standard enamel for compartment doors, cover plates, and structural parts of the MCC. Do not apply paint or filler until repairs, tests, and final shop inspection are completed. Epoxy based powder coat is acceptable.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Verify dimension of the housekeeping pad and the embedded leveling channels and conduit stub-ups.

3.02 INSTALLATION

A. Install the motor control center in accordance with the manufacturer's published instructions.

B. Torque bus bar bolts to manufacturer's recommendations and tighten nuts and bolts on the steel structure to ensure structural integrity.

C. Adjust the magnetic setting on motor circuit protectors in accordance with motor inrush currents (nameplate data).

D. Select and install motor starter overload relay heater coils based on motor nameplate data.

E. Touch up scratches and verify data on nameplates.

F. Install warning labels on Motor Control Centers as required in Section 16195, 2.02, F.

END OF SECTION

Section 16510

LIGHTING FIXTURES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Specification for:

1. LED lighting fixtures

2. High intensity discharge (HID) lighting fixtures

3. Emergency lighting fixtures

4. Exit fixtures

5. Incandescent lighting fixtures

6. Photo cells

1.02 REFERENCES

A. American National Standards Institute/National Fire Protection Association (ANSI/NFPA)

1. No. 70 - National Electrical Code (NEC)

a) Article 410 - Lighting Fixtures, Lampholders, Lamps and Receptacles

b) Article 500 - Hazardous (classified) locations

c) Article 700 - Emergency Systems

2. No. 101 - Life Safety Code

B. American National Standards Institute (ANSI)

1. C78.379 - Electric Lamps - Incandescent and High Intensity discharge Reflector Lamps - Classification of Beam Patterns.

2. C82.4 - Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).

C. American National Standards Institute/Illuminating Engineering Society (ANSI/IES): The IES Handbook shall be used as a basis for design and construction of lighting systems.

D. American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc./Illuminating Engineering Society (ASHRAE/IES): ASHRAE/IES 90.1 - 1989 - Energy Efficient Design of new Buildings Except Low-Rise Residential Buildings.

E. American National Standards Institute/Underwriters Laboratories (ANSI/UL).

1. UL8750 - LED Lighting Fixtures.

2. UL1571 - Incandescent Lighting Fixtures.

3. UL1572 - High Intensity Discharge Lighting Fixtures.

4. UL844 - Fixtures for Hazardous Areas.

1.03 SUBMITTALS

A. Submit the following under the provisions of Section 01330 – Submittal Procedures:

1. Outline dimensions, support points and unit weight.

2. Operation and maintenance data.

3. Complete test report with photometric curves.

4. Storage, handling, and installation recommendation.

5. Connection diagrams.

6. Catalog data.

1.04 QUALITY ASSURANCE

A. Tests. Run manufacturer's tests on lighting fixtures in accordance with applicable Underwriters Laboratories (U.L.) Standards 1570, 1571 and 8750

1.05 DELIVERY, STORAGE AND HANDLING

A. Have lighting fixtures individually packed to permit ease of handling and to provide protection from damage during shipping, handling and storage.

PART 2 P R O D U C T S

2.01 ACCEPTABLE MANUFACTURERS

A. Benjamin Div., Thomas Industries

B. Crouse-Hinds, Div. of Cooper Industries

C. G.E. Lighting System

D. Guth Lighting

E. Holophane Company, Inc.

F. Hubbell Lighting, Inc.

G. Killark Electric Mfg. Company

H. Lithonia Lighting

I. Pauluhn Electric

J. Wide-Lite Corporation

K. Dual-Lite Company

2.02 REQUIREMENTS

A. Provide lighting fixtures in accordance with the lighting plan Drawings and Lighting Fixture Schedules.

PART 3 E X E C U T I O N

3.01 INSTALLATION

A. Install fixtures in accordance with manufacturer's instructions, NEC Articles 410, 500 and 700 as applicable, and the Drawings.

B. Wire up fixtures in accordance with the Drawings and ensure proper switching, circuiting and balanced loads.

C. Make sure proper grounding and bonding are provided for fixtures and raceways.

D. Install specified lamps in each fixture.

E. When applicable, aim and adjust fixtures in accordance with directions as indicated on the Drawings.

F. Energize and test fixtures for proper operation.

G. Check the illumination level with a light meter and ensure that sufficient light is reaching areas where tasks are performed and that egress paths are properly illuminated during emergency situations.

END OF SECTION

SECTION 16663

MOTOR PROTECTION RELAY

PART 1 G E N E R A L

1.01 CONDITIONS

A. This specification is issued for this specific project only. Reproduction of this document for any other purpose is prohibited.

B. Contractor shall comply with Section 3.07, A, 3 of this specification before bidding.

1.02 SUMMARY

A. Section Includes:

1. Motor Protection Relay (MPR) and related devices commonly used with them.

2. Programming Requirements.

1.03 REFERENCES

A. National Fire Protection Association (NFPA): NFPA 70-90 - National Electrical Code (NEC).

1.04 DEFINITIONS

A. Motor Protection Relay (MPR): Primary protective function shall be the thermal model consisting of the following elements:

1. Overload curves

2. Negative sequence unbalance/single phase bias

3. Motor cooling time constants.

1.05 SUBMITTALS

A. Shop Drawings:

1. Motor Protection Relay showing dimensions and features including installation details.

2. Current and potential transformers showing dimensions and

features including installation details.

B. Product Data:

1. Product data for Motor Protection Relay, C.T's, P.T.'s and accessories specified in this Section, including descriptive data and C.T. ratios.

2. Include parts list.

C. Test Results: Certified reports of field tests and observations.

D. With each submittal, include a copy of the applicable specification(s) page(s) for the item submitted and mark "Complies" or "Non-Compliance" or "Exception" adjacent to the applicable paragraph. Identify applicable drawing sheet number and specification section on front of each submittal cover.

1.06 QUALITY ASSURANCE

A. Items provided under this section shall be listed and labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.

2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.

B. Regulatory Requirements:

1. Components and Installation:

a) NFPA 70 "National Electrical Code (NEC)."

b) Local codes and ordinances.

C. Single-Source Responsibility: Not Applicable.

1.07 MAINTENANCE

A. Extra Materials:

1. Maintenance Stock, Spare Parts: As recommended by Manufacturer.

PART 2 P R O D U C T S

2.01 MOTOR PROTECTION RELAY (MPR) / REMOTE DISPLAY

A. General: Provide MPR in indicated type, as integral components of motor control centers; and also as individually enclosed and mounted single units.

B. Designed to monitor and protect any 3-phase, 200-480VAC motor drawing 1-800 full load amps (external CTs are required for motor current draw above 9 FLA).

C. A 3-digit LED display that is used for programming, real-time operational information and displaying diagnostic codes and aid in troubleshooting a fault condition.

D. Features protection 3-phase motors from:

1. Voltage single-phase/phase loss
2. Phase reversal
3. Low voltage
4. High voltage
5. Voltage unbalance
6. Rapid cycling
7. Undercurrent
8. Overcurrent
9. Current unbalance
10. Current single-phase/phase loss
11. Low control voltage
12. Ground fault
13. Contact failure
14. Low power
15. High power

E. Communication Capabilities:

1. Modbus RTU

2. Modbus TCP

3. DeviceNet

4. Profibus

F. The Equipment interface shall have the capability of connecting to the following systems:

1. HMI (Human-Machine Interface)

2. SCADA (supervisory Control and Data Acquisition)

3. DCS (Distributed Control System)

4. PLC (Programmable Logic Controllers)

5. SymCom Model RM-1000 Modbus remote display

G. Manufacturer: SymCom

H. Model: 777-LR-P2 Surface or DIN rail mount

I. Display Model: RM-1000

2.02 CURRENT TRANSFORMER (CT)

A. Motor 9 amp and above, phase current CT's shall be provided for all three phase legs. CT rating shall be determined based on the size of manufacturer's motor FLA.

2.03 SOFTWARE

A. Manufacturers programming, operation, maintenance and data analysis software shall be included in MPR equipment package. Complete instructions and any special equipment required for installation, setup, programming, operation, maintenance and data analysis shall be provided as part of the MPR equipment package. Special cables, plugs and adaptors for loading and downloading data to a computer shall be included.

B. All programming and startup shall be done by qualified and certified technician.

C. All programming will be coordinated with Motor Manufacturers and shall

conform to their standards.

PART 3 E X E C U T I O N

3.01 INSTALLATION

A. MPR / REMOTE DISPLAY

1. Install MPR as shown on plans or as described in specifications.

2. Installation shall be done according to manufacturer's recommendations.

3. Locate as indicated and install in accordance with manufacturer's written installation instructions.

4. Provide devices and connections to MPR as shown on plans.

5. Provide remote display and connect to MPR via RS-485

B. Current Transformer: CT's shall be rated for current parameters and shall be installed according to the manufacturer's recommendations with hardware intended for mounting CT's.

3.02 IDENTIFICATION

A. Identify components and wiring in accordance with Section 16195 – "Electrical Identification".

3.03 CONTROL WIRING INSTALLATION

A. Wiring to CT's shall be installed according to related NEMA and NEC standards and codes. All wiring to be rated for application and shall be neatly bundled and secured with clamps. All wires are to be terminated with proper lugs. C.T. lugs shall be ring type only.

3.04 CONNECTIONS

A. Check connectors, terminals, bus joints, and mountings for tightness.

B. Tighten field-connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

3.05 GROUNDING

A. Provide equipment grounding connections for individually mounted Overcurrent Protective Devices (OCPD) units as indicated and as required by NEC. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.06 COORDINATION STUDY

A. Where coordination study recommends changes in types, classes, features or ratings of equipment or devices indicated, make written request for instructions. Obtain instructions from Engineer before ordering equipment or devices recommended to be changed.

3.07 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

1. Supplier's or manufacturer's technician for equipment specified herein shall be present at job site or classroom designated by Owner for minimum of one (1) workday, travel time excluded, for assistance during plant construction, plant startup, equipment adjustment, and training of Owner's personnel for plant operation. Include minimum of:

a) One man-day for Instructional Services.

2. Supplier or manufacturer shall direct services to specific system and equipment operation, maintenance, and troubleshooting.

3. Programming of the Motor Protection Relay alarm and trip set points and all testing shall be performed by manufacturer representative or certified technician.

4. All of the motor data available from the manufacturer, including overload curves and thermal characteristics, and all motor circuit information must be furnished by the Contractor to the Engineer a minimum of two weeks prior to programming of SymCom unit.

B. Testing:

1. Reports: Prepare certified written reports on tests and observations. Report defective materials and workmanship and unsatisfactory test results. Include complete records of repairs and adjustments made.

2. Labeling: Upon satisfactory completion of tests and related effort, apply label to tested components indicating test results, date, and

responsible person.

3. Schedule visual and mechanical inspections and electrical tests with at least one (1) week advance notification.

4. Pre-testing: Upon completing installation of system, perform following preparations for tests:

   a) Make insulation resistance tests of OCPD buses, components, and connecting supply, feeder, and control circuits.

   b) Make continuity tests of circuits.

   c) Include full updating on final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.

   d) Comply with manufacturer's instructions for installation and testing of OCPDs.

5. Visual and mechanical inspection: Include following inspections and related work.

   a) Overcurrent-Protective-Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system arrangement and parameters. Where discrepancies are found, test organization shall recommend final protective device ratings and settings. Use accepted revised ratings or settings to make final system adjustments.

6. Retest: Correct deficiencies identified by tests and observations and retest. Verify by system tests that specified requirements are met.

3.08 CLEANING

A. Upon completion of installation, inspect MPR. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

END OF SECTION

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