



Pre-Purchase of Horizontal Split Case Pumps
for the
Central Water Integration Pipeline Project

SAWS Job No. 18-8616
Solicitation No. 18- 18091

RELEASED FOR BID
JUNE 2018

DIVISIONS 1, 11



Tetra Tech, Inc.
Texas Registered Engineering Firm No. 3924
700 North Saint Mary's Street, Suite 300
San Antonio, Texas 78205



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DIVISION 11

EQUIPMENT

SECTION 11110

HORIZONTAL SPLIT-CASE CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This specification describes the equipment, materials, and incidentals required for the horizontal split-case pumps package for the Stone Oak Pump Station to be furnished by a single responsible Pump Manufacturer for installation by Others (Contractor). The Pump Manufacturer will be required to provide pumps, drivers, motors and drive arrangements with seals, couplings, base plates, guards, supports, anchor bolts and appurtenances as shown on the Drawings and specified in this Section, including vibration switches, and RTDs as shown on the P&IDs.
1. Provide four (4) horizontally mounted, axial split-case, single stage, double suction, centrifugal pumps for the Stone Oak Pump Station.
 - a. Equipment Tags: 50-PMP-01, 50-PMP-02, 50-PMP-03, 50-PMP-04
- B. The unit shall be furnished with all necessary accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not, and as required for an installation incorporating the highest standards for the type of service, including field testing and instructing the regular operating personnel in the care, operation, and maintenance of all equipment.
- C. The Pump Manufacturer will be selected and issued a Purchase Order by the Owner for early submittal of shop drawings prior to advertising and bidding of the Terminus Treatment Facilities Bid Package, which will be awarded to a General Contractor, referenced herein as Contractor. The Pump Manufacturer shall be responsible for coordination with the construction schedule of the Contractor to ensure that equipment is delivered to the site in accordance with the Contractor's schedule. The Pump Manufacturer shall also coordinate with the Contractor to ensure that all related systems furnished under the Contractor's scope of work will form a complete integrated operating system. The Pump Manufacturer for this project shall coordinate the pumps with the equipment as described herein and on the drawings supplied by the Contractor, and their manufacturers.
- D. The Pump Manufacturer shall confirm the pump rotation from the plans prior to manufacture.

1.02 RELATED WORK

- A. Section 01300 Submittals
- B. Section 01600 Material and Equipment
- C. Section 01640 Manufacturer's Field Services

- D. Section 01730 Operation and Maintenance Data
- E. Section 01752 Facility Startup Commissioning Requirements
- F. Section 16151 Large Induction Motors

1.03 DEFINITIONS

- A. Relevant terminology shall be defined according to the American National Standard for Centrifugal Pumps for Nomenclature, Definitions, Application and Operation; and the Hydraulic Institute Standards (HI) ANSI/HI 1.1-1.5.

1.04 SUBMITTALS

- A. Pre-Purchase Contract Schedule: It is anticipated that this pre-purchase contract will follow the approximate schedule below:
 - 1. Submittals- Preliminary (with the bid)
 - 2. Purchase Order for Submittals Only: July 13, 2018
 - 3. Submittals – Level 1: August 1, 2018
 - 4. Submittals – Level 2: August 31, 2018
- B. All submittals shall use English units and shall be written in English.
- C. Submittals shall be made in accordance with the requirements in Section 01300 and as specified herein.
- D. The Pump Manufacturer shall submit the following with the bid:
 - 1. Certified dimensional drawings and weights of each item of equipment and auxiliary apparatus to be furnished, including pump, motor and base plate.
 - 2. Submit Manufacturer's certified rating curves for each pump, showing pump characteristics for discharge head, Allowed Operating Range (AOR), Preferred Operating Range (POR), capacity, brake horsepower, pump efficiency at the "rated" point, pump efficiency curve for pump, and guaranteed net positive suction head required (NPSHR) over the entire range of pumping requirements. This information shall be prepared specifically for each pump provided. Catalog sheets showing a family of curves will not be acceptable.
 - 3. Submit motor data sheets per Section 16151, Part 1.03.C.1-10.

- E. The Pump Manufacturer shall submit the following with Level 1 submittals (August 1, 2018):
1. Submit pump/motor coupling manufacturer, model number, AGMA 9002-A clearances and tolerances.
 2. Cross-sectional drawings with detailed construction of each component in the pump along with the ASTM material designations.
 3. Bill of materials.
 4. Shaft seal drawing and shaft coupling.
 5. Certified pump support and anchor bolt plans and details.
 6. Materials certifications for castings, impellers, shafts, and shaft sleeves.
 7. Submit hydraulic thrust and radial load calculations along with L10 bearing life calculations of each bearing. L10 bearing life is 100,000 hours.
 8. Shaft design calculations along with worst case shaft deflections at the wear rings and at the mechanical seals.
 9. Data sheets applicable to proposals, purchase, and as-built drawings.
 10. Certified drawings of auxiliary systems.
 11. Forces and moments analysis, along with thrust calculations at the pump feet and at the anchor bolts. Also provide certified pump support and anchor bolt plans and details.
 12. Manufacturer's installation instructions.
 13. Factory test procedure.
 14. Schedules for factory witness testing.
 15. Factory test book per Paragraph 2.24.D.
 16. Motor data per Section 16151.
 17. Preservation; packing, and shipping-procedures per Section 01730.
 18. QA/QC program as described herein.
 19. Spare parts recommendations and price lists.
 20. Material safety data sheets.
- F. The Pump Manufacturer shall submit the following with Level 2 submittals (August 31, 2010):
1. Electrical and instrumentation schematics, wiring diagrams, and bills of materials.
 2. Electrical and instrumentation arrangement drawings and lists of connections.
 3. Drawings of bearing temperature sensors (RTDs), location and mounting details.
 4. Drawings of oil level alarm switches.

- G. The Pump Manufacturer shall submit the following with Level 3 submittals:
1. Certified test data for-factory acceptance testing.
 2. Certified hydrostatic test data.
 3. Vibration analysis data for pump and motor.
 4. Natural frequency analysis calculations.
 5. Torsional analysis calculations.
 6. Noise test results of factory test.
 7. Manufacturing progress reports.
 8. Certified motor test data as specified in Section 16151.
 9. Installation operations and maintenance manuals per Section 01730. Manuals shall include data for each pumping unit, including pump and motor.
 10. Report of installation, inspection, testing, and observations for each pumping unit.
 11. Letter of Certification.

1.05 REFERENCE STANDARDS

- A. Design, manufacture, and assembly of elements of the equipment herein specified shall be in accordance with, but not limited to, current published standards of the following, as applicable:
1. American Bearing Manufacturer's Association (ABMA).
 2. American Gear Manufacturer's Association (AGMA).
 3. American Institute of Steel Construction (AISC).
 4. American Iron and Steel Institute (AISI).
 5. American Society of Mechanical Engineers (ASME).
 6. American National Standards Institute (ANSI).
 7. American Society for Testing Materials (ASTM).
 8. American Welding Society (AWS).
 9. Anti-Friction Bearing Manufacturer's Association (AFBMA).
 10. American Water Works Association (AWWA).
 11. Hydraulic Institute Standards (HI).
 12. Institute of Electrical and Electronics Engineers (IEEE).

13. Instrumentation, Systems, and Automation Society (ISA).
14. International Standards Organization (ISO).
15. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS).
16. National Electrical Code (NEC).
17. National Electrical Manufacturer's Association (NEMA).
18. NSF International Strategic Registrations, Ltd. (NSF).
19. NSF Standard 61 - Drinking Water System Components.
20. Occupational Safety and Health Administration (OSHA).
21. Society of Automotive Engineers (SAE).
22. Steel Structures Painting Council (SSPC).
23. Underwriters' Laboratories, Inc. (UL).

1.06 QUALITY ASSURANCE

- A. The equipment covered by these Specifications is intended to be standard pumping equipment of proven ability as manufactured by reputable companies having extensive experience in the production of such equipment. The equipment furnished shall be designed and constructed in accordance with the best practice and methods, and shall operate satisfactorily when installed as shown on the Drawings. The manufacturer of the pump units shall have a quality management system in place and shall be ISO 9001 and 14001 certified.
- B. The Pump Manufacturer shall be fully responsible for the design, arrangement, and operation of all connected rotating components, including soleplates, if any, of the assembled pumping unit mounted on a fabricated steel base plate to ensure that neither harmful nor damaging vibrations occur at any speed within the specified operating range.
- C. The new high service water pumping units shall be complete, including pump, motor, RTDs, and terminal boxes. The high service water Pump Manufacturer shall be responsible for the furnishing and performance of the complete pumping units.
- D. The Pump Manufacturer shall have furnished pumping units in the United States which are similar in design, type, and service, and comparable in size, head, and capacity to those specified to be furnished. Such comparable pumping units shall have been in satisfactory operation for a period of not less than five years.
- E. The Pump and Motor Manufacturers shall currently have maintenance and repair facilities established and in operation in the United States for a period of not less than three years. Such facilities shall be fully equipped and staffed with qualified personnel for

making repairs to damaged pumps and motors shall stock or have direct access to a full line of maintenance spare parts.

F. Vibration:

1. The Pump Manufacturer shall review the Specifications and Drawings, including piping, pipe supports, harnessing arrangements, and foundations to fully evaluate the field installation conditions prior to bidding.
2. Acceptable field vibration and factory vibration limits shall be in accordance with the latest version of the HI Standards. Vibrations in excess of specified limits shall not be acceptable.
3. The Pump Manufacturer's field representative shall measure and record unfiltered vibration amplitudes in velocity units in/sec rms at each of the pump and driver bearing housings in two planes in a radial orientation and in one plane axially. The amplitude measured shall not exceed the limit specified above at any point within the pump's Preferred Operating Range (POR), and it shall not exceed 130% of the limit at any point outside the POR but within the Allowable Operating Range (AOR).

G. Services of Manufacturer's Representative:

1. Provide services of Pump Manufacturer's factory service Engineer specifically trained in the installation, operation, and maintenance of pumping units as specified herein. The services of the Manufacturer's Representative shall be made available during the installation period for assistance to the Contractor for adjusting and checking equipment.
2. The factory representative(s) shall be provided for trips and durations as shown below.

	<i>Services Provided by Factory Representative</i>	<i>Minimum Number of Trips ^{(a),(b)}</i>	<i>Minimum Time at Site Per Trip (Hours)</i>
1	Supervise Setting of Pump Bases, Installation of Pumps, and Check Pump Leveling and Pre-Alignment ^(c)	1	8
2	Inspect Final Pump Alignment ^(d) , Supervise Startup and Initial Run to Demonstrate Successful Operation, Instruct Engineer and Owner's Reps in Proper Startup and O&M	1	8
3	Additional Trips for Troubleshooting Following Installation ^(e)	-	-

(a) Representative(s) shall be present at frequent enough intervals to ensure proper installation, testing, and initial operation of the equipment.

(b) This assumes all pumps are shipped together. Additional trips shall be included for additional shipments.

(c) Before piping connection.

(d) After piping connection. The Manufacturer's representative shall provide to the Design Engineer a written certification that each pump has been installed in accordance with the Manufacturer's recommendations.

(e) Representative(s) shall be present as necessary to operate successfully following start-up. Additional trips/duration address issues associated with equipment defects will be at the cost of the manufacturer.

- H. Casting Quality Assurance/Control: The Pump Manufacturer shall submit an internal quality control - quality assurance program for the review by the Design Engineer. As a minimum the QA/QC program shall include the following:
1. Before manufacture:
 - a. A list of all subcontractors/suppliers outside of the contiguous United States that will be supplying parts and materials for the pumps, and their experience on similar projects for the past 10 years. The list of subcontractors is to be provided within 45 days of the Pump Manufacturer's Purchase receipt of Purchase Order.
 - b. Copies of a dimensional control protocol to establish the manner in which the machining of the castings will be performed, and the control for dimensions for the upper and lower casing castings and the impeller casting.
 - c. Copies of the quality control protocols and reports to confirm that the patterns have been correctly produced.
 2. After manufacture:
 - a. Three-dimensional checks to confirm that castings are within Pump Manufacturer's standards. Copies of all reports are to be provided to the Design Engineer for review.
 - b. For each heat number, the mechanical properties of the pour.
 - c. For each heat number, the chemical composition of the pour.
 - d. Documentation of all heat numbers and pours for the project, to include those castings that were scrapped by the foundry.
 - e. Photographic documentation that the castings comply with the requirements of MSS SP-55.
 - f. Copies of magnetic particles test reports or Hydro and visual reports for the volute and impeller.
 - g. Copies to the protocols for hydrostatic testing and copies of the hydrostatic testing reports.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. The Pump Manufacturer shall provide unloading, storage, and handling instructions prior to shipment.
- B. Pumping units shall be shipped with the motor space heaters connected to a terminal board and ready to be energized.
- C. All equipment shall be delivered in good, sound condition, and free from damage. Equipment which has been damaged will be rejected. Pump Representative shall be on the site to witness the arrival, inspection, and unloading process as specified.

- D. The Contractor shall be responsible for proper unloading, handling, and storage of equipment in accordance with the Manufacturer's instructions.

1.08 MAINTENANCE

- A. Pump Spare Parts: Furnish the Manufacturer's standard set of spare parts for each size pump, including at least the following:
 - 1. One set of pump bearings.
 - 2. One complete mechanical seal.
- B. Motor/Coupling Spare Parts: Furnish the Manufacturer's standard set of spare parts for each size pump, including at least the following:
 - 1. One spare gasket to fit between coupling hub flanges.
 - 2. One complete flexible couplings.
- C. Spare Parts Delivery/Storage: Crate and deliver spare parts in substantial wood boxes with hinged covers. Clearly and indelibly identify the contents of each box on its exterior. Each part shall be sealed, wrapped, or otherwise protected from corrosion during storage.

1.09 PERFORMANCE GUARANTEE

- A. The Manufacturer shall guarantee the performance of each pumping unit to meet or exceed the specified performance. The guarantee shall include the complete pumping unit assembly, and shall cover speed, capacity, head, efficiency, brake horsepower, motor horsepower, and the performance curves for the pump. The capacity, head, and efficiency guarantee shall apply to the Rated Point (Primary Condition) on the pump's head capacity curve at the specified head and capacity specified herein. If the pumping units fail to meet the efficiency at Rated Point, corrective measures shall be taken as indicated in Part 2.

1.10 WARRANTY

- A. The Pump Manufacturer's warranty period shall be concurrent with the Contractor's for two (2) years, commencing at the time of final acceptance by the Owner which shall begin no later than April 15, 2020. Guarantee shall cover all necessary labor, equipment, materials, and replacement parts resulting from faulty or inadequate equipment design, improper assembly, defective workmanship and materials, leakage, breakage or other failure of all equipment and components furnished by the manufacturer.

PART 2 PRODUCTS

2.01 GENERAL

- A. Manufacturer List, no equals:
 - 1. Fairbanks Nijhuis
 - 2. Flowserve, Inc.
 - 3. Goulds
 - 4. Patterson
 - 5. Sulzer

- B. Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.

2.02 PERFORMANCE AND DESIGN CRITERIA

- A. Pumping units shall be designed for the operating conditions as follows:

<i>Pump Tag</i>	<i>50-PMP-01, 50-PMP-02, 50-PMP-03, 50-PMP-04</i>
Design Points:	
Primary Condition (2 pumps) ^(a) :	
Capacity per pump:	5,208 gpm (7.5 MGD)
Total Design Head (TDH)	249 ft
Minimum NPSHA:	70.7 ft
Minimum Pump Efficiency	82%
Secondary Condition ^(a) :	
Capacity per pump:	4,632 gpm (6.7 MGD)
Total Design Head (TDH):	257 ft
Maximum NPSHA:	70.6 ft
Minimum Pump Efficiency	80%
Low flow condition ^(a) :	
Capacity per pump:	5 MGD
Total Design Head (TDH):	284 ft
Maximum NPSHA:	90.7 ft
Minimum Pump Efficiency	70%
Operating head range for full speed continuous operation	200-280 ft
Minimum shutoff head	290 ft
Maximum nominal pump speed.	1,800 rpm

Maximum power required at pump input shaft at any point from minimum operating head to shutoff head.	415 bhp
Pump rotation as viewed from driven end	See drawings
Minimum pump suction nozzle size	12 in
Minimum pump discharge nozzle size	10 in

^(a) The conditions listed shall operate within the pump's preferred operating range (POR), as described per HI Standard 9.6.3.

- B. All specified conditions shall be at rated speed, unless otherwise indicated.
- C. The minimum hydrostatic test pressure shall be 1.5 times shutoff head.
- D. The pump manufacturer shall account for up to 2 minutes of ball valve travel time to account for the duration of run time at shutoff head conditions.

2.03 CASINGS

A. Materials:

1. Pump casings shall be cast iron conforming to ASTM A48.
2. 125 lb flange rating – ANSI/ASME B16.1, Class 125 raised-face dimensions and drilling.

B. Design/Fabrication:

1. Casings shall be of sufficient thickness and suitably ribbed, if necessary, to withstand all stresses and strains to which it may be subjected during erection, testing, and operation.
2. Casings shall be of sufficient strength, weight and thickness to provide accurate alignments and prevent excessive deflection.
3. Free of blowholes, sand holes, and other detrimental defects, with smooth water passages.

C. Split-Case Provisions: Casings shall be split on the horizontal centerline with suction and discharge nozzles cast integrally with the lower half. Removal of the upper half of the casing shall allow the rotating element to be removed without disconnecting the suction and discharge flanges or without disturbing pipe connections or pump alignment. Lifting eyes or lugs shall be cast into the upper casing. Provide tapped holes in flange of upper casing with jack bolts that allow the casing halves to be separated during disassembly.

D. Taps and plugs: Casings shall be tapped for drains, vents, priming, water seal, and pressure gages. All taps shall be shipped with brass plugs. Plugs will be removed in the field, as necessary, to make connections for the miscellaneous piping and appurtenances. Provide a 3/4" tap in the top of the volute for an air release valve.

- E. Finishes: Apply special interior coating as specified under Paragraph 2.22, Interior Finish for Casings.

2.04 IMPELLERS

- A. Materials: Entirely made of nickel aluminum bronze ASTM B148 UNS C958 or AISI Stainless Steel Type 316.
- B. Type: Double suction, enclosed type.
- C. Design/Fabrication:
 - 1. Designed with ample strength and stiffness for maintaining the maximum capacity of the unit.
 - 2. The impeller shall be a one-piece casting completely machined on all exterior surfaces and dynamically balanced. The interior water passage shall have uniform sections and smooth surfaces and shall be free from cracks and porosity.
 - 3. Statically and dynamically balanced to prevent whipping and vibration throughout the operating range, from shutoff head to run out. Perform a precision balance of the entire rotating assembly to ANSI S2.9, G6.3 and provide the balance certificate in the quality control section of the O&M Manual.
 - 4. Pump impeller assemblies shall be statically and dynamically balanced to within 0.5% or W times R squared, where W equals weight and R equals impeller radius.
 - 5. No fillers of any type will be allowed.
- D. Mounting: The impeller shall be mounted on the shaft with a single key which extends beyond the impeller hub, locking the impeller and shaft sleeves against rotation on the shaft.

2.05 WEAR RINGS (CASING AND IMPELLER)

- A. Each pump casing and impeller shall be fitted with removable wearing rings.
- B. Materials:
 - 1. Casing Wear Rings: AISI Type 316 Stainless Steel
 - 2. Impeller Wear Rings: Match impeller material as specified above.
 - 3. Casing Wear Rings and Impeller Wear Rings shall have a Brinell hardness difference of 50.
- C. Type: Full labyrinth double-ring type, single labyrinth double-ring type, or "L" double-ring type.

- D. Design/Fabrication:
1. The casing wear rings shall be positioned in the casing and locked against rotation by the upper half of the case.
 2. Wear rings shall be designed and machined to close tolerances to minimize leakage. The diametrical clearance shall not exceed 0.030-inch, and be not less than 0.001-inch per inch of ring diameter.

2.06 SHAFT

- A. Materials: High Grade Alloy 416 Stainless Steel.
- B. Design/Fabrication:
1. Stress relieved, machined to true dimension, accurately ground and polished over the entire length.
 2. The shaft shall be provided with oil throwers or Inpro seal to prevent oil creeping from the bearings. All parts shall have polished surfaces.
 3. The pump shaft shall be fitted with threads, lock nut, and keyway to fasten the pump half-coupling hub securely.
 4. Shaft diameter shall be sized to prevent torsional and flexural deflection which would cause whipping and vibrating under any condition.
 5. Maximum allowable flexural shaft deflection shall be not more than 75 percent of the radial wearing ring clearance.

2.07 SHAFT SLEEVES

- A. Shafts, where exposed to water or passing through glands and stuffing boxes, shall be protected by renewable (removable) sleeves. Stuffing boxes shall have hardware constructed of corrosion-resistant metals.
- B. Materials:
1. AISI Type 316 Stainless Steel
- C. Design/Fabrication:
1. The sleeves shall be secured in place, for both directions of pump rotation, with shaft nuts incorporating set screws for locking purposes.
 2. The sleeves shall be provided with O-rings to prevent leakage between the shaft and sleeves.
 3. Shaft sleeve nuts shall be threaded.

2.08 SHAFT MECHANICAL SEALS

- A. Pumps shall be supplied initially with mechanical type split seals which are interchangeable with conventional packing.
- B. Materials:
 - 1. Stationary Seal Face: Carbon.
 - 2. Rotary Holder: Stainless Steel, Grade 316.
 - 3. Rotary Seal Face: Ceramic or Silicon Carbide.
 - 4. Seal Glands: Stainless Steel, Grade 316.
 - 5. Springs: Stainless Steel, Grade 316.
 - 6. Elastomers: Viton or Ethylene Propylene
- C. Type:
 - 1. John Crane Type I
- D. Design/Fabrication:
 - 1. Seal glands shall have a flush connection at the top and along the vertical centerline or at 30 to 45 degrees from the horizontal centerline.
 - 2. Seal must consist of assemblies which fit together over a shaft to form a self-setting and aligning cartridge seal design.
 - 3. The seal must eliminate the need for shims or dimensions to be taken for proper installation.
 - 4. Provide water flushing per API Plan 11 with stainless steel seal water tubing, with stainless steel hand valve, from the pump casing to the gland flush connection. The hand valve shall be tagged with a stainless steel warning tag indicating the valve is to be open at all times during operation.
 - 5. Any additional equipment required, such as pressure relief valve, flow switch, or flow indicator shall be provided by Manufacturer at no additional cost to the Owner. Any instrumentation required for these devices shall be provided by the Manufacturer.

2.09 MISCELLANEOUS FITTINGS

- A. Small fittings and accessories inside the pump and around the shaft sleeves, such as set screws, bolts, and nuts that are exposed to water or water spray, shall be made of non-corrosive materials such as bronze or stainless steel.
- B. Materials: Bronze, stainless steel, or other approved non-corrosive materials.

2.10 PUMP BEARINGS

- A. Pump bearings shall be antifriction, double row, deep-groove type ball bearings. They shall be designed and sized for 100,000 hours calculated minimum L10 rated bearing life at 25% BEP per ANSI/HI 1.3-2013. Each bearing shall be capable of carrying both line and thrust type loads. All bearings shall be manufactured in the United States.
- B. Provide Inpro bearing isolators.
- C. Pump bearings shall be ring oil lubricated or oil bath lubricated. A constant oil level oiler shall be provided. Pump design shall allow for the bearing to be removed without disturbing the upper casing for inspection and replacement of the bearings, seals and shafts.
- D. Bearing housing shall be designed to maintain shaft alignment and ensure long bearing and lubricate life.

2.11 BEARING BRACKETS

- A. The bearing brackets shall be accurately machined and doweled to the casing or with 360 degrees attachment to the upper and lower casing for a perfect shaft alignment by full register fit to the casing. The manufacturer shall have the option of constructing the bearing brackets integral to or separate from the pump casing.

2.12 PUMP BASE PLATE

- A. A support base for pump and motor shall be provided.
- B. The support base shall be structurally capable of supporting the weight of the pump and motor and resisting torsional movement.
- C. The support base shall have adequate drainage.
- D. Submittal of support base design to the Design Engineer prior to fabrication is required.
- E. The pump and motor shall be mounted on a steel base plate or a steel drip rim base plate with integral drip channels incorporated on each side. Pump and motor mounting surfaces shall be machined for ease of realignment after motor replacement.

2.13 ACCESSORIES

- A. Lifting Lugs: Shall be provided and positioned to provide balance during lifting.
- B. Equipment base shall be manufactured and provided by the pump manufacturer and assembled together with the pump.
- C. Jacking Bolt kit or a horizontal alignment tool set shall be provided. Jack bolts should be present at HSP motors to allow alignment in both directions (8 bolts – 2 each).
- D. Oil lubricated units shall be provided with constant level oilers or will sight glasses arranged to indicate operating and static oil levels as described in Section 2.14 herein.
- E. Pump impeller shall be balanced as described in Section 2.04.C.4. to ensure that all rotating parts shall operate smoothly without excessive vibration as defined by manufacturer.

2.14 LUBRICATION

- A. Bearings shall be ring oil lubricated reservoir type. Lubrication oil for bearings shall be food grade.
- B. Oil reservoirs shall include an opening for filling, an overflow opening, a drain at the lowest point, an oil level site glass, and an oil level indicator. Under each oil bearing housing install ESCO oil site conditioning glass. Oil site glass shall be external to the bearing house with proper oil level marks on bearing housing or site glass.

2.15 ANCHOR BOLTS

- A. Design/Manufacturing:
 - 1. Pump Manufacturer shall provide the anchor bolts requirements to the Contractor prior to construction of the structural equipment pad as described below. The Contractor shall provide anchor bolts based on Pump Manufacturer's requirements.
 - 2. Anchoring system shall be appropriately sized and provided by the Pump Manufacturer to adequately handle all loads applied for the piping configuration shown on the drawings in accordance with the Hydraulic Institute Standards. Minimum size: 1/2" diameter anchor bolts.
 - 3. Bolts shall be of adequate length and design to transfer loads into the structural equipment pad.
 - 4. Structural and seismic calculations for pumps: Include calculations for reactions at anchor bolts and selection of the size depth and number of bolts required for use with Simpson Set Epoxy anchor system. Manufacturer can assume Grade 60 Rebar and 4,000 psi concrete. Seismic design parameters are as follows:

<i>Seismic Design Parameters</i>				
<i>Site Classification</i>	F_a	F_v	S_s	S_I
B	1.0	1.0	0.074 g	0.030 g

Where: F_a = Site coefficient
 F_v = Site coefficient
 S_s = Mapped spectral response acceleration for short periods
 S_I = Mapped spectral response acceleration for a 1-second period

2.16 SUCTION AND DISCHARGE CONNECTIONS

- A. Flange Type: Flanges: Suction and discharge nozzles shall be Class 125 lb, flanged, drilled, and machined to match AWWA C207 flanges of connecting pipe. Flanges shall be flat- faced.
- B. Design/Fabrication:
 - 1. Designed for through bolting and straddling vertical and horizontal centerline.
 - 2. Gaskets shall conform to AWWA C207.

2.17 PUMP/MOTOR COUPLINGS

- A. Flexible couplings shall be the heavy-duty type, designed so that each pump shaft may be removed without disturbing the positing or adjustment of the driving unit. Coupling shall be Falk Lifelign Gear Coupling, as manufactured by the Rexnord Corporation. Minimum factor of safety of 1.5 times shaft strength shall be used. Horizontal surface of the couplings shall be machined parallel to the axis of the shaft, and faces shall be machined perpendicular to the axis of the shaft. Provide appropriate coupling gaurgs, acceptable to OSHA< securely attached to the pump base with stainless steel bolts and nuts. Supply couplings with a precision balance certificate from the Pump Manufacturer.
- B. The drive shaft coupling gear shall be gear type and all metal.
- C. Lubrication: Oil or grease.
- D. Baseplate: Cast iron or fabricated steel.

2.18 EQUIPMENT APPURTENANCES

- A. Pumping equipment shall be provided with all necessary equipment appurtenances to make the pumping units functional.
 - 1. Bolts and nuts shall conform to the requirements of ASTM A307.
 - 2. Threads shall be clean-cut and shall conform to ASME B1.1.
 - 3. Stainless steel bolts, nuts, and washers shall be Type 316.

4. Unspecified bolts, nuts, washers shall be zinc coated after being threaded by the hot-dip process conforming to ASTM A123 as appropriate.
- B. Metal equipment guards shall be provided on all equipment driven by open shafts.
1. Guards shall be designed to enclose the drive mechanism completely and be easily removable.

2.19 INFORMATION PLATES / MARKINGS

- A. Materials:
1. Nameplate: 16-gauge stainless steel with ¼-inch die-stamped equipment tag number securely mounted in a readily visible location.
- B. Pump Nameplate: The nameplate shall clearly show pump information and complete performance data, including:
1. Manufacturer's name.
 2. Pump size, type, and model number.
 3. Serial number.
 4. Speed.
 5. Impeller diameter.
 6. Primary Duty Point- Capacity and head rating.
 7. Bearing identification, name, and number.
 8. Pump weight, motor weight.
 9. Date of manufacture.
 10. Other pertinent data.

2.20 ASSEMBLY, MOUNTING, & ALIGNMENT

- A. Factory Pre-mounting and Alignment. Pumps with their job motors shall be pre-mounted and pre-aligned. Mounting holes shall be drilled and tapped at Pump Manufacturer's factory. Factory alignment data shall be furnished to the Contractor. Pump Manufacturer shall drill pump and motor feet only for dowels. Do not drill base plate or install dowels at factory; ship loose.
- B. The Pump Manufacturer shall approve and sign off on proper installation.

- C. A qualified factory-trained manufacturer's representative shall personally inspect the equipment at the jobsite and shall certify in writing that the equipment has been installed, adjusted, and tested, in accordance with the manufacturer's recommendations.

2.21 INTERIOR FINISH FOR CASINGS

- A. Coat interior of pump casings with ceramic epoxy coating to enhance pump efficiency. Prepare and shop-prime, as stated in this Section.
- B. Materials: Prime and Finish Coating: Belzona 1341N efficiency enhancement coating for potable water (ceramic epoxy coating) or fusion bonded epoxy.
- C. Procedure:
 - 1. Surface Preparation: As recommended by coatings Manufacturer, minimum blast clean to near white SSPC-SP-10.
 - 2. Application (prime and finish coating): Apply 25 mils DFT of Belzona coating or fusion bonded epoxy.
 - 3. Testing: Perform Holiday Test.
 - 4. Touchup: After testing is complete and prior to shipment, touch up surfaces. Provide touch up kit for contractors use during installation. If holiday test is required, perform at shop prior to shipment and provide certification.

2.22 EXTERIOR FINISH

- A. Exterior of pumps, motors, frames, base plates, and appurtenances shall be painted prior to shipment from factory. Pump units shall be prepared and shop-primed as follows:
 - 1. Surface Preparation:
 - a. All bare metals or areas that were shop primed that have been damaged shall be abrasive blast cleaned to SSPC-SP6, commercial blast cleaning standards.
 - b. Shop primed items, stored on site for a prolonged period prior to coating, shall be prepared for coating following the coating manufacturer's recommendations prior to applying touch-up and subsequent coats. Surface preparation may include brush-off abrasive blasting or spot blasting to SSPC-SP6, commercial blast cleaning standards, for areas where the primer has been damaged and bare metal is showing.
 - c. Non-ferrous metals shall be degreased and cleaned by washing with a water based dispersant such as Carboline Surface Cleaner #3. Rinse thoroughly with clean water after cleaning.

2. Coating System:
 - a. Prime coat for ferrous and non-ferrous metal: Two part epoxy primer. Tnemec's Series 140, must be white, at 4.0 mils DFT.
 - b. Intermediate coat for ferrous metal: Two part epoxy. Tnemec Series 140 with beige color at 3.0 mils DFT.
- B. Contractor to apply finish coating in the field: Two coats of epoxy primer and polyurethane finish coat at 4-6 mils nominal DFT per coat.

2.23 DRIVE UNITS

- A. Electric Motors.
 1. The electric motors shall be designed as specified in Section 16151 – Large Induction Motors.

2.24 SHOP TESTING

- A. Each pumping unit, including pump and motor, shall be witness tested at the Pump Manufacturer's factory as specified herein. Each unit shall be hydrostatically tested in accordance with the Hydraulic Institute Standards. Acceptance testing shall be per HI Standards Table 14.6-3.4, Grade 1B.
- B. FACTORY WITNESS TESTING
 1. One representative from the Owner and one representative from the Engineer will witness the High Service Pump factory pumping unit test.
 2. Witness Test Trip
 - a. The Contractor shall reimburse the Engineer for Engineer's time at a rate of \$1,200 per day times the number of days required for the factory test visit, travel days included.
 - b. The Contractor shall arrange to provide an interpreter/guide for the entire time that the Owner's representatives are in the country for trips outside North America.
 - c. Provide a testing schedule before the trip agenda is set. Tests may not start any sooner than 12 hours after arrival at hotel for trips outside North America. Owner and Engineer will review agenda to ensure adequate time is allowed for shorter flights.
 - d. For trips outside North America, the Contractor shall provide and pay for at least one cellphone to be used by the Owner's representatives, purchased in the United States with a United States phone number that works at all times and locations as required by the witness testing.
 - e. The Contractor shall obtain any letters of invitation to enter the country in question on business and be responsible for paying for and making all arrangements to obtain the visa for each person.

- f. Each of the Owner's Representatives shall be responsible for obtaining their own passport. This is not the responsibility of the Contractor.
- g. The Contractor shall designate a local firm that does Visas to collect each passport, send it overnight to their representative. The Contractor's local firm shall be responsible for all Visa processing requirements and then overnight each passport directly back to each person. Each Owner's and Engineer's Representative shall have the Visas in hand at least two weeks before the flight.
- h. Provide Economy Class (Coach) Flight arrangements. Provide confirmed reservations at least two weeks before the trip.
- i. Owner's and Engineer's Representatives shall be allowed to return at any time. Contractor shall be responsible for any penalties, if applicable. Owner and the Engineer will stay no more than two weeks for factory testing. For factory test requiring more than two weeks, Contractor shall make travel arrangements for additional personnel from Owner and Engineer.
- j. For each additional trip after the first that is required due to witnessed testing partial/complete failure or incomplete occurrence because the Contractor or Manufacturer is not ready, any component of the motors/pumps are not ready for testing, or any other reason caused by the Manufacturers, Contractor, or his Subcontractors/Suppliers, the Contractor shall pay all costs described in 2.24.B.2. In addition, Contractor shall reimburse Engineer for Engineer's labor at \$1,200 per day.

C. FACTORY TESTING

1. Each constant speed pumping unit shall be tested with its job motor by the Pump Manufacturer at their plant prior to shipment. Each pumping unit shall be tested with water in accordance with the Standards of the Hydraulic Institute, Centrifugal Pump Section Test Code and Rotodynamic Pumps for Hydraulic Performance Acceptance Tests to determine compliance with Pump Manufacturer's head-capacity curve and confirm guaranteed wire-to-water efficiency. A hydrostatic test of the pump casing shall also be performed. Model tests will not be accepted. Factory testing shall be the final criteria for acceptance by the Owner for the tests specified in Paragraph 2.24.E. of this Section. Acceptance criteria for vibration as specified in this section shall include both factory and field tests. Field testing will be the final criteria for acceptance by the Owner for the tests specified in Paragraph 2.24.E. Factory test data and results shall be submitted for review prior to the equipment being shipped to the jobsite.
2. All factory pumping unit tests shall be performed with actual motors to be supplied to ensure that the same motor/pump units that are factory tested together are installed together in the field.

3. Perform NPSH testing on the first unit ready for testing. Determine the Net Positive Suction Head required under both “1% head drop” and at “3% head drop” conditions and provide a composite curve for each.
4. The factory test report shall be certified by a licensed Professional Engineer. Certified copies of the test data for each pump shall be furnished to the Owner as part of the Test Book referenced in Paragraph D. Test curves and data sheets shall include head-capacity curve, brake horsepower curves, overall (wire to water) efficiency curves, motor Manufacturer’s efficiency curves, pump efficiency curves, NPSH requirements, and a sketch of the test installation. Data for the entire pump range (from minimum head to shut-off) shall be included.
5. Shop tests shall be made at the speeds and horsepower required by the pump. Suction conditions for the test shall duplicate the Net Positive Suction Head available for continuous operation under which the pump will operate. Pumps shall have a minimum NPSH margin of 25%.
6. All tests for pumps shall be run at specified speeds indicated in the respective specification over the full range of the curve.
7. Pump Manufacturer shall provide one digital copy of video recordings with sound for each size pumping unit showing disassembly and reassembly of the pumps. Written copies of the sound script shall also be bound and provided to the Owner for their use in operation and maintenance.
8. Only after receipt, review, and approval of all factory test data, and preliminary O&M Manuals for pumps and motors, the Owner will give permission to Pump Manufacturer for shipment of pumping units.

D. FACTORY TEST BOOK

1. The Pump Manufacturer shall prepare and submit a Test Book for the Owner’s review at least 60 days before any testing is scheduled. The Test Book shall be the test report minus test data and shall contain the following information:
 - a. Description of tests to be conducted.
 - b. Description of test procedures.
 - c. Copy of test standards.
 - d. Calibration of Instruments. All instruments shall be calibrated in accordance with Hydraulic Institute Standards just prior to and after all performance testing. Manufacturers performing the shop tests shall furnish the Owner approved certifications of calibrations. Bourdon or bellows gages shall be calibrated at the time of each test.
 - e. A certified curve showing the calibration of the flowmeter used in the pump capacity test shall be furnished as part of the data and permanently bound with all other data. The data shall include coefficient of discharge and flow versus differential pressure if an orifice plate or venturi is used.

- f. Dimensional layout of test assembly and reservoir.
- g. Photos of test facility.

E. FACTORY TESTS TO BE PERFORMED

1. Hydrostatic Test: Each new pump casing shall be hydrostatically tested to one and one half times its maximum working pressure or 150 psi, whichever is greater. Maximum working pressure is defined here as the shutoff head pressure. Test duration shall be 30 minutes. Submit certified hydrostatic test results and test procedures.
2. Performance Test: Record data at a minimum of ten flows vs. head conditions with three of the points being those indicated below. Enough points shall be tested so that a smooth curve may be drawn through the points.
 - a. Allowable tolerances for the desired points shall be as defined in the Hydraulic Institute Standards, Section 14.6, acceptance grade 1B.
 - b. The manufacturer shall make continuous measurements and record the maximum down-thrust and maximum up-thrust for all conditions of its operation, including momentary loads from start-up and shut-down.
 - c. The pump test results shall specify the pump performance curve to be performed to at least minimum head within the allowable operating range to shut-off head and define minimum head.
 - d. The performance test for all pumping units shall be conducted with the pump and job motor.
 - 1) Shut-off head.
 - 2) Rated point.
 - 3) Minimum head point for continuous operation without cavitation.
3. Vibration Tests: Demonstrate the pumping unit runs smoothly during the tests. Vibration readings shall be taken and recorded at points specified in Paragraph 2.24.E. Factory acceptance criteria shall be as specified by the Hydraulic Institute Criteria.
4. Noise Tests. Noise readings shall be taken and recorded at points specified below:
 - a. Maximum Noise Level: The maximum noise level of each assembled pumping unit located within or outside a structure shall not exceed 85 dBA at a distance of one meter (3.281 feet) from the nearest surface of the machine. Measurements shall be made on each complete unit, which includes the pump, motor, and coupling.
 - b. Sound tests shall be recorded at a minimum of five flow versus head conditions, including shut-off head, rated point, and minimum head point for continuous operation without cavitation. Sound level measurements

shall be made on the pumping unit under single unit operation. All sound level testing in the factory may be witnessed by the Owner, Pump Manufacturer and Motor Manufacturer.

5. Test Log: Record the following:
 - a. Total Head.
 - b. Flow capacity measured by factory instrumentation and storage volumes.
 - c. Power requirements.
 - d. Average difference in elevation of water surface in suction well to pump discharge centerline for duration of test.
 - e. Pump suction and discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.
 - f. Pump speed.
 - g. Water temperature.
 - h. Elevation of test stand.
 - i. F.F.T. vibration plots of amplitude versus time out to 150,000 cycles/min at twelve points (three points per bearing, x, y, z). Vibration levels on test stand shall meet the specified vibration limits at the factory. Field vibration analysis will be performed by an independent testing laboratory on installed pump unit.
 - j. Perform noise test in accordance with Section 2.24.E.6.
6. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards, if necessary.

PART 3 EXECUTION

3.01 LEVELING

- A. The base plate will be set to true level using machinist's level. The tolerance for leveling will not exceed 2/1000 inch per foot length along any side of the base plate. The Representative for the Pump Manufacturer shall be present during the leveling. The Pump Manufacturer shall certify that the leveling is in accordance with the limits specified herein and is acceptable to the Manufacturer.

3.02 STORAGE & EXERCISE

- A. The Contractor shall provide any required maintenance, exercise, and storage for all pumping units included in this Specification, in accordance with Manufacturer recommendations.

3.03 INSTALLATION

- A. The Contractor shall install pumping units as shown on the Drawings and in accordance with the Manufacturer's instructions and approved shop drawings. The Manufacturer shall provide Special Services as specified.
- B. Installation of the pump and motor shall be in accordance with American National Standard for Centrifugal Pumps for Nomenclature, Definitions, Application, and Operation Hydraulic Institute ANSI/HI 1.1-1.5 and Manufacturer's printed instructions.

3.04 FIELD QUALITY CONTROL

- A. Conduct field test as specified below:
 - 1. Each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation, or overheating of bearings.
 - 2. The following field testing shall be conducted:
 - a. Startup, check, and operate the pump system over its entire speed range. Unless otherwise specified, vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of three pumping conditions defined by the engineer.
 - b. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least four pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.
 - c. Determine bearing temperatures by contact type thermometer. A run time of at least 20 minutes, or until temperature is stabilized, shall precede this test, unless insufficient liquid volume is available.
 - d. Electrical and instrumentation tests shall conform to the requirements of the Section under which that equipment is specified.
 - 3. Field testing will be witnessed by the Engineer. The Contractor shall furnish three weeks advance notice of field-testing.
 - 4. In the event any pumping system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.
 - 5. After each pump system has satisfied the requirements, the Contractor shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the field tests, a listing of all persons present during the test, and the test data.
 - 6. The Contractor shall bear all costs of field tests, including related services of the Manufacturer's representative, except for power and water, which the Owner will

bear. If available, the Owner's operating personnel will provide assistance in field testing.

B. Functional Tests: Conduct on each pump.

1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation. Pump and motor shall be aligned using a laser alignment instrument at final site.
2. Vibration Test:
 - a. Test with units installed and in normal operation, and discharging to connected piping systems at rates between the low discharge head and high discharge head conditions specified, and with the actual building structures and foundations provided shall not develop at any frequency or in any plane, peak-to-peak vibration amplitudes exceeding the limits specified.
 - b. If units exhibit vibration in excess of the limits specified, adjust or modify as necessary.
3. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.
4. Noise Test: Test pumping for noise in accordance with Paragraph 2.24.E.4. Equipment installed that exceeds allowable noise level limits must be re-worked, reinstalled, balanced or adjusted to reduce noise. Methods to reduce noise, including equipment insulation, must be approved by the Engineer.

C. Owner's Acceptance Basis

1. The Owner will accept the pumps after demonstration of proper functioning of all components and upon successful completion of the factory and field acceptance tests.
2. Penalty for Efficiency: If, as a result of the factory test, the efficiency of any pumping unit (pump and motor) is less than the specified minimum wire-to-water efficiency at Rated Point, the Owner, at his discretion, may reject the equipment, and require the Pump Manufacturer to provide a pump and motor as specified
3. There is no credit for efficiency values obtained during factory testing that are greater than the guaranteed wire-to-water efficiency.
4. If, as a result of the factory and field testing of the pumping units for vibration failed to meet the acceptance criteria, the Owner may reject the pumping units or required pumping unit supplier to modify the units to comply with specified vibration limits. All expense of retesting the units by Independent Testing Laboratory shall be borne by the Pump Manufacturer.

3.05 TRAINING

- A. The Pump Manufacturer shall provide instructional training on the operation and maintenance of the equipment, including pump and motor, as specified in this section.
1. Provide manufacturer's services for training of plant personnel in operation and maintenance of the equipment furnished under this section.
 2. The training shall be for a period of not less than one eight-hour day.
 3. The cost of training program to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.
 4. Provide detailed O&M manuals to supplement the training course. The manuals shall include specific details of equipment supplied and operations specific to the project.
 5. The training session shall be conducted by a manufacturer's qualified representative.

END OF SECTION



DIVISION 16

ELECTRICAL

SECTION 16151

LARGE INDUCTION MOTORS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A This Section specifies the requirements for custom-built, premium electric motors as specified. Unless otherwise shown or specified, the motors shall be single speed, single winding, in strict compliance with the requirements specified herein. The driven equipment manufacturer shall select the exact motor speed.
- B Medium Voltage Induction Motors
 - 1. The provisions of this Section shall apply to all medium voltage AC squirrel cage induction motors.

1.02 RELATED WORK

- A Section 11110 Horizontal Split-Case Centrifugal Pumps

1.03 SUBMITTALS

- A Submittals shall be made in accordance with the requirements of Section 01300 and as specified herein.
- B Submittals for equipment specified herein shall be made as a part of equipment furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned unreviewed.
- C Shop Drawings and Product Data. For each motor specified under this Section, submit the following information:
 - 1. Nameplate data in accordance with NEMA MG-1.
 - 2. Additional Rating Information:
 - a. Service factor
 - b. Locked rotor current
 - c. No load current
 - d. NEMA insulation system classification
 - e. Temperature rise at rated full load, by resistance temperature detector (RTD) and by resistance.
 - 3. Maximum ambient temperature for which motor is designed.
 - 4. Frame size, outline dimensions, net weight and weight of rotating element. Include surge protection dimensions and weight.

5. Conduit box dimensions and usable volume as defined in NEMA MG-1 and NFPA 70 and internal arrangements.
 6. NEMA machine type (ODP, WP-1, TEFC, etc.).
 7. Bearing size and calculation, based on L10 life.
 8. Lubrication (compatible with pump manufacture).
 9. Efficiency at 1/4, 1/2, 3/4, full load, and service factor.
 10. Power factor at 3/4 and full load.
 11. Space heater voltage and wattage.
 12. Surge protection information, including mounting details.
 13. Platinum resistance temperature detector (RTD) literature with wiring diagram.
 14. ALARM and TRIP temperatures for winding and bearing RTDs.
 15. Locations and sizes of lubrication connections, vents, drains, etc.
 16. Locked rotor withstand time.
 17. Allowable time periods between starts
 18. Schematic and interconnection diagrams.
 19. Instruction manual.
 20. Maximum sound level in accordance with NEMA MG-1.
 21. Date of Manufacture
 22. Cable terminations
 23. Maximum Power Factor Capacitor Bank KVAR that can be switched with the motor.
 - 24.
- D. Factory Tests. Submittals shall be made for factory tests specified herein.
- E. Field Test Reports. Submittals shall be made for field tests specified herein.
- F. Operation and Maintenance Manuals.
1. Manufacturer's contact address and telephone number for parts and service.
 2. Project record drawings clearly indicating operating features and including as-

built shop drawings, outline drawings, and schematic and wiring diagrams.

3. Instructions for erection, alignment (including tolerances), and preparation for use.
4. Complete description of safety equipment, safety procedures, and safety precautions.
5. Normal starting, running and shutdown procedures, as well as emergency shutdown procedures.
6. Recommended number of starts in any 24-hour period.
7. Normal maintenance, inspection and lubrication procedures.
8. Recommended spare parts list.
9. Recommended renewal parts list
10. Record Documents for the information required by the submittals above.

1.04 REFERENCE STANDARDS

- A Motors shall be designed, built, and tested in accordance with the latest revision of the following standards:
 1. National Electrical Manufacturers Association Inc. (NEMA)
 - a. NEMA MG1 Part 20 – Large Machines.
 - b. NEMA MG2 - Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators.
 - c. NEMA MG3 - Sound Level Prediction for Installed Rotating Electrical Machines.
 2. National Fire Protection Association (NFPA)
 - a. NFPA-70 - National Electrical Code.
 3. Institute of Electrical and Electronics Engineers, Inc. (IEEE)
 - a. IEEE Std 1 - General Principles for Temperature Limits in the Rating of Electric Equipment.
 - b. IEEE Std 43 - Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
 - c. IEEE Std 85 - Test Procedures for Airborne Sound Measurements on Rotating Electric Machinery.

- d. IEEE Std 112 – Standard Test Procedure for Polyphase Induction Motors and Generators.
 - e. IEEE Std 275 - Recommended Practice for Thermal Evaluation of Insulation Systems for AC Electric Machinery Employing Form-wound Pre-insulated Stator Coils, Machines Rated 6,900 V and Below.
 - f. IEEE Std 429 - Standard Test Procedure for the Evaluation of Sealed Insulation Systems for AC Electric Machinery Employing Form-wound Stator Coils.
4. Anti-Friction Bearing Manufacturer's Association Inc. (AFBMA):
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 DEFINITIONS

- A. Motors specified herein are three-phase, squirrel cage induction type, except as specifically specified elsewhere in these Specifications.
- B. The word "Drive" shall be construed to mean the driven equipment, i.e. pump, hoist, fan, compressor.
- C. If there is inconsistency of size on different Drawing sheets or between Drawings and other sections of Specifications, relating to the horsepower designation, then the larger size shall be required.

1.06 QUALITY ASSURANCE

- A. Unit Responsibility. The electric motor shall be furnished guaranteed by the driven equipment manufacturer, to assure single unit responsibility.
- B. When motors are furnished with driven equipment, the driven equipment supplier shall be responsible for mounting the motor and driven equipment as a complete unit, correctly aligned and coupled with the coupling or sheave specified on the driven equipment data sheet, and for designing vibration, special, or unbalanced forces resulting from equipment operation.
- C. The Contractor, at no additional cost to the Owner, shall make structural, mechanical and electrical changes that are necessitated because the Contractor selects equipment with dimensional, power or mechanical differences from that shown on the Drawings. All engineering costs associated with revisions shall also be borne by the Contractor.
- D. Motor Compatibility. The Contractor shall satisfy himself that the motor included with the drive is compatible with driven equipment and complies with these Specifications. In the event that the motors described in these Specifications cannot be applied to the application or equipment offered, the Contractor may submit an exception, stating clearly the deviations and the reasons for such deviations. The acceptance or rejection of such deviations shall be at the sole discretion of the Owner/Engineer.

E Motors manufactured prior to the date of this Contract will not be acceptable.

1.07 JOBSITE DELIVERY, STORAGE AND HANDLING

- A The equipment shall be delivered as specified in Section 11110.
- B Where space heaters are provided in motors, provide temporary electrical power and operate space heaters, during jobsite storage and after motors are installed in permanent location, until equipment is placed in service.
- C The motor shaft shall be rotated on a monthly basis, if such is recommended or required by the motor manufacturer; the date recorded, and copies of the record provided to the Owner/Engineer and the manufacturer. The manufacturer shall confirm receipt of the rotation record.

1.08 WARRANTY

- A The Manufacturer's warranty period shall be concurrent with the Contractor's for two (2) years, commencing at the time of final acceptance by the Owner which shall begin no later than April 15, 2020. Guarantee shall cover all necessary labor, equipment, materials, and replacement parts resulting from faulty or inadequate equipment design, improper assembly, defective workmanship and materials, leakage, breakage or other failure of all equipment and components furnished by the Manufacturer.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. General Electric
 - 2. US Motors
 - 3. TECO – Westinghouse
 - 4. Siemens
 - 5. Toshiba
- 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.

2.02 GENERAL REQUIREMENTS:

- A Each motor provided shall have an Identification Tag Number, conforming to the numbering system and equipment name shown on the Drawings.

- B. Specific motor data such as HP, RPM, enclosure type, etc., is specified under the detailed specification for the mechanical equipment with which the motor is supplied.
- C. Motors shall have sufficient horsepower and torque capacity to drive the equipment without overloading under all conditions, without exceeding the nameplate rating of the motor and without use of the service factor.
- D. Motors shall be NEMA Design B standard, unless otherwise specified.
- E. All motors shall be continuous time rated suitable for operation in a 50 degrees C ambient, unless specified otherwise.
- F. The motors shall be provided with an anti-reverse ratchet to prevent reversing due to phase reversal or backspin at shutdown.
- G. Each motor shall have couplings keyed to shafts. Coordinate with the driven equipment manufacturer with regard to finished product.
- H. Where frequent starting occurs, the design for frequent starting duty shall be equal to the duty service required by the driven equipment.
- I. Altitude: Under 3300 FT.
- J. The motor manufacturer's nameplates shall be engraved or embossed on stainless steel and fastened to the motor frame with stainless steel screws or drive pins. Nameplates shall indicate clearly all of the items of information enumerated in NEMA Standard MG1, as applicable, including but not limited to the following information:
 - 1. Main Nameplate
 - a. Horsepower (output).
 - b. RPM at full load.
 - c. Time rating.
 - d. Frequency.
 - e. Number of phases.
 - f. Model number.
 - g. Rated voltage.
 - h. Service factor.
 - i. Full load amps.
 - j. Insulation class.
 - k. NEMA design letter.
 - l. NEMA code letter.
 - m. Temperature Rise.
 - n. Manufacturer's Frame size
 - o. Date of manufacture.
 - p. Direction of rotation (if uni-directional).
 - q. Thermal protection.
 - r. Motor Weight
 - s. Ambient temperature rating
 - t. Max KVAR for power factor correction

- u. Efficiency
 - v. Power factor
- 2. Heater Nameplate.
 - a. Voltage and wattage.
- 3. Bearings Nameplate.
 - a. Bearing manufacturer's name, identification, and recommended lubricant.
- 4. Dynamic Balance Nameplate.
 - a. Furnish and mounted on motor.
- K. Motors shall have a breather drain in each end bracket of a TEFC motor enclosure. Stainless steel automatic breather drains shall be provided in the lowest part of both end brackets to allow drainage of condensation.
- L. Motors shall have an oversized, gasketed, cast iron conduit box, field adjustable in 90-degree increments unless the box contains equipment, diagonally split with tapped NPT threaded conduit entrance hole, and shall exceed the minimum volumes defined in IEEE 841-2001. Neoprene conduit box cover gasket and neoprene lead seal gasket with flexible nipples to ensure the seal is maintained as the leads are moved shall be furnished. Provision for grounding shall be provided in the conduit box utilizing a mounted clamp-type lug.
- M. Provide separate accessory lead conduit boxes. Minimum size entrance hub shall be ¾" C. Resistance temperature detector leads shall not occupy the same box with any other type of power or monitoring leads.
- N. Provide lifting lugs on the motor frame.

2.03 RATING:

- A. Description. Unless otherwise specified, the motors shall be induction motors, single speed. The driven equipment manufacturer shall determine the speeds. Nameplate horsepower of the motor shall not be less than that shown on the Drawings, and as specified herein.
- B. Nameplate horsepower rating of motor shall be equal to or greater than the total horsepower requirement for the driven equipment. Motor shall be designed in accordance with applicable provisions of the latest NEMA Standard Publication for Motors and Generators, MG-1, Part 20, subject to modifications and additions as herein set forth.
- C. Motors shall be suitable for full voltage direct-on-line starting.
- D. All motors shall have a service factor of 1.15.

1. In sizing motors, no portion of a motor's service factor above 1.0 shall be used in normal continuous operation of the motor.
- E. All motors shall have Class H insulation and shall be rated at the following temperature rises:
1. For motors 1500 horsepower and less, the motor windings shall be capable of operating continually at 115% of nameplate horsepower, with rated voltage and frequency applied, and with a temperature rise by embedded detector not exceeding 80 C over a 50 C ambient temperature.
 2. The ambient air temperature shall be defined as air immediately surrounding the motor.
- F. Voltage: Motor voltage, phase and frequency shall be 4000V and as specified with the driven equipment.
- G. Power Factor: Minimum Power Factor at Full Load: greater than 0.85. The motor manufacturer shall not utilize correction capacitors to achieve this power factor.
- H. Starting Voltage: Each motor shall be capable of accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90% of motor rated voltage.
- I. Locked Rotor Current: The locked rotor current of the motor shall be limited in accordance with the National Electrical Code and NEMA MG-1 standards, to a maximum of Code Letter G, (6.29 kVA per horsepower). The code letter shall be clearly shown on the nameplate.
- J. Safe Stall Time: Safe stall time shall not be less than 15 seconds.
- K. Noise Measurement: The noise level as measured by IEEE Standard 85, the maximum noise level shall be 85 dBA at 1 meter and shall be coordinated with pump manufacturer, and submitted for approval.
- L. Slip: The full load RPM shall match or exceed the pump design RPM.
- M. The Contractor shall coordinate with the motor manufacturer and Division 16484 motor control manufacturer to provide the correct capacitor kVAR to correct the power factor as specified. The capacitors shall be mounted in each individual motor controller.
- N. Efficiency: See Section 11110.

2.04 STATOR

- A. The stator core shall be built up with high grade, non-aging laminated silicon steel, C5 or better. Each lamination core shall be plated to minimize eddy current losses. The laminations shall be adequately secured to the stator frame and securely held in place at each end. There shall be no perceptible buzzing of laminations during operation. Provide slot wedges for rigidity.

- B. The motor stator winding shall be provided with premium grade full Class H insulation or better. Silicone rubber insulation is not acceptable
1. A VPI insulation system shall be used to provide high resistance to moisture and other contaminates.
 2. All windings shall be copper; assembled using form wound coils of the same size and shape. Random wound coils are not acceptable.
 3. The form wound coils shall be constructed with copper wire. The stator construction method shall accommodate VPI treatment. The coils shall be covered with strand insulation consisting of Dacron polyester glass fiber film or other high temperature insulating film.
 4. Provide full length slot liners rated 5000 volts minimum which extend beyond the stator core iron to reduce the possibility of tracking to ground.
 5. Coil insulation shall be tightly applied to eliminate all air voids.
 6. Coils shall be tightly inserted into the stator slots without damage. Coils shall be secured to surge ring or treated rope and securely laced to one another as necessary to prevent distortion and expansion.
 7. The end turns shall be blocked top, sides and bottom. The surge ring shall be designed and installed to prevent movement during starting and short circuit conditions.
 8. The entire stator shall be oven cured to provide a completely sealed insulation system.

2.05 ROTOR

- A. The shaft shall be steel, accurately machined, smoothly finished, with sufficient strength to withstand all stresses resulting from normal operation at any speed up to and including a 25% over-speed condition. Provide shaft end details coordinated with pump and shafting as specified.
- B. The core shall be built up with high-grade non-aging silicon steel, each single piece lamination core plated to minimize eddy current losses. Core mechanical integrity shall not rely on any electrically active component
- C. Rotor bars and end ring shall be copper or copper alloy with uniform resistance characteristics so as to equalize thermal stresses. The bars shall be rectangular or shaped to meet motor starting and running torque requirements. Each copper rotor bar shall be mechanically locked or secured in the rotor pole slots to minimize movement and vibration. Rotor end rings shall be free of circumferential joints and shall be 100% swaged to the rotor bars by an induction or torch brazing process.
- D. Rotors shall be statically and dynamically balanced prior to assembly. Balancing shall be checked after assembly with the motor running at rated speed. Run out on the shaft

shall be checked and in no case shall they exceed 0.001 inch measured with a precision indicator with the reading taken at the end of the shaft.

- E. The cage bars shall be copper or a copper alloy with uniform resistance characteristics so as to equalize thermal stresses. ALUMINUM ROTOR BARS ARE NOT ACCEPTABLE. Rotor bar shall be in tension at all times and shall be brazed at the end ring connections. Fabricated aluminum rotors are unacceptable.

2.06 BEARINGS

A. Horizontal Motors

1. Motors shall have anti-friction open or single-shield, vacuum-degassed steel ball or roller bearings, electric motor quality, with extended pipe zerk fitting and 1/2-lb relief fitting for external lubrication while machine is in operation. The bearing shield shall be on the motor winding side of the bearing unless the design is a flow through system. If so, the bearings shall not be shielded.
2. Heavy brackets mounted from the motor frame shall support the bearing housings.
3. The bearings shall have a rated fatigue life of L10 100,000 hours for direct coupled applications, minimum.
4. When a continuous axial thrust condition exists, the motor shall be provided with a supplement thrust bearing or two anti-friction bearings of adequate size to handle the momentary and continuous thrust conditions specified.
5. A high-quality bearing seal shall be provided to prevent moisture and contaminants from entering the shaft end into the bearing, and provided with means of flushing old lubricant and introducing new lubricant. This shall be supplied in addition to tight mechanical bearing housing fits.
6. The rotor end play limits and the shaft position, when magnetically centered shall be scribed on the shaft and a suitable reference point shall be indicated on the sleeve bearing housing. The pump supplier shall provide a limited end float coupling. A minimum of 1/2-inch total shaft end float is required.
7. The opposite drive end bearing shall be insulated from shaft-bearing-frame current. Bearing temperature detectors shall also be insulated.

2.07 LEADS:

- A. Motor Leads. Use ASTM B 173, Class G, stranded copper.
- B. Provide permanent identification numbers on leads according to NEMA MG 1-2.02. Provide each lead with additional identification within six inches of the stator frame. Use crimp-on, solderless copper terminals on leads and place heat-shrink insulation sleeves or covers between leads and terminals.

- C. The motor leads shall have the same class of insulation as the motor stator windings. Leads shall be numbered for clockwise rotation when facing the opposite of the shaft end.
- D. Cable termination material shall be as manufactured by Raychem; 3M Corp.; Elastimold or equal. All material used in terminating medium voltage cables shall be as recommended by the cable manufacturer. Cables shall be terminated in accordance with the kit supplier's drawings.
- E. Cable terminations shall meet or exceed IEEE Standard 48, Class I requirements.
- F. The motor leads and medium voltage cables shall not be spliced.
- G. Cable accessories shall be by one manufacturer to assure adequate installer training and application assistance.

2.08 ENCLOSURE

- A. Unless otherwise specified, motor enclosure shall be TEFC, as specified herein and be in compliance with NEMA MG-1.
- B. The manufacturer shall arrange the intake and discharge air outlets such as to minimize the intake of air from the discharge of an adjacent motor.
- C. Air inlets and outlets shall be protected by vermin-proof, corrosion resistant louvers. The air inlets shall be located on end or side as required by the application.

2.09 HARDWARE

- A. Use structural bolts, washers, nuts, pins, and similar items manufactured of high-strength stainless steel. Use only hexagon-head bolts and hexagon nuts.

2.10 TERMINAL BOXES

- A. Description. Provide custom built, gasketed, oversized conduit boxes and terminal housing cabinets for all wiring connections to motor. The cable entrance to the boxes shall be from the bottom side. Unless otherwise shown on the Drawings, all terminal boxes shall be located on the same side of the motor. Verify exact location of cable entry, before design, from the Contract Drawings.
- B. Main Terminal Housing. The main terminal box shall be custom designed to accommodate all conductors and specified accessories located in the Terminal Housing.
 - 1. Provide NEMA multiple-hole pads with standoff insulators, as defined in NEMA MG 1 Table 20.3 to terminate the incoming motor leads.
 - 2. The motor terminal box shall be sized to accommodate prefabricated shrink-on cable terminators as manufactured by 3-M or RayChem without exceeding the minimum bending radii per cable manufacturer.

3. Motor leads shall be marked for permanent identification.
 4. Provide grounding lug in box for incoming equipment grounding conductor(s). The main terminal box shall be installed integral with the motor.
 5. Where lightning arrestors, and/or surge capacitors are shown or specified to be located in the Terminal Housing, the size of the housing shall be increased to accommodate the additional equipment.
 6. Refer to plans for conduit size entering terminal box.
- C. Space Heater Terminal Box: Provide a separate terminal box on the motor for termination of the wires on strap screw or tubular clamp terminal blocks.
 - D. RTD Terminal Box: Provide a separate terminal box on the motor for termination of motor, bearing and ambient RTD leads, for termination of the wires on tubular screw clamp terminal blocks. Box shall accommodate a 2-1/2" C minimum.
 - E. Signal leads using low voltage or current shall not be housed in the same connection box as leads carrying 120 volts or currents in excess of 1/2 ampere.
 - F. Leads shall be suitably marked and identified with heat shrink markers.
 - G. Accessories boxes shall have stainless steel nameplates, attached with stainless steel screws. The nameplates shall say "SPACE HEATER", BEARING RTD's", "WINDING RTD's", etc.
 - H. Accessories boxes shall be bottom entry.
 - I. Use only corrosion-resistant materials.
 - J. Permanently identify all leads and terminals.
 - K. All wires and electrical connections shall be copper.
 - L. All wiring penetrating the motor frame shall be protected against chaffing with grommets.

2.11 SURGE PROTECTION

- A. Provide Lightning arrester (4.5Kv) to limit the magnitude of the transient voltage spike and surge capacitor (0.5 microfarad) to limit the rate of rise of voltage. Both shall be located in the Terminal Box on the motor. The surge capacitor shall be connected between the motor and lightning arrester and capacitor lead length shall be less than three (3) feet.

2.12 GROUNDING MEANS

- A. Provide a grounding lug threaded into the motor frame within the motor terminal box and other motor conduit boxes. Lug shall be similar and equal to Burndy KC Servit.

Provide two NEMA 2-hole ground pads located near the base of the motor mounted 180° apart.

2.13 SPACE HEATERS

- A. Type. Electric resistance, 120 volts, silicon rubber clad or rubber epoxy or equivalent non-oxidizing exterior, with maximum surface temperature of 130 degrees C (266 degrees F).
- B. Alternatively, provide two stainless-steel-sheathed conventional space heaters, each with rated watts at the specified voltage equal to twice the required value, and connect in series.
- C. Space heaters shall maintain the internal temperature above dew point when motor is not operating.
- D. Heaters shall not be located directly in access opening where they may pose a danger of burn or shock to servicemen.
- E. Space heater wiring shall be routed to prevent wire being between the frame and space heater.

2.14 RESISTANCE TEMPERATURE DETECTORS (RTDs)

- A. Type: Platinum, 100 OHM at 0 degrees C.
- B. Quantity.
 - 1. Six: Two per phase for the motor windings.
 - 2. Two: One for each Motor Bearing. Each thrust bearing and lower radial guide bearing shall have a 100-ohm platinum RTD installed for sensing bearing temperature.
 - 3. One: Ambient RTD, adjacent to, or in the inlet air path, for WP1 and WP2 motors.

2.15 SPARE PARTS

- A. Manufacturer's standard shop paints for prime and finish coats are acceptable. Include one pint of finish paint for each motor. If environmental regulations prohibit paint shipment, the Contractor may supply the same paint type and color from a local source.

2.16 SPECIAL TOOLS

- A. Furnish with the equipment, one (1) set of any special tools or devices required for the assembly, operation, and maintenance of all equipment furnished.
- B. Motor manufacturer shall furnish one Altek RTD calibrator model 211, or equal, to check the proper installation of RTD's prior to final acceptance.

2.17 LUBRICANT

- A. Furnish with the equipment, oil of the recommended type and grade, in sufficient quantity for initial filling and for operation during acceptance tests and installation.
- B. The Manufacturer shall provide a list of lubricants available sources. In addition, provide the Owner with a sufficient quantity of lubricant for required service during the first 12 months after start-up.

2.18 FACTORY TESTS

- A. Perform Routine Factory Tests for Polyphase Medium Induction Motors and the tests specified herein: The method of testing shall be in accordance with IEEE Std 112, and shall be in accordance with NEMA MG1. The following tests shall be included and done at the factory on the motors provided, and certified test reports shall be submitted.
 - 1. No load power at rated voltage
 - 2. Measurement of locked rotor current
 - 3. Power factor
 - 4. Speed
 - 5. Current at rated horsepower
 - 6. KW input at rated horsepower
 - 7. No-load readings of current and speed at normal voltage and frequency.
 - 8. High-potential test per MG1-20.18 and IEEE Std 43.
- B. In addition, the motors shall receive a complete test in accordance with IEEE 112, and certified copies of the test data recorded on appropriate forms of IEEE 112, together with a certified statement of compliance with minimum specified power factor and efficiencies shall be furnished to the Owner/Engineer. The recorded data on the forms shall be in sufficient clarity and detail to permit third-party longhand validation and verification of any computer-generated results.

PART 3 EXECUTION

3.01 INSTALLATION

- A. The Contractor shall install motors in accordance with the Manufacturer's instructions and recommendations.
- B. The Contractor shall align motor carefully and properly with the driven equipment.
- C. The Contractor shall secure equipment to mounting surface with anchor bolts. Provide anchor bolts meeting Manufacturer's recommendation and of sufficient size and number

for the specified load conditions.

- D. Inspect each motor for physical damage.
- E. Inspect each motor for proper installation, rated voltage, phase and speed.
- F. Provide electrical wiring and connections as specified herein and in Division 16.
- G. Lubricate oil-lubricated bearings.
- H. Check for proper phase and ground connections.

3.02 MOTOR MANUFACTURER SERVICE ENGINEER: FIELD TESTING

- A. The motor manufacturer shall furnish the services of a competent service engineer, who shall have had a minimum of five years experience in the installation, adjustment, and operation of the equipment that is being furnished under this contract. This service is to ensure proper installation and adjustment of the motor, instruct personnel in proper operation, maintenance, and care of the equipment, for making operation tests of equipment, and recommendations for obtaining the most efficient use thereof.
- B. The service engineer shall arrive at the site after the motor installation but prior to testing and start-up. He shall verify the proper installation, alignment, wiring, lubrication, and connection of all appurtenances prior to start-up. He shall be present during testing, and start-up and shall certify to the Owner in writing that the motors have been properly installed and operate satisfactorily.
- C. Minimum 24 hours required to be on-site, not including travel time, on at least four (4) different occasions to be coordinated with field service requirements in Section 11110:
 - 1. Check motor installation
 - 2. Pump start-up and testing
 - 3. Troubleshooting
 - 4. Personnel training
- D. Field-Testing: The following tests shall be performed on the motors after installation in the field.
 - 1. Polarization Index Test: Measure and record the motor's insulation resistance polarization index (10 minute \ 1 minute ratio), at 2500 VDC, per IEEE Standard 43. Minimum acceptable polarization index ration shall be greater than 2.0 (>2.0).
 - 2. Motors shall have a 1-hour run-in while uncoupled from the driven load. The motor temperatures shall be monitored and recorded, every 5 minutes from just before start to the end of the hour test. Record operating amps, voltage, and vibration levels.

3. Monitor motors during startup and commissioning to record operating amps, voltage and operating vibration levels.
 4. Submit test report and all recorded field data. Submit copies of the raw data recorded in the field, signed by the person recording the data, and typewritten reports certified by the Contractor. The motors will not be accepted until the reports are submitted and approved.
- E. Inspect for unusual mechanical or electrical noise or signs of overheating during initial test run.

3.03 EQUIPMENT PROTECTION AND RESTORATION

- A. Touch-up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

3.04 MANUFACTURER'S CERTIFICATION

- A. A qualified factory-trained manufacturer's engineer shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.
- B. The Contractor shall provide an electronic copy of the manufacturer's service engineer's certification.

3.05 TRAINING

- A. Motor Manufacturer shall provide services for training in accordance with Section 11110.
- B. The cost of training program to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the equipment being supplied.
- C. Provide detailed O&M manuals to supplement the training course. The manuals shall include specific details of equipment supplied and operations specific to the project.
- D. The training session shall be conducted by a manufacturer's qualified representative.
- E. The Owner shall have the right to videotape the training for the Owner's use.

END OF SECTION



APPENDIX A

DIVISION 1

GENERAL REQUIREMENTS

SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. This section describes the requirements for preparing and presenting submittals that are necessary for the execution of this contract. Requirements within the following subject areas are included:
1. Definitions.
 2. Procedures.
 3. Product Data.
 4. Shop drawings.
 5. Samples.
 6. Manufacturer's certificates.
 7. Miscellaneous submittals.
 8. Schedule of Values.
 9. Quality Control Documentation (Blank Copies of Report).

1.02 DEFINITIONS

- A. Product Data and Shop Drawing - General Definition
1. Drawings, diagrams, illustrations, brochures, schedules, bills of materials and other data prepared by the EARLY PROCUREMENT EQUIPMENT SUPPLIER (SUPPLIER), his subcontractors, suppliers or distributors, or equipment manufacturers and fabricators; illustrating the manufacture, fabrication, construction, or installation of the Work or a portion thereof.
- B. Shop Drawings
1. Assembly and fabrication drawings, bills of materials for items shop fabricated exclusively for this project. In addition, shop drawings should show fabrication details of each part, the assembly of each part and how each part and/or assembly is integrated into the project including existing parts or assemblies.

C. Manufacturer's Representative

1. Manufacturer's representative shall be from the manufacturer's plant with five (5) years of experience in the actual problems of manufacturing, installing, and operating the particular product. Sales representatives or agents of the manufacturer will not be acceptable.

D. Working Drawings

1. SUPPLIER prepared plans for temporary structures and facilities. Working drawings for elements of work that may affect the safety and health of persons or property will be certified by an engineer licensed in the State of Texas. Calculations, as necessary, will accompany working drawings.

E. Design Calculations

1. Whenever the SUPPLIER is required to submit design calculations as part of a submittal, such calculations shall bear the signature and seal of a professional engineer registered in the appropriate branch. ENGINEER reserves the right to request submittal by SUPPLIER of a hard copy of design calculations.

1.03 PROCEDURES

A. Electronic Submittal Procedures

1. All electronic submittals shall be transmitted in Portable Document Format (PDF) as generated by the Adobe Acrobat Professional Version 7.0 or higher.
2. It will be the SUPPLIER's responsibility to scan all necessary documents or convert previously received electronic files from vendors into pdf format before uploading the files to the specific designated project site. Scanned images must be at a readable resolution. For most documents, they should be scanned at 300 dots per inch (dpi). Optical character Recognition (OCR) capture must be performed on these images so that text can be searched and copied from the generated PDF file.
3. When it is not possible to make submittals electronically, SUPPLIER may deliver submittals to OWNER using conventional mail only after securing OWNER's written approval. When electronic submittals are not possible, hard copy submissions will be made as required in this section. Submittal of a transmittal page into the contract-specific Prolog site of Portal by SUPPLIER shall still be required for recordkeeping.
4. When electronic submittal is not possible and upon securing OWNER's written approval, SUPPLIER may submit hard copies of product data and shop drawings according to the following distribution list:
 - a. OWNER's designated Agent (if applicable): Three (3) copies.
 - b. OWNER (if a designated Agent reviews the submittals): One (1) copy.
 - c. ENGINEER: One (1) copy.

5. If regular mail delivery is approved by OWNER, the submittal transmittal form shall still be logged into the contract specific Contract and Project Management System (CPMS) by SUPPLIER for record keeping purposes.
6. All responses to a submittal by ENGINEER will be made electronically and no hard copies of the response will be sent to SUPPLIER.

B. Supplier's Responsibilities

1. Submit a list of specified submittals and identify the long lead items to the OWNER within five (5) calendar days of receipt of the Notice to Proceed (NTP).
2. Within 30 days after the pre-construction conference and at the same time that the initial critical path schedule is submitted, a schedule shall be submitted of the items of materials and equipment for which shop drawings are required by the specifications. For each required shop drawing, the date shall be given for intended submission of the drawing to ENGINEER for review and the date required for its return to avoid delay in any activity beyond the scheduled start date. Sufficient time shall be allowed for initial review, correction and resubmission, and final review of all shop drawings. In no case shall a schedule be acceptable which allows less than 21 days for each review by ENGINEER.
3. SUPPLIER to approve all submittals prior to submission.
4. SUPPLIER shall submit dimensional and layout drawings and product data, certified correct for construction, for review by the ENGINEER.
5. Submit shop drawings and product data in accordance with the approved submittal schedule. Also, submit shop drawings to the ENGINEER for review prior to their need in the Work, allowing sufficient time for the ENGINEER's review and the SUPPLIER response.
6. SUPPLIER shall make specific mention of those items that vary from the requirements of the Contract Documents in the letter of transmittal. The letter transmittal shall include the specification number, detail name/number, or plan sheet of the item being submitted.
7. Submit shop drawings and product data covering related items of equipment or material or integrated systems of equipment or material at the same time. Partial submissions will not be accepted.
8. All submittals, regardless of origin, shall be stamped with the approval of SUPPLIER and identified with the name and number of this contract, SUPPLIER name, and references to applicable specification paragraphs and Contract Drawings. Each submittal shall indicate the intended use of the item in the Work. When catalog pages are submitted, applicable items shall be clearly identified and inapplicable data crossed out. The current revision, issue number, and date shall be indicated on all drawings and other descriptive data.
9. SUPPLIER shall be solely responsible for the completeness of each submission. SUPPLIER stamp of approval is a representation to OWNER that SUPPLIER accepts sole responsibility for determining and verifying all quantities, dimensions, field construction criteria,

materials, catalog number, and similar data, and that SUPPLIER has reviewed and coordinated each submittal with the requirements of the Work and the Contract Documents.

10. SUPPLIER shall coordinate shop drawings and product data with drawings previously submitted, with drawings being prepared, and with drawings and data previously approved. All such coordination shall be indicated by reference.
11. SUPPLIER shall assign a sequential number to each submittal.
 - a. Assignment of numbers shall be by means of a letter prefix, a sequence number, a letter suffix to indicate resubmittals and a specification number. For example, submittal SD-012C-01300 is the third re-submittal of the twelfth Shop Drawing for the Project.
 - b. The sequence number shall be issued in chronological order. Resubmittals shall be followed by a letter of the alphabet to indicate the number of times a submittal has been resubmitted to the ENGINEER for processing. As an example, a shop drawing with the number SD-001 indicates that the submittal is the first shop drawing submitted for the project. Shop Drawing Number SD-002A indicates that the submittal is the second shop drawing submitted for and is being submitted for the second time. Acceptable prefixes for submittals are as follows:

i.	SD -Shop Drawing
ii.	PS – Project Schedule
iii.	RD – Record Data
iv.	OM – Operation and Maintenance Manual
 - c. Correct assignment of numbers is essential as different submittal types are processed in different ways. Some submittals received do not require that any response be given for the material. SUPPLIER and ENGINEER shall both maintain a log of submissions to allow the processing of SUPPLIER's submittals to be monitored. Logs will be reviewed periodically to determine that all submittals are received and processed.
 - d. Submittals shall be marked to show clearly the applicable sections of the specification and sheet number of drawings.
 - e. Submittals shall be accompanied by a Submittal Transmittal Form to be provided by the OWNER. A separate form shall be used for each specific item, class of material, equipment, and items specified in separate discrete sections, etc. for which a submittal is required. Submittals for various items shall be made with a single form when the items taken together constitute a manufacturer's package or are so functionally related that they should be.
12. SUPPLIER shall not deliver to the site, storage, or incorporate into the Work, any materials or equipment for which approved submittals have not been obtained.
13. If a submittal is returned to the SUPPLIER marked “NO EXCEPTIONS NOTED”, formal revision and resubmission shall not be required. SUPPLIER may proceed to perform submittal related Work.

14. If a submittal is returned marked “EXCEPTIONS NOTED”, SUPPLIER shall make the corrections on the submittal, but formal revision and resubmission shall not be required and the SUPPLIER shall proceed with the Work.
15. If a submittal is returned marked “RETURNED FOR CORRECTION,” the SUPPLIER shall revise it and resubmit to the OWNER for review. Resubmittal and a grade of “NO EXCEPTIONS NOTED” or “EXCEPTIONS NOTED” is required before the SUPPLIER may proceed with the Work, unless approved in writing by the OWNER. Resubmittal of portions of multi-page or multi-drawing submittals shall not be allowed. For example, if a Shop Drawing submittal consisting of 10 drawings contains one drawing noted as “RETURNED FOR CORRECTION”, the submittal as a whole is deemed “RETURNED FOR CORRECTION”, and all 10 drawings are required to be resubmitted.
16. If a submittal is returned marked “NOT ACCEPTABLE,” it shall mean either that the submitted material or product does not satisfy the Specification, the submittal is so incomplete that it cannot be reviewed, or it is a substitution request not in accordance with the General Conditions of the Contract. SUPPLIER shall prepare and deliver a new submittal to the ENGINEER for review.
17. Resubmittal of rejected portions of a previous submittal shall not be allowed. When resubmittals are needed, every change from a submittal to a resubmittal or from a resubmittal to a subsequent resubmittal shall be clearly identified and flagged on the resubmittal by SUPPLIER.
18. When resubmittals are needed, resubmittals shall be made within 30 days of the date on which documents to be modified or corrected were posted on CPMS by ENGINEER or its designated reviewer (electronic submittals) or of the postmark date of the letter returning the material (if a hard copy-type submittal was approved by OWNER), whichever is later. A time extension shall be considered by ENGINEER only if within the required number of days SUPPLIER submits an acceptable request for an extension of time, listing the reasons why the resubmittal cannot be completed within the stipulated time.
19. The need for more than one resubmittal, or any other delay in obtaining ENGINEER’s review of submittals, shall not entitle SUPPLIER to extension of the Contract Times unless delay of the Work is the direct result of a change in the Work authorized by a Change Order or failure of OWNER to review and return any submittal to SUPPLIER within the specified review period.
20. SUPPLIER shall not deliver to the site, store, or incorporate into the Work, any materials or equipment for which approved submittals have not been obtained.
21. When electronic submittals are not possible, hard copy submissions shall be made as required in this Section. Submittal of a transmittal form into the contract-specific web-based project management system by SUPPLIER shall still be required for record keeping.
22. SUPPLIER is responsible for frequent monitoring of the web-based documents and the submittal process status.

C. ENGINEER Responsibility

1. ENGINEER will conduct a thorough review within 21 calendar days after its receipt in CPMS so as not to create delay. This review will be for general conformance, subject to the requirements of the Contract Documents, and will be an effort to assist the SUPPLIER to discover errors and omissions in submittals. ENGINEER review, approval, or other appropriate action regarding SUPPLIER submissions will be only to check conformity with the design concept of the Project and for compliance with the information contained in the Contract Documents and shall not extend to means, methods, techniques, sequences or procedures of construction (except where a specific means, method, technique, sequence or procedure of construction is indicated in or required by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate component item will not indicate approval of the assembly into which the item is functionally integrated. SUPPLIER shall make corrections required by ENGINEER, and shall return the required number of corrected copies of Shop Drawings to the OWNER. SUPPLIER may be required to resubmit, as required, revised Shop Drawings or Samples for further review and approval. SUPPLIER shall direct specific attention in writing to any new revisions not specified by SUPPLIER on previous SUPPLIER submissions.
2. ENGINEER review does not relieve the SUPPLIER of the obligation and responsibility to coordinate the Work and plan the details of the Work.
3. The OWNER reserves the right to require written confirmation from the SUPPLIER that the comments placed on submittals stamped "Exceptions Noted" will actually be followed.
4. Review by the ENGINEER will not be construed as relieving the SUPPLIER of the responsibility for the accuracy, proper fit, functioning, or performance of the Work.

1.04 PRODUCT DATA

- A. Product data, including materials reproduced from manufacturer's product catalogs will not be larger than 8 ½" by 11" in size.
- B. Catalog data will be explicit with regards to the name of the manufacturer and to the details of the products being furnished. It will also be complete enough to enable the OWNER to determine that the products being submitted conform to the requirements of the Specifications.
- C. For submittals with more than one style or size of a product on a sheet, the SUPPLIER will clearly indicate which product is being submitted for review.
- D. SUPPLIER will provide electronic submittals in .pdf format of all product data to the OWNER. Files shall be readable using Adobe Acrobat Reader Version 7.0.

1.05 SHOP DRAWINGS

- A. SUPPLIER shall reasonably check and verify all field measurements and will submit to the OWNER for review and approval. These shop drawings will bear a stamp from the SUPPLIER that indicates that the SUPPLIER has reviewed the shop drawings and that the submittal is complete and in compliance with Contract Documents.

- B. Substitute and “Or Approved Equal” Items: Meet requirements of Paragraph 5.12 of the General Conditions.
- C. SUPPLIER will submit detailed drawings and descriptions of proposed deviations from details or component arrangement indicated on the Plans.
- D. Single line drawings will not be acceptable. Copies of the Plans will not be accepted for submission as drawings, nor will catalog numbers alone of materials or equipment.
- E. SUPPLIER will submit electronic copies in .pdf format of each shop drawing to the OWNER for review. Files shall be readable using Adobe Acrobat Reader 7.0.

1.06 SAMPLES

- A. SUPPLIER will furnish samples of items and materials as required. Samples shall be submitted to the OWNER in duplicate. Each sample will be properly labeled and identified by providing the following:
 - 1. Date.
 - 2. Job name for which it is offered.
 - 3. Specification section and paragraph.
 - 4. SUPPLIER’s name.
 - 5. Supplier and trade name.
 - 6. Other data indicating conformance to the Specifications.
 - 7. Color charts or samples with manufacturer’s number.

1.07 MANUFACTURER’S CERTIFICATES AND AFFIDAVITS

- A. Where specified in the Contract Documents that a certificate and affidavit shall be submitted to the OWNER for review of a particular product, or component of a product, such submittals shall be made in accordance with the following:
 - 1. A certificate submitted for a product, or component of a product, indicates test results proving that product, or component of a product, meets the requirements of the standard specified in the Contract Documents.
 - 2. An affidavit consisting of a sworn statement by an official of the company manufacturing the product indicating that the information on the certificate is true and accurate shall accompany the certificate.
 - 3. A statement from the SUPPLIER, or his subcontractors, suppliers, or other agent which indicates that a particular item of equipment, product, or component of a product, meets the

requirements of the Contract Documents shall not be considered a certificate and will not be approved.

1.08 MANUFACTURER'S REPRESENTATIVE

- A. SUPPLIER will include in the Contract Price the cost of furnishing competent and experienced manufacturer's representatives who will represent the manufacturer on products finished and to assist the SUPPLIER to install the products in conformity with the Contract Documents.

1.09 MISCELLANEOUS SUBMISSIONS

- A. Provide the following submissions electronically using the designated project website (to be defined during the initial construction meeting). Files shall be readable using Adobe Acrobat Reader 7.0. Provide hard copies as requested by OWNER.

1. Work plans.
2. Quality Control (QC) Plan.
 - (i) QC Plan must be submitted and approved prior to commencing Work.
3. Accident reports.
4. Inspection and test reports.
5. Guarantees and warranties.
6. Operation and Maintenance Manuals.
7. Course of Action Plan (Fuel Spill or Other Substances).
 - (i) SUPPLIER must submit the Course of Action Plan (Fuel Spill or Other Substances) to the OWNER prior to start of construction.
 - (ii) With regard to the accidental spill of fuel, the Plan must address the procedures required by applicable regulations and laws.
8. SUPPLIER's Safety and Health Plan.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

SECTION 01600

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This Section describes the requirements for material and equipment that are necessary for the execution of this contract. Requirements within the following subject areas are included:
1. Products.
 2. Preparation for shipment.
 3. Packaging and delivery of spare parts and tools.
 4. Shipment and handling.
 5. Inspection
 6. Storage and protection
 7. Inventory control.
 8. Product options.
 9. Substitutions.
 10. Systems demonstration.
 11. Warranties.

1.02 PRODUCTS

- A. The term "products" means new material, machinery, components, equipment, fixtures, and systems forming the Work. It does not include machinery and equipment used for preparation, fabrication, conveying, and erection of the Work. Products may also include existing materials or components required for reuse.
- B. Do not use materials and equipment salvaged from this project, except as specifically permitted by the Plans.
- C. Materials and equipment to be provided under this contract shall be standard catalogue products of manufacturers regularly engaged in the manufacture of the products and shall duplicate material and equipment in satisfactory service for at least two (2) years.
- D. Material and equipment shall meet the requirements of the Contract and shall be suitable for the installation for which they are planned. Where two (2) or more of the same equipment class are furnished, the equipment shall be from the same manufacturer and shall be interchangeable. Materials and equipment shall be new and free from defects.

- E. Materials and equipment shall be installed in accordance with the requirements of the Plans and approved recommendations of the manufacturer.

1.03 PREPARATION FOR SHIPMENT

- A. When practical, equipment shall be factory assembled. The equipment parts and assemblies that are shipped unassembled shall be furnished with an assembly plan and instructions. The separate parts and assemblies will be match-marked or tagged in a manner to facilitate field assembly.
- B. Generally, machined and unpainted parts subject to damage by the elements shall be protected with an application of a strippable protective coating.
- C. Equipment shall be packaged or crated in a manner that will provide protection from damage during shipping, handling, and storage.
- D. The outside of the package or crate shall be adequately marked or tagged to indicate its contents by name and equipment number, if applicable, approximate weight, special handling precautions, and recommended storage procedures.

1.04 PACKAGING AND DELIVERY OF SPARE PARTS AND SPECIAL TOOLS

- A. Spare parts and special tools shall be properly marked to identify the associated equipment by name, equipment type, and part number. Parts shall be packaged in a manner for protection against damage from the elements during shipping, handling, and storage. Spare parts and special tools shall be shipped in boxes that shall be marked to indicate the contents. Delivery of spare parts and special tools shall be made prior to the time the associated equipment is scheduled for its initial test run.

1.05 SHIPMENT AND HANDLING

- A. Shipments shall be addressed to the CONTRACTOR who will be responsible for their receipt, unloading, handling, and storage at the site. The OWNER will not accept deliveries on behalf of the CONTRACTOR or his subcontractors nor assume responsibility for the security of the materials, equipment, or supplies delivered to the site.
- B. CONTRACTOR will transport and handle products in accordance with manufacturer's instructions.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.06 INSPECTION

- A. Immediately upon receipt of equipment and materials at the job site, the CONTRACTOR will inspect for completeness and any evidence of damage. Should there appear to be any damage, the CONTRACTOR will immediately notify the Construction Observer/Inspector (COI).

CONTRACTOR will then be responsible for notifying the manufacturers and the transportation company of the extent of the damage. If the item or items require replacing, the CONTRACTOR will take the necessary measures for replacement.

1.07 STORAGE AND PROTECTION

- A. CONTRACTOR will store products in accordance with the manufacturer's instructions, with seals and labels intact and legible. Sensitive items will be stored in weather-tight enclosures; with the humidity and temperature maintained within the ranges recommended by the manufacturer.
- B. For exterior storage of fabricated products, the CONTRACTOR will place on sloped supports above ground. Products that are subject to deterioration will be covered with an impervious sheet and will be supplied with adequate ventilation to avoid condensation.
- C. CONTRACTOR will store loose granular materials on solid surfaces in a well-drained area in such a manner as to prevent mixing.
- D. CONTRACTOR shall arrange to provide access for inspection. He will also periodically inspect to ensure products are undamaged and are maintained under required conditions.

1.08 INVENTORY CONTROL

- A. Equipment and materials shall be stored in a manner to provide easy access for inspection and inventory control. CONTRACTOR shall keep a running account of all materials in storage to facilitate inspection and to estimate progress payments for materials delivered but not installed in the Work.

1.09 PRODUCT OPTIONS

- A. CONTRACTOR has the following options in providing products specified for the Work:
 - 1. Products specified by reference standards or by description only: CONTRACTOR may provide any product meeting the standard.
 - 2. Products specified by naming one or more manufacturers: CONTRACTOR may provide the product from the named manufacturer or he may submit a request for substitution for any manufacturer not specifically named.

1.10 SUBSTITUTIONS

- A. Only after execution of the Contract will the OWNER consider requests from the CONTRACTOR for substitutions. Substitutions will be considered only when a product becomes unavailable due to no fault of the CONTRACTOR or is shown to be superior to the specified product.

- B. CONTRACTOR will document each request with complete data substantiating compliance of proposed substitution with the Contract Documents. Each request constitutes a declaration from the CONTRACTOR that:
 - 1. CONTRACTOR has investigated the proposed product and determined that it meets or exceeds, in all respects, the specified product.
 - 2. CONTRACTOR will provide the same warranty for substitution as for the specified product.
 - 3. CONTRACTOR will coordinate installation and make all other changes, which may be required for the Work to be complete in all respects.
 - 4. CONTRACTOR waives claims for additional costs and/or time, which may subsequently become apparent.
- C. Substitutions will not be considered when they are indicated or implied on shop drawings or product data submittals without a separate written request, or when acceptance will require substantial revision of the Contract Documents.
- D. OWNER will determine acceptability of proposed substitution, and will notify CONTRACTOR of acceptance or rejection in writing within a reasonable period of time.
- E. Only one request for substitution will be considered for each product. When substitution is not accepted, the CONTRACTOR will provide the specified product.

1.11 SYSTEMS DEMONSTRATION

- A. Prior to final inspection, demonstrate operation of each system to the OWNER.
- B. CONTRACTOR will instruct the OWNER's personnel in operation, adjustment, and maintenance of equipment and systems, using the operation and maintenance data as the basis of instruction.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

SECTION 01640

MANUFACTURER'S FIELD SERVICES

PART 1 GENERAL

1.01 SCOPE

This section shall govern the requirements established for MANUFACTURER'S field services associated with the installation of equipment.

1.02 RELATED WORK

- A. Section 01300 – Submittals
- B. Section 01600 – Material and Equipment
- C. Section 01752 – Facility Start Up/Commissioning Requirements

1.03 DESCRIPTION OF WORK

CONTRACTOR shall arrange for and coordinate the MANUFACTURER'S services as specified below.

1.04 SUBMITTALS

- A. Training Plan (Pre Start Up and Post Start Up):
 - 1. Submit not less than 21 calendar days prior to start of equipment testing and revise as necessary for OWNER's acceptance.
 - 2. Submit MANUFACTURER'S tentative training schedule, training plan, and contact person not less than 60 calendar days prior to commencement of any training.
 - a. MANUFACTURER'S proposed Training Plan shall include the elements presented in the Outline of Instruction Training Plan specified herein. Specific components and procedures shall be identified in the proposed Training Plan. Hands-on demonstrations planned for the instruction shall be described in the Training Plan. The MANUFACTURER shall indicate the estimated duration of each segment of the Training Plan.
 - b. Outline of Instruction Training Plan:
 - i. Equipment Description and Purpose
 - ii. Equipment operation
 - iii. Detailed component description
 - iv. Equipment preventative maintenance (PM)
 - v. Equipment troubleshooting
 - vi. Equipment corrective maintenance

3. Provide complete training materials, to include operation and maintenance data as required in this section to be retained by each trainee.
- B. Quality Control Submittals:
1. MANUFACTURER'S Certificate of Proper Installation:
 - a. When specified in the individual equipment specification sections or Equipment Schedule, submit certificate certifying:
 - i. The product or system has been installed in accordance with the MANUFACTURER'S recommendations, inspected by a MANUFACTURER'S authorized representative, and serviced with the proper lubricants.
 - ii. Necessary safety equipment has been properly installed.
 - iii. Electrical and mechanical connections have been made meeting quality and safety standards as required.
 - iv. Free from undue stress imposed by exterior connections or loads.
 - v. Proper adjustments have been made and the product or system is ready for testing, facilities startup, operational test, and operation.
 - b. Submit MANUFACTURER'S Certificated of Proper Installation Form at end of this Specification.
 4. Certificate of Successful Equipment Testing: Prepare and submit where specified in individual equipment specification sections or Equipment Schedule, and upon completion of successful testing of respective equipment by the CONTRACTOR. See Certificate of Successful Equipment Testing Form at end of this Specification.
 5. Certificate of Successful Equipment System, Subsystem or Component, Start Up Testing including Functional and Performance Tests: Prepare and submit where specified in individual equipment specification sections or Equipment Schedule, and upon completion of successful Start Up testing of respective equipment system, subsystem or component by the CONTRACTOR. See Certificate of Successful Equipment System, subsystem or component Start Up Testing Form at end of this Specification.
 6. Certificate of qualification of MANUFACTURER'S representative.

1.05 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

Authorized representative of the MANUFACTURER, Certified by MANUFACTURER, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, system, subsystem, or component. Representative subject to acceptance by OWNER. No substitute representatives will be allowed unless prior written approval by OWNER has been given.

1.06 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

- A. Where MANUFACTURER'S field services are specified, furnish MANUFACTURER'S representative qualified to provide these services. Where time is necessary in excess of that

stated in the Contract Documents for MANUFACTURER'S field services, additional time required to perform the specified services shall be considered incidental work.

- B. Coordinate and Schedule MANUFACTURER'S field services to avoid conflicting with other field testing or other MANUFACTURER'S field services. Determine that all conditions necessary to allow successful testing have been met before scheduling field services.
- C. Only those days of service approved by OWNER will be credited to fulfill the specified minimum services.
- D. If specified, MANUFACTURER'S field services shall include as a minimum:
 - 1. Assistance during installation to include observation, guidance, instruction of CONTRACTOR's assembly, erection, installation or application procedures.
 - 2. Inspection, checking, and adjustment as required for equipment to function as warranted by MANUFACTURER and necessary to provide written approval of installation.
 - 3. Revisiting the site as required to correct problems and until installation and operation are acceptable to OWNER.
 - 4. Resolution of assembly or installation problems attributable to, or associated with, respective MANUFACTURER'S products, equipment, system, subsystem and components.
 - 5. Assistance during testing and Start Up demonstration, and until product acceptance by the OWNER.
 - 6. Training of OWNER's personnel in the operation and maintenance of respective products as required herein.
 - 7. Completion of MANUFACTURER'S Certificate of Proper Installation and applicable certificates of Successful Equipment Testing and Successful Equipment System, Subsystem or Component Start Up Testing, as required, including functional and performance tests service. (Forms at the end of this Specification)

1.07 TRAINING SCHEDULE

- A. List specified equipment, system, subsystem, and component with respective MANUFACTURERS that require training services of MANUFACTURER'S representatives and show:
 - 1. Estimated dates for installation completion.
 - 2. Estimate training dates to allow for multiple sessions when several shifts are involved.

3. Use Equipment Schedule as guidance and revise as needed to meet individual equipment specifications or MANUFACTURER'S requirements for the preparation of estimated dates. Dates must be included as milestones on general project schedule, and must be coordinated as to allow completion of the project including Start Up Phase by Substantial Completion Date.
- B. Adjust training schedule to ensure training of appropriate personnel as deemed necessary by OWNER and to allow full participation by MANUFACTURER'S representatives. Adjust schedule for interruptions in operability of equipment.
 - C. Training shall not proceed until all individual equipment, systems, subsystems or components have been installed and approved by the MANUFACTURER and completed the testing requirements indicated in specification 01650.
 - D. Pre Start Up Training:
 1. Coordinate and furnish classroom training sessions with the OWNER's operating personnel and MANUFACTURER'S representatives.
 2. Conduct training prior to as defined in Specification Section 01752 – Facility Start-up/Commissioning Requirements.
 3. Provide Draft O&M Manuals.
 - E. Post Start Up Training:
 1. Coordinate and furnish on-site training sessions with the OWNER's operating personnel and MANUFACTURER'S representatives.
 2. Conduct after Facility Start Up, but prior to Operational Testing of the equipment as defined in Specification Section 01752.
 3. Provide Final O&M Manuals.

1.08 TRAINING OWNER'S PERSONNEL

- A. Provide trained, articulate personnel acceptable to the OWNER to coordinate and expedite training, to be present during training coordination meetings with OWNER and familiar with operation and maintenance manual information.
- B. MANUFACTURER'S Representative shall provide the number of days of training for equipment as indicated in the Equipment Schedule section. Operator training days shall be in addition to MANUFACTURER'S field services required as indicated in the Equipment Schedule and submittals sections.
 1. All training will be performed during the operating staff's normal business hours and at other times requested and approved by the OWNER.
- C. MANUFACTURER'S representatives to provide detailed training to OWNER's personnel on operation and maintenance of specified product (equipment, system, subsystem, and

component) and as required in applicable Contract Documents. This includes operation, disassembly, and assembly of major equipment items, start up, shutdown, safety concerns, troubleshooting, installation, alignment, and recommended corrective and preventative maintenance procedures for all equipment.

1. Training services include Pre Start Up classroom instruction and Post Start Up onsite hands-on instruction.
2. MANUFACTURER'S Representative shall be familiar with system operation and maintenance requirements for specified equipment, system, subsystem, or component.

D. Taping of Training Sessions: MANUFACTURER to videotape Pre Start and Post Start Up training sessions and furnish to the OWNER.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

SAN ANTONIO WATER SYSTEM
EQPT TAG NO.: _____
PROJECT NO.: _____

EQPT SERIAL NO.: _____
EQPT/SYSTEM: _____
SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

- Installed in accordance with MANUFACTURER'S recommendations.
- Inspected, checked, and adjusted.
- Serviced with proper initial lubricants.
- Electrical and mechanical connections meet quality and safety standards.
- All applicable safety equipment has been properly installed.

Comments: _____

I, the undersigned MANUFACTURER'S Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Manufacturer: _____

By MANUFACTURER'S Authorized Representative: _____
(Print Name/Authorized Signature)

CERTIFICATE OF SUCCESSFUL EQUIPMENT TESTING

SAN ANTONIO WATER SYSTEM
EQPT TAG NO.: _____
PROJECT NO.: _____

EQPT SERIAL NO.: _____
EQPT/SYSTEM: _____
SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

- Serviced for proper operation, efficiency, and capacity.
- Field adjusted for secure satisfactory operation.
- Tested continuously under actual or simulated operation conditions.
- Tested over the full range of speed and pressure.
- Tested at every level of control.

Comments: _____

I, the undersigned Contractor's Representative, hereby certify that I am (i) a duly authorized representative of the contractor, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Contractor: _____

By Manufacturer/Supplier Authorized Representative: _____
(Print Name/Authorized Signature)

By Contractor's Authorized Representative: _____
(Print Name/Authorized Signature)

CERTIFICATE OF SUCCESSFUL EQUIPMENT SYSTEM, SUBSYSTEM OR COMPONENT START UP TESTING

SAN ANTONIO WATER SYSTEM
EQPT TAG NO.: _____
PROJECT NO.: _____

EQPT SERIAL NO.: _____
EQPT/SYSTEM: _____
SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

- Demonstrate all operational features, instrumentation, and control functions while in automatic mode.
 - Checked for proper installation, started and successfully tested.
- System has been functionally tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer.)
- System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer.)
- Facility is ready for intended operation.

Comments: _____

I, the undersigned Contractor's Representative, hereby certify that I am (I) a duly authorized representative of the contractor, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Contractor: _____

By Manufacturer/Supplier Authorized Representative: _____
(If Required) (Print Name/Authorized Signature)

By Contractor's Authorized Representative: _____
(Print Name/Authorized Signature)

END OF SECTION

SECTION 01730

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 DEFINITIONS

- A. Maintenance Operation: As used in the Maintenance Summary Form, attached to this specification, maintenance operation is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.
- B. System and Subsystem: Refer to Section 01652 – System Operation and Section 01752 – Facility Startup and Commissioning Requirements.

1.02 QUALITY ASSURANCE

- A. Manuals for equipment and systems shall be prepared by equipment manufacturer or system Supplier.

1.03 SEQUENCING AND SCHEDULING

- A. Manual Outline: Submit detailed outline of each manual prior to preparation of Preliminary Manuals.
- B. Manuals for Equipment and Systems:
 - 1. Preliminary Manuals: Submit prior to shipment date for equipment, system, subsystem, or component. Include copy of warranties, bonds, and service agreements if specified.
 - 2. Final Manuals: Submit not less than 30 days prior to equipment or system field testing or startup.
- C. Manuals for Materials and Finishes:
 - 1. Preliminary Manuals: Submit at least 30 days prior to request for final inspection.
 - 2. Final Manuals: Submit within 10 days after final inspection.

1.04 GENERAL

- A. Furnish for each item of equipment or system as specified in the individual Specification sections.
- B. Prepare data for use by OWNER's personnel in the form of an instructional manual in both paper format and on electronic media. Data for electronic media shall be provided to OWNER on optical compact disc.

C. Manual Format:

1. Size: 8-1/2 inches x 11 inches.
2. Paper: 20-pound minimum, white for typed pages.
3. Text: Manufacturer's printed data, or neatly typewritten.
4. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
5. Provide flyleaf for each separate product or each piece of operating equipment, with typed description of product and major component parts of equipment and provide with heavy section dividers with numbered plastic index tabs.
6. Provide each manual with title page, and typed table of contents with consecutive page numbers. Place contents of entire set, identified by volume number, in each binder.
7. Cover: Identify each volume with typed or printed title "OPERATION AND MAINTENANCE MANUAL, VOLUME NO. – OF –", if applicable, and list:
 - a. Project title.
 - b. Designate the system or equipment for which it is intended.
 - c. Identity of separate structure as applicable.
 - d. Identity of equipment number and Specification section.
8. Assemble and bind material in same order as specified, as much as possible.
9. Final copy shall not have fax copies or photocopies of manufacturer information. Each manual shall have original materials.
10. Binders:
 - a. Preliminary Manuals: Heavy paper covers.
 - b. Final Manuals: Commercial quality, substantial, permanent, three-ring binders with durable, cleanable, plastic binders.
11. Table of contents neatly typewritten, arranged in a systematic order:
 - a. CONTRACTOR, name of responsible principal, address, and telephone number.
 - b. List of each product required to be included, indexed to content of each volume.

- c. List with Each Product: Name, address, and telephone number of Subcontractor, Supplier, installer, and maintenance contractor, as appropriate.
 - i. Identify area of responsibility of each.
 - ii. Provide local source of supply for parts and replacement.
 - d. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
12. Product Data:
- a. Include only those sheets that are pertinent to specific product.
 - b. Clearly annotate each sheet to:
 - i. Identify specific product or part installed.
 - ii. Identify data applicable to installation.
 - iii. Delete references to inapplicable information.
13. Drawings: Supplement product data with Drawings as necessary to clearly illustrate:
- a. Relations of component parts of equipment and systems.
 - b. Control and flow diagrams.
 - c. Coordinate drawings with Project record documents to assure correct illustration of completed installation.
 - d. Do not use Project record documents as maintenance manual drawings.
 - e. Provide reinforced punched binder tab, bind in with text.
 - f. Reduced to 8-1/2 inches x 11 inches, or 11 inches x 17 inches folded to 8-1/2 inches x 11 inches.
 - g. Where reduction is impractical, fold and place in 8-1/2-inch x 11-inch envelopes bound in text.
 - h. Identify Specification section and product on Drawings and envelopes.
14. Instructions and Procedures: Within text, as required to supplement product data.

- a. Handling, storage, maintenance during storage, assembly, erection, installation, adjusting, testing, operating, shutdown in emergency, troubleshooting, maintenance, interface, and as may otherwise be required.
 - b. Organize in a consistent format under separate heading for each different procedure.
 - c. Provide a logical sequence of instructions for each procedure.
 - d. Provide information sheet for OWNER's personnel, including:
 - i. Proper procedures in the event of failure.
 - ii. Instances that might affect the validity of warranties or Bonds.
15. Warranties, Bonds, and Service Agreements.
- D. Electronic Format: All electronic submittals shall be transmitted in Portable Document Format (PDF) as generated by the Adobe Acrobat Professional Version 7.0 or higher. The PDF file(s) shall be fully indexed using the Table of Contents, searchable with thumbnails generated.
1. File names shall use the “eight dot three” convention (XXXXXX_YY.pdf), where X is the five digit number corresponding to the specification section, and YY is a sequential ID number. The ID number is to track multiple O&M manuals per specification section. If technical problems require breaking of the submittal into multiple files then a letter extension shall be added to the end of the filename (example: 13100.01A.PDF). The number of files shall be kept to a minimum.
 2. Scanned images must be at a readable resolution. For most documents, they should be scanned at 300 dots per inch (dpi). Optical Character Recognition (OCR) capture must be performed on these images. OCR settings shall be performed with the “original image with hidden text” option in Adobe Acrobat Exchange.
 3. One PDF document (PDF file) shall be created for each equipment service manual. The entire manual shall be converted to a single .PDF file via scanning or other method of conversion. Drawings or other graphics shall also be converted to .PDF format and included into the single PDF document. Pages that must be viewed in landscape format shall be rotated to the appropriate position for easy reading on screen. Word searches of the PDF document must operate successfully.
 4. The PDF documents shall have a bookmark created in the navigation frame for each major entry (“Section” or “Chapter”) in the Table of Contents. Thumbnails shall be generated for each page or graphic in the PDF file.
 5. Labeling: As a minimum requirement, include the following labeling on all final O&M materials.

- a. Manufacturer Name
- b. Equipment name and/or O&M title spelled out in complete words. (example: “Operations and Maintenance Manual” “Oscillating Wastewater Converter”)
- c. Specification Section No.
- d. Project Name

1.05 SUBMITTAL PROCEDURE

A. Sequencing and Scheduling

- 1. Manual Outline: Submit to OWNER detailed outline of each manual prior to preparation of Preliminary Manuals.
- 2. Manuals for Equipment and Systems
 - a. Preliminary Manuals: Submit prior to shipment date for equipment, system, subsystem, or component. Include copy of warranties, Bonds, and service agreements if specified.
 - b. Final Manuals: Submit not less than 30 days prior to equipment or system field testing or startup.
- 3. Manuals for Materials and Finishes
 - a. Preliminary Manuals: Submit at least 30 days prior to request for final inspection.
 - b. Final Manuals: Submit within 10 days after final inspection.

B. Preliminary Manuals

- 1. Submittal Procedure: In accordance with Section 01300 – Submittals.
- 2. If Accepted submit six (6) hard copies of Final Manual.
- 3. If Rejected:
 - a. Follow procedure as outlined in Section 01300 – Submittals.

C. Final Manuals:

- 1. If different than accepted Preliminary Manuals, submit:
 - a. Two (2) copies of any necessary supplemental material, including revised table of contents.
 - b. Instructions for insertion of supplemental material in unreturned sets.

2. If Final Manuals are acceptable, CONTRACTOR will be so notified as outlined in Section 01300 – Submittals.
3. If rejected, and at OWNER's option:
 - a. Follow procedure as outlined in Section 01300 – Submittals.

1.02 MANUALS FOR EQUIPMENT AND SYSTEMS

- A. Content for Each Unit (or Common Units) and System:
 1. Description of unit and component parts, including controls, accessories, and appurtenances:
 - a. Function, normal operating characteristics, and limiting conditions.
 - b. Performance curves, engineering data, nameplate data, and tests.
 - c. Complete nomenclature and commercial number of replaceable parts.
 2. Operating Procedures:
 - a. Startup, break-in, routine, and normal operating instructions.
 - b. Test procedures and results of factory tests where required.
 - c. Regulation, control, stopping, and emergency instructions.
 - d. Description of operation sequence by control manufacturer.
 - e. Shutdown instructions for both short and extended duration.
 - f. Summer and winter operating instructions, as applicable.
 - g. Safety precautions.
 - h. Special operating instructions.
 - i. Installation instructions.
 3. Maintenance and Overhaul Procedures:
 - a. Routine operations.
 - b. Guide to troubleshooting.
 - c. Disassembly, removal, repair, reinstallation, and reassemble.
 4. Installation Instructions: Including alignment, adjusting, calibrating, and checking.

5. Original manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
6. Spare parts ordering instructions.
7. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, and terminals).
8. Manufacturer's printed operating and maintenance instructions.
9. As-installed, color-coded piping diagrams.
10. Charts of valve tag numbers, with the location and function of each valve.

B. Maintenance Summary:

1. Compile an individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or sub-units.
2. Format:
 - a. Use Maintenance Summary Form bound with this section, or an electronic facsimile of such.
 - b. Each Maintenance Summary may take as many pages as required.
 - c. Use only 8-1/2-inch x 11-inch size paper.
 - d. Complete using typewriter or electronic printing.
3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.
4. Recommended Spare Parts:
 - a. Data to be consistent with manufacturer's Bill of Materials/Parts List furnished in O&M manuals.
 - b. "Unit" is the unit of measure for ordering the part.
 - c. "Quantity" is the number of units recommended.
 - d. "Unit Cost" is the current purchase price.

C. Content for Each Electric or Electronic Item or System:

1. Description of Unit and Component Parts:
 - a. Function, normal operating characteristics, and limiting conditions.

- b. Performance curves, engineering data, nameplate data, and tests.
 - c. Complete nomenclature and commercial number of replaceable parts.
 - d. Interconnection wiring diagrams, including all control and lighting systems.
2. Circuit Directories of Panel Boards:
 - a. Electrical service.
 - b. Controls.
 - c. Communications.
 3. List of electrical relay settings, and control and alarm contact settings.
 4. Electrical interconnection wiring diagram, including control and lighting systems.
 5. As-installed control diagrams by control manufacturer.
 6. Operating Procedures:
 - a. Routine and normal operating instructions.
 - b. Sequences required.
 - c. Safety precautions.
 - d. Special operating instructions.
 7. Maintenance Procedures:
 - a. Routine operations.
 - b. Guide to troubleshooting.
 - c. Adjustment and checking.
 - d. List of relay settings, control and alarm contact settings.
 8. Manufacturer's printed operating and maintenance instructions.
 9. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

1.07 MANUALS FOR MATERIALS AND FINISHES

A. Content for Architectural Products, Applied Materials, and Finishes:

1. Manufacturer's data, giving full information on products:

- a. Catalog number, size, and composition.
- b. Color and texture designations.
- c. Information required for reordering special-manufactured products.
- 2. Instructions for Care and Maintenance:
 - a. Manufacturer's recommendation for types of cleaning agents and methods.
 - b. Cautions against cleaning agents and methods that are detrimental to product.
 - c. Recommended schedule for cleaning and maintenance.
- B. Content for Moisture Protection and Weather Exposed Products:
 - 1. Manufacturer's data, giving full information on products:
 - a. Applicable standards.
 - b. Chemical composition.
 - c. Details of installation.
 - 2. Instructions for inspections, maintenance, and repair.

1.08 SUPPLEMENTS

- A. The supplements listed below, following “END OF SECTION”, are part of this Specification.
 - 1. Forms: Maintenance Summary Form.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

MAINTENANCE SUMMARY FORM

PROJECT: _____ CONTRACT NO.: _____

1. EQUIPMENT ITEM _____

2. MANUFACTURER _____

3. EQUIPMENT/TAG NUMBER(S) _____

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS) _____

5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____

6. MANUFACTURER'S LOCAL REPRESENTATIVE _____

a. Name__ Telephone No. _____

b. Address _____

7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	Frequency	Lubricant (If Applicable)
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

8. LUBRICANT LIST

Reference Symbol	Shell	Standard Oil	Gulf	Arco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

SECTION 01752

FACILITY START UP COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE

- A. This section covers starting of systems for all items of mechanical, electrical, and control equipment. Additional requirements may be specified in individual equipment section.
- B. Procedures and actions required of the CONTRACTOR, which are necessary to achieve a Letter of Substantial Completion.
 - 1. Pre Start Up (Construction Phase)
 - a. Factory Tests
 - b. Field Test
 - c. Test Log Submittals
 - 2. System Start Up
 - a. Functional Tests
 - b. Performance Tests
- C. Procedures and actions required of the CONTRACTOR, which are necessary to achieve a Memo of Final Acceptance.
 - 1. Operational Test

1.02 RELATED WORK

- A. Section 01300 – Submittals
- B. Section 01600 – Material and Equipment
- C. Section 01640 – Manufacturer’s Field Services

1.03 DEFINITIONS

- A. System: The overall process, or a portion thereof, that performs a specific function. A system may consist of the entire facility or two (2) or more subsystems as well as two (2) or more types of equipment or components.

- B. Pre Start Up: The period of time of unspecified duration during construction and installation activities which the CONTRACTOR, with assistance from MANUFACTURER's Representatives, performs the following sequence:
1. Finishes construction work so that the Project has reached a tentative state of Substantial Completion pending completion of the System Start Up.
 2. MANUFACTURER's Field Services
 - a. Equipment and Pre Start Up Assistance
 - b. Installation and Equipment Testing Certifications
 - c. Pre Start Up Training
- C. System Start Up: A period of time of specified duration, following the Pre-Start Up Period, during which the CONTRACTOR initiates process flow through the facility and operates the facility without exceeding specified downtime limitations, to prove the functional integrity of the mechanical and electrical equipment and components; the control interfaces of the respective equipment; and components comprising the facility, as evidence of Substantial Completion. The following test activities must be executed by the CONTRACTOR with assistance from the MANUFACTURER's Representative as needed.
1. Functional Tests: Test or tests performed by the CONTRACTOR in the presence of the OWNER to demonstrate that installed equipment, system, subsystem or components meet MANUFACTURER's installation and adjustment requirements; and other requirements specified including, but not limited to: noise, vibration, alignment, speed, proper electrical and mechanical connections, thrust restraint, proper rotation, and initial servicing.
 2. Performance Test: A test performed by the CONTRACTOR in the presence of the OWNER and after all required functional tests specified, to demonstrate and confirm that the equipment, system, subsystem or components meet the specified performance requirements.
 3. MANUFACTURER's Field Services
 - a. Equipment and System Start Up Assistance
 - b. Equipment, System, Subsystem, or Component Start Up Testing Certification.
 - c. Post Start Up Training
- D. Operational Test: A test of specified duration, performed by the OWNER with the assistance of the CONTRACTOR after all System Start Up testing has been completed. The equipment, system, subsystem, or component shall operate continuously without any malfunctions.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.01 DESCRIPTION OF WORK

- A. All items of mechanical and electrical equipment shall be tested for proper operation, efficiency, and capacity. All required adjustments, tests, operation checks, and other Pre Start Up activity shall be provided.

3.02 PRE START UP (CONSTRUCTION PHASE)

A. FACTORY TESTS

- 1. All items of equipment so specified shall be tested at the point of MANUFACTURER's facility at the CONTRACTOR's expense. Submittals shall in accordance with Section 01300 – Submittals.
- 2. Coordinate with the OWNER and ENGINEER for factory test schedule, if witness testing of equipment is specified in individual specification of the equipment.
- 3. Equipment shall not be shipped until the ENGINEER has reviewed the test results and notified the CONTRACTOR in writing that the equipment is acceptable for shipment. Such acceptance, however, shall not be considered as final acceptance, which will only be made on the basis of the test results of the equipment after installation.

B. FIELD TESTS

- 1. All items of mechanical, electrical, and control equipment shall be tested by the CONTRACTOR after installation for proper operation, efficiency, and capacity. CONTRACTOR's test operation of each piece of equipment shall continue for not less than eight (8) hours without interruption. All moving parts of equipment and machinery shall be carefully tested for operation, and adjusted so all parts move freely and function to secure satisfactory operation. All parts shall operate satisfactorily in all respects, under continuous full load and in accordance with the specified requirements, for the full duration of the eight (8) hour test period. If necessary, corrections or repairs shall be made and the full eight-hour test operation, as specified, shall be completed after all parts operate satisfactorily.
- 2. CONTRACTOR shall furnish and pay for all power, water, fuels, oil, grease, chemicals, and auxiliaries that are required for conducting the CONTRACTOR's testing of the equipment for proper operation, efficiency, and capacity during Pre Start Up.
- 3. Field Tests of all process and pumping equipment, drive motors, including auxiliaries shall be made in accordance with the appropriate and approved test codes of the American Society of Mechanical Engineers (ASME), Hydraulic Institute Standards, National Electrical Manufacturers Association (NEMA), and Institute of Electrical and Electronics Engineers (IEEE).

4. Field testing shall be conducted before the Work is ready for System Start Up and is substantially complete so each item of equipment is ready for integrated operation with other equipment at the facility. Testing, measuring, and calibrating procedures shall be submitted to the ENGINEER for review and acceptance prior to field testing of equipment. The facility control system must be in place and MANUFACTURER's Certificate of Proper Installation must be completed prior to equipment tests.
5. All equipment shall be tested continuously under actual or simulated operating conditions. Equipment shall be tested over the full range of speed, capacity and pressure. Equipment shall also be tested at every level of control. Valves shall be throttled as required to simulate the full operating range. Curves shall be developed from the test data and compared to the specified performance criteria. CONTRACTOR shall provide all appurtenances as required, but not limited to flow meters for liquid and gas flow pressure gauges and throttling valves, to verify performance. CONTRACTOR shall be fully responsible for the operation and maintenance of the equipment during Pre Start Up. During testing, pressure, flow rate, amperage, voltage, vibration, equipment temperature, ambient temperature, tank level and the level of all water surfaces shall be measured. MANUFACTURER's representative shall make all necessary field adjustments and correct defects in materials or workmanship during this test period. The equipment shall be properly filled, by the CONTRACTOR, with oil and grease.
6. The period of inspection, Pre Start Up operation, and field adjustment shall be as required to achieve satisfactory installation and operation of the items furnished.

C. TEST LOG SUBMITTALS

1. MANUFACTURER's Certificate of Proper Installation – Utilize the MANUFACTURER's Certificate of Proper Installation Form from Section 01640 – Manufacturer's Field Services, supplemented as necessary, to document results, problems, and conclusions.
2. Equipment Test - Test report and certification of test for each piece of equipment, system, subsystem, or component specified. See Section 01640.
3. I/O Loop Test – Third Party Independent Test Agency.
4. Equipment Calibration Sheets - Certifications of calibration for testing equipment and permanent equipment.
5. Electrical Testing - Third Party Independent Test Agency.
6. Certificate of Successful Equipment Testing – Utilize the Certificate of Successful Equipment Testing Form from Section 01640 – Manufacturer's Field Services, supplemented as necessary to document results, problems, and conclusions.

D. ADDITIONAL PRE START UP ACTIVITIES

1. General activities include:

- a. Cleaning.
- b. Removing temporary protective coatings.
- c. Flushing and replacing greases and lubricants, where required by the MANUFACTURER.
- d. Lubrication.
- e. Check shaft and coupling alignments and reset where needed.
- f. Check and set motor, pump and other equipment rotation, safety interlocks, and belt tensions.
- g. Check and correct if necessary leveling plates, grout, bearing plates, anchor bolts, fasteners, and alignment of piping which may put stress on pumping equipment connected to it.
- h. All adjustments required.

2. Minimum activities include:

- a. Bearings and Shafts
 - i. Inspect for cleanliness, clean and remove foreign materials.
 - ii. Verify alignment.
 - iii. Replace defective bearings, and those which run rough or noisy.
 - iv. Grease as necessary, in accordance with MANUFACTURER's recommendations.
- b. Drives
 - i. Adjust tension in V-belt drives, and adjust vary pitch sheaves and drives for proper equipment speed (if necessary).
 - ii. Adjust drives for alignment.
 - iii. Clean and remove foreign materials before starting operation.
- c. Motors
 - i. Check each motor for comparison to amperage nameplate value.
 - ii. Correct conditions which produce excessive current flow, and which exist due to equipment malfunction.
 - iii. Check each motor for proper rotation.
- d. Pumps
 - i. Check glands and seals for cleanliness and adjustment before running pump.
 - ii. Inspect shaft sleeves for scoring.
 - iii. Inspect mechanical faces, chambers, and seal rings, and replace if defective.
 - iv. Verify that piping system is free of dirt and scale before

circulating liquid through the pump.

- e. Valves
 - i. Open and close valves by hand and operate to check for binding, interference, or improper functioning.
 - ii. Inspect both manual and automatic control valves, clean bonnets and stems.
 - iii. Tighten packing glands to assure no leakage, but permit valve stems to operate without galling.
 - iv. Replace packing in valves to retain maximum adjustment after system is judged complete.
 - v. Replace packing on any valve which continues to leak.
 - vi. Remove and repair bonnets which leak.
 - vii. Coat packing gland threads and valve stems with an appropriate surface preparation after cleaning.
- f. Verify that control valve seats are free from foreign material, and are properly positioned for intended service.
- g. Tighten all pipe joints after system has been field tested. Replace gaskets which show any sign of leaking after tightening.
- h. Inspect all joints for leakage.
- i. Promptly remake each joint which appears to be faulty, do not wait for rust to form.
- j. Clean threads on both parts, apply compound and remake joints.
- k. Clean strainers, dirt pockets, orifices, valve seats, and headers in fluid system, to assure freedom from foreign materials.
- l. Open traps and air vents where used, remove operating elements. Clean thoroughly, replace internal parts and put back in readiness mode.
- m. Remove rust, scale and foreign materials from equipment and renew defaced surfaces.
- n. Set and calibrate permanent equipment.
- o. Check each electrical control circuit to assure that operation complies with Contract Documents and requirements to provide desired performance.
- p. Inspect each pressure gage and thermometer for calibration. Replace items which are defaced, broken, or which read incorrectly.
- q. Repair damaged insulation.
- r. Vent gases trapped in any part of systems. Verify that liquids are drained from all parts of gas or air system.
- s. Calibrate testing equipment for accurate results.
- t. Check power supply to electric-powered equipment for correct voltage.

- u. Adjust clearances and torque.
- v. Test piping for leaks.
- w. Balance HVAC systems, measuring airflow (cfm) static pressure, and component pressure losses. Furnish report documenting results of balancing.
- x. Equipment and electrical tagging complete.
- y. All spare parts and special tools delivered to OWNER.

3.03 SYSTEM START UP

A. SUBMITTALS

1. Administrative Submittals.
 - a. Functional and Performance test schedules.
 - b. Plan for equipment, systems, subsystem, or component at least twenty-one (21) calendar days prior to start of related testing. Include test plan, procedures, and log format.
 - c. Schedule and plan of System Start Up activities at least thirty (30) calendar days prior to commencement.
2. Certificate of Successful Equipment, System, Subsystem, or Component Start Up Testing – Utilize the Certificate of Successful Equipment, system, subsystem, or component Start Up Testing Form from Section 01640 – Manufacturer’s Field Services, supplemented as necessary, to document functional and performance procedures, results, problems, and conclusions.

B. CONTRACTOR FACILITY START UP RESPONSIBILITIES

1. General
 - a. Prepare and pretest all equipment insofar as possible to check its ability for sustained operation, including inspections and adjustments by manufacturer’s servicemen.
 - b. Be responsible for System Start Up of all facilities constructed under this Contract.
 - c. Perform Work for tests specified.
 - d. Demonstrate proper installation, adjustment, function and performance of equipment, systems, subsystem, or components, control devices, and required interfaces individually and in conjunction with process instrumentation and control system.
 - e. CONTRACTOR shall furnish and pay for all power, water, fuels, oil, grease, chemicals, and auxiliaries that are required for conducting CONTRACTOR's testing of the equipment for proper operation, efficiency, and the capacity during System Start Up.

C. OWNER'S FACILITY STARTUP RESPONSIBILITIES

1. General

- a. Review CONTRACTOR's test plan and schedule.
- b. Witness each functional and performance tests.
- c. Provide assistance and support for start up and performance testing.
- d. OWNER will operate the portion of facilities that are not part of the construction contract.

D. TESTING PREPARATION

1. General.

- a. Complete Work associated with the equipment, system, subsystem, or components and related processes before testing, including related MANUFACTURER's representative services.
- b. Furnish qualified MANUFACTURER's representatives when required to assist in testing.
- c. Utilize the Certificate of Successful Equipment, System, Subsystem or component Start Up Testing Form from Section 01640 – Manufacturers Field Services, supplemented as necessary, to document functional and performance procedures, results, problems, and conclusions.
- d. Schedule and attend pretest (functional and performance) meetings related to test schedule, plan of test, materials, chemicals, and liquids required, facilities' operations interface, OWNER involvement.
- e. Designate and furnish one or more persons to be responsible for coordinating and expediting CONTRACTOR's System Start Up duties. The person or persons shall be present during System Start Up meetings and shall be available at all times during the System Start Up period.
- f. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required to conduct testing.

2. Cleaning and Checking: Prior to starting functional testing.

- a. Calibrate testing equipment for accurate results.
- b. Inspect and clean equipment, devices, connected piping, and structures so they are free of foreign material.
- c. Lubricate equipment in accordance with MANUFACTURER's instructions.
- d. Turn rotating equipment by hand and check motor-driven equipment for correct rotation.

- e. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
 - f. Check power supply to electric-powered equipment for correct voltage.
 - g. Adjust clearances and torque.
 - h. Test piping for leaks.
 - i. Obtain completion of applicable portions of MANUFACTURER's Certificate of Proper Installation in accordance with Section 01640 – Manufacturer's Field Services.
3. Ready-to-test determination will be by OWNER based at least on the following:
- a. Notification by CONTRACTOR of equipment and system readiness for testing.
 - b. Acceptable Test Log Submittal to OWNER.
 - c. Acceptable testing plan.
 - d. Acceptable Final Draft Operation and Maintenance Manuals.
 - e. Receipt of MANUFACTURER's Certificate of Proper Installation, as required.
 - f. Receipt of Certificate of Successful Equipment Testing, as required.
 - g. Adequate completion of Work adjacent to, or interfacing with, equipment to be tested.
 - h. Availability and acceptability of MANUFACTURER's representative, when specified, to assist in testing of respective equipment, and satisfactory fulfillment of other specified MANUFACTURER's responsibilities.
 - i. Equipment and electrical tagging complete.
 - j. All spare parts and special tools delivered to and become property of the OWNER.

E. FUNCTIONAL TEST - GENERAL

- 1. Begin testing at a time mutually agreed upon by the OWNER and CONTRACTOR.
- 2. OWNER and MANUFACTURER's Representative will be present during test. Notify in writing MANUFACTURER's representative(s) at least twenty-one (21) calendar days prior to scheduled date of functional tests.
- 3. Separate items of equipment demonstrated to function properly during subsystem testing may require no further Functional test if documentation of subsystem testing is acceptable to OWNER.
- 4. Conduct functional tests as specified for each equipment, system, subsystem, on component for a minimum period of eight (8) hours.

5. Demonstrate all operational features and instrumentation and control functions while in automatic mode.
6. If, in OWNER's opinion, functional test results do not meet requirements specified, the systems will be considered as non-conforming.
7. Performance testing shall not commence until the equipment, system, subsystem, or components meets the specified functional tests.

F. PERFORMANCE TEST - GENERAL

1. Begin testing at a time mutually agreed upon by the OWNER and CONTRACTOR.
2. OWNER will be present during test. Notify in writing MANUFACTURER's representative(s) at least twenty-one (21) days prior to scheduled date of performance tests.
3. Conduct performance tests as specified for each equipment, system, subsystem, or component for a minimum period of one (1) day.
4. Unless otherwise indicated, furnish all labor, materials, and supplies for conducting the test and taking all samples and performance measurements.
5. Prepare performance test report summarizing test method. Include test logs, pertinent calculations, and CONTRACTOR's Certificate of Successful Equipment, System, Subsystem, or Component Start Up Testing.

G. SYSTEM START UP TEST PERIOD

1. General.
 - a. Attend planning meetings and arrange for attendance by key major equipment MANUFACTURER representatives as required by the Contract Documents.
 - b. Designate one or more persons on the CONTRACTOR's staff to be able for coordinating and expediting CONTRACTOR's System Start Up duties.
 - c. When System Start Up has commenced, schedule remaining Work so as not to interfere with or delay the completion of System Start Up.
 - d. Support System Start Up activities with adequate staff to prevent delays. Such staff shall include, but not be limited to, equipment, system, subsystem, or component, MANUFACTURER's representatives, electricians, instrumentation and control personnel, millwrights, pipe fitters, and plumbers.
 - e. Furnish and coordinate specified MANUFACTURER's System Start Up services.
2. System Start Up Testing.
 - a. System Start Up of the entire system or any portion thereof requires the

coordinated operation of the facilities by the CONTRACTOR, SUBCONTRACTORS, OWNER's operating personnel, ENGINEER, and MANUFACTURER's representatives.

- b. System Start Up of the entire facility or any portion thereof shall be considered complete when, in the opinion of the OWNER, the facility or designated portion has operated in the manner intended without interruption. This includes any training, functional or performance test periods specified herein.
 - c. An interruption may include but is not limited to any of the following events.
 - i. Failure of CONTRACTOR to maintain qualified onsite System Start Up personnel as schedule D.
 - ii. Failure to meet specified functional or performance tests.
 - iii. Failure of any critical equipment, system, subsystem or component that is not satisfactorily corrected within two (2) hours after failure.
 - iv. Failure of any non-critical equipment, system, subsystem, component that is not satisfactorily corrected within four (4) hours after failure.
 - v. As may be determined by OWNER.
 - d. An interruption will require the System Start Up, then in progress, to be stopped and restarted after corrections are made.
3. Startup Test Reports: As applicable to the equipment furnished, certify in writing that:
- a. Hydraulic structures, piping systems, and valves have been successfully tested.
 - b. Equipment, systems, subsystems, or component have been checked for proper installation, started, and successfully tested to indicate that they are operational.
 - c. Equipment, systems, subsystems, or components are capable of performing their intended functions, including fully automatic.
 - d. Facilities are ready for intended operation.
 - e. Final O&M Manuals have been submitted and approved by OWNER.

3.04 OPERATIONAL TEST

- A. As a condition of Partial Acceptance (Substantial Completion), after all functional and performance tests and the entire system is safe and ready to operate, the OWNER will test all constructed facilities using all specified systems in combination with each other for a period of thirty (30) days continuous operation (either actual or simulated) without interruption due to malfunctions of constructed facilities. All defects of material or

workmanship which appear during this test period shall be corrected by the CONTRACTOR. After such corrections are made, the thirty (30) day test shall be restarted at zero and run again before partial acceptance (substantial completion) of the equipment. The time need not be continuous based on malfunctions of associated existing facilities.

- B. OWNER will supply all power, water, oil, fuels, grease, chemicals, auxiliaries, and operating personnel required for this final operational test.
- C. Each MANUFACTURER who furnishes equipment that requires factory trained service personnel shall adjust the equipment until the operational tests have been met and the results of the operational tests have been accepted by the ENGINEER.
- D. CONTRACTOR's Representative shall be on site for the thirty (30) day operational test for assisting in the operation and maintenance of the System.

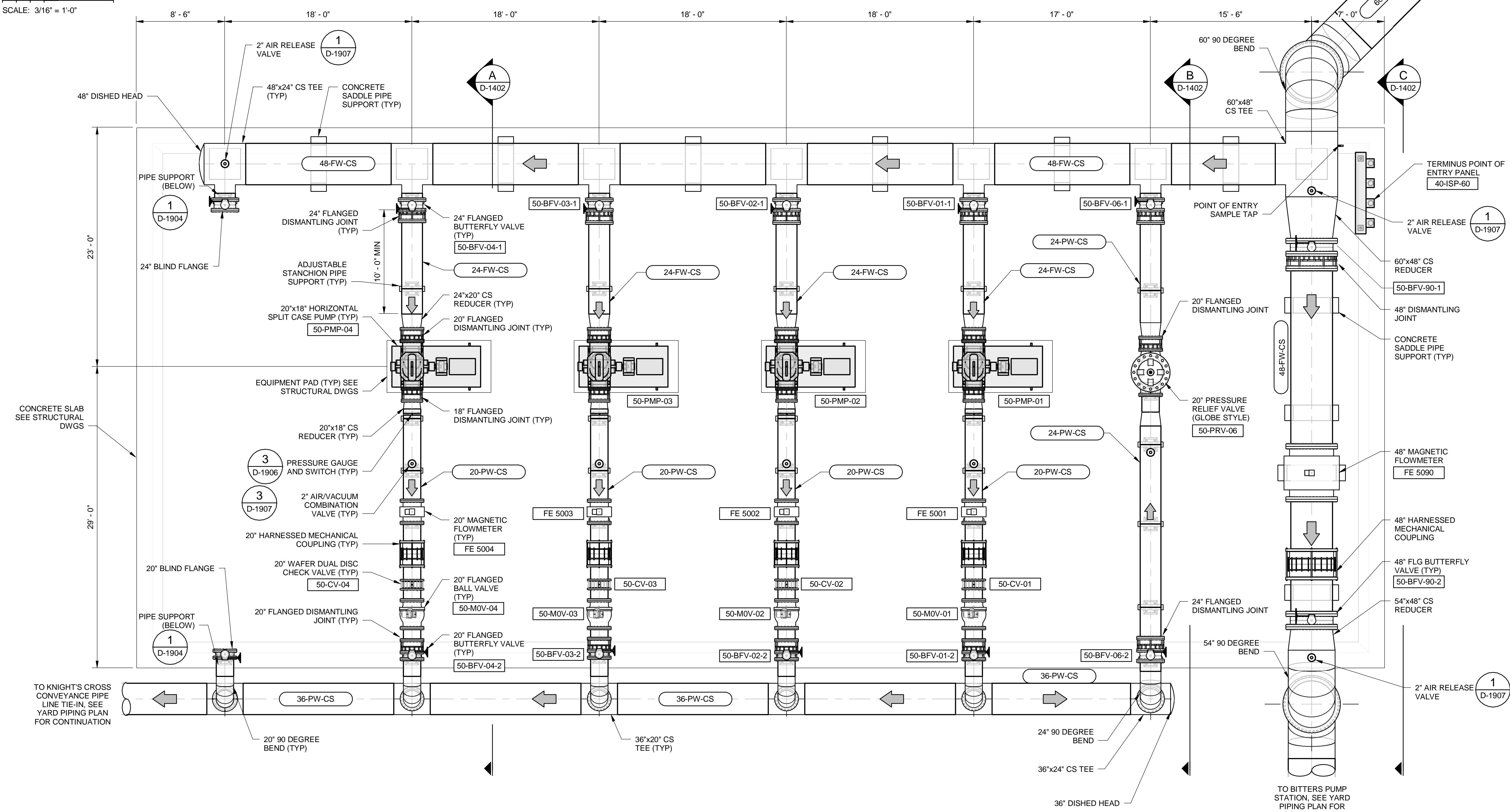
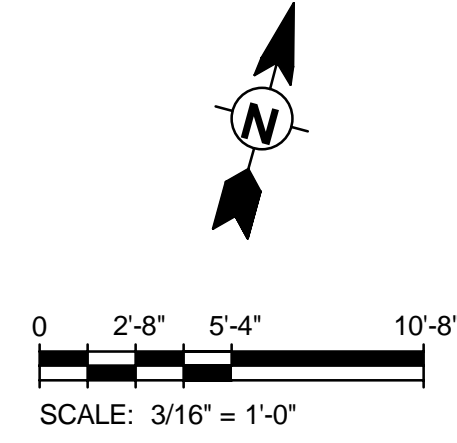
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APPENDIX B

DRAWINGS

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EQUIPMENT PLAN
SCALE: 3/16" = 1'-0"

TETRA TECH
Texas Registration No. F-3924
www.tetra.tech.com
700 N. St. Mary's, Suite 300
San Antonio, TX 78205
Ph (210) 298-7900 Fax (210) 226-6467
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100% SUBMITTAL

SAN ANTONIO WATER SYSTEM

MARK	DATE	DESCRIPTION

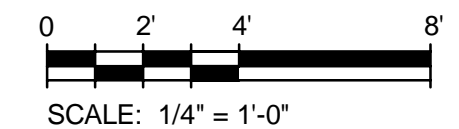
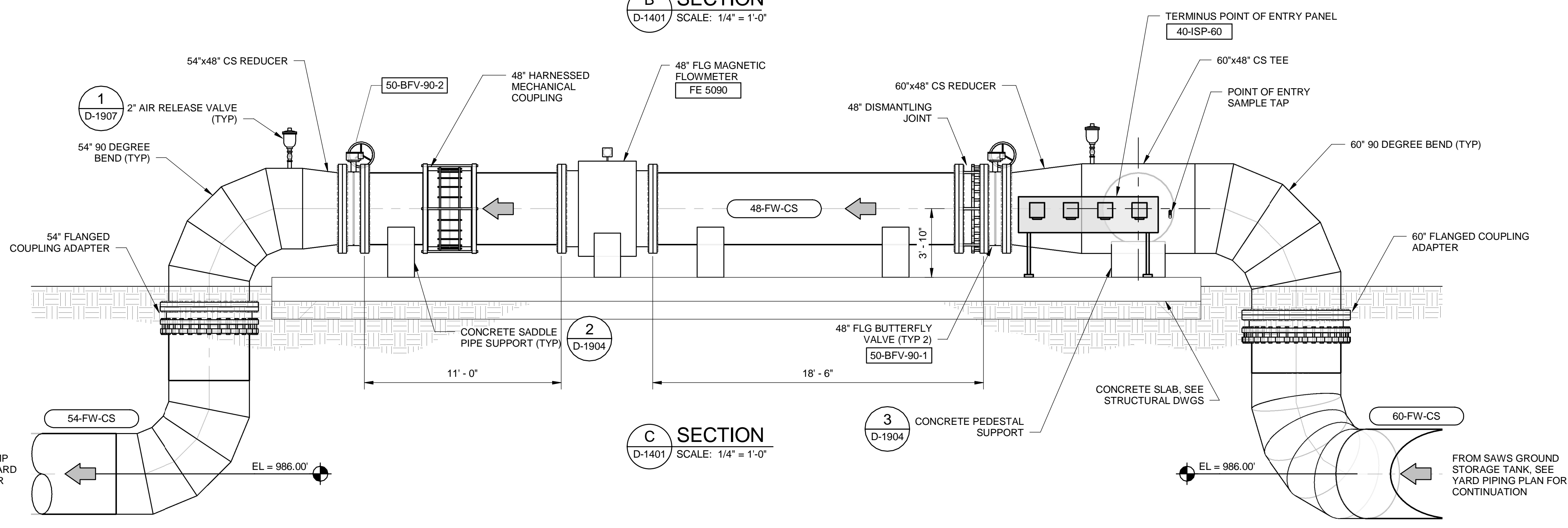
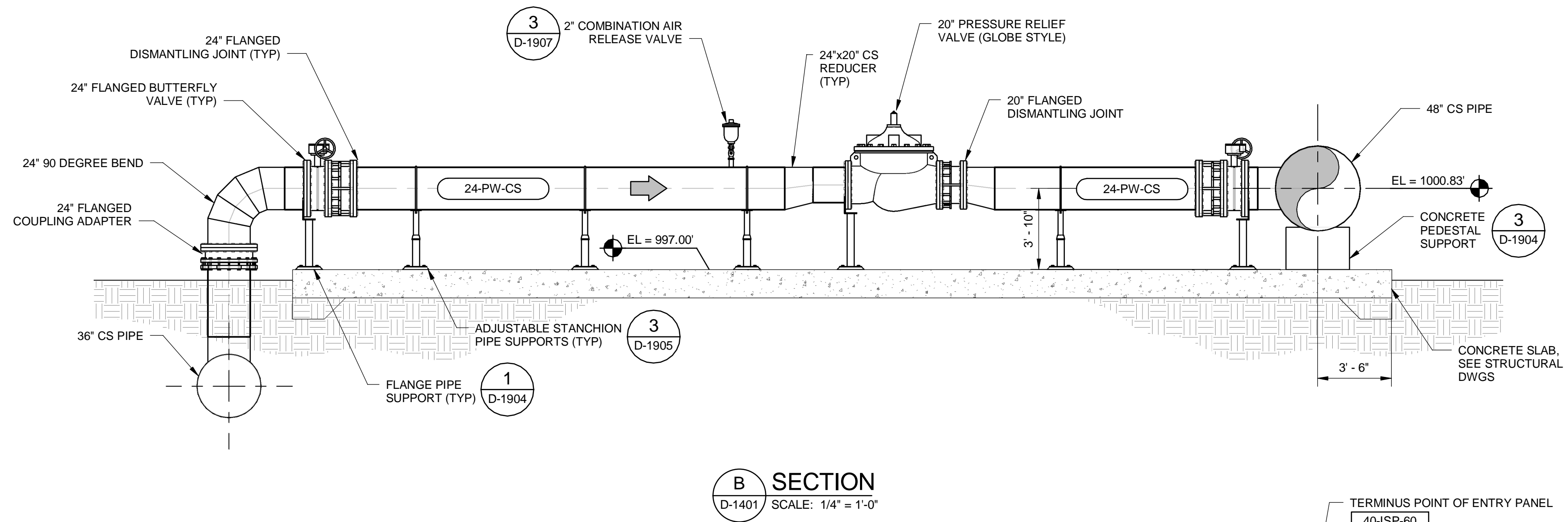
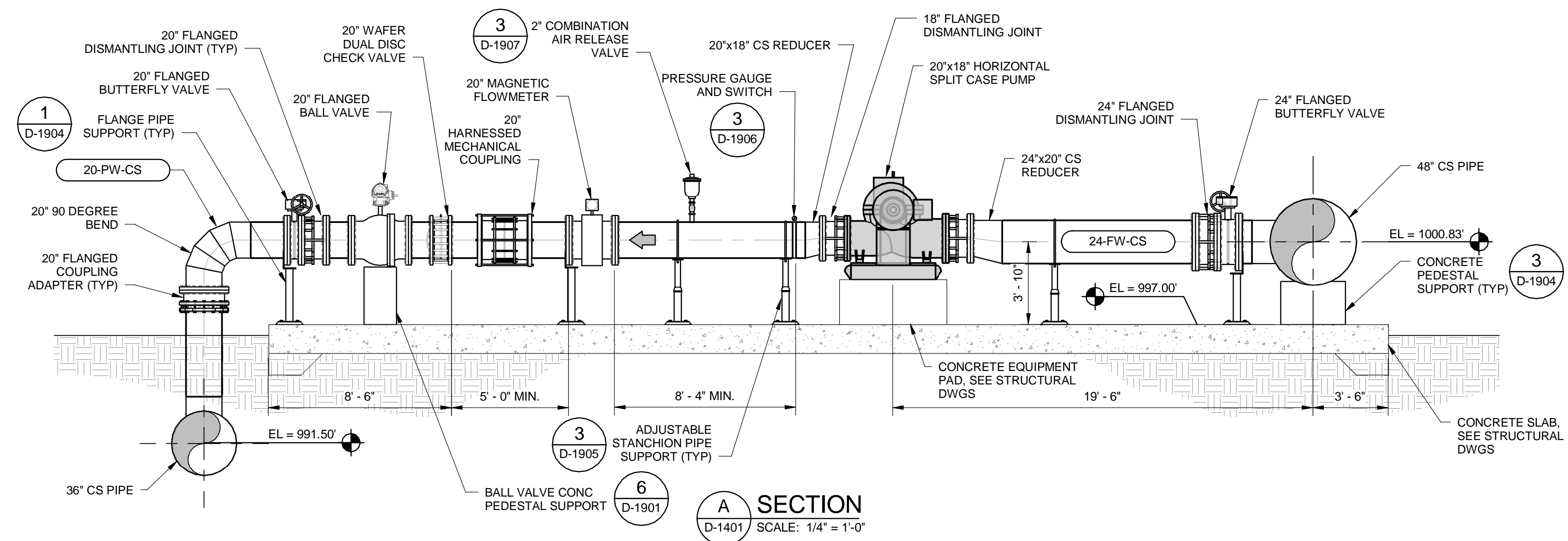
SAN ANTONIO WATER SYSTEM
CENTRAL WATER INTEGRATION PIPELINE
PROJECT TERMINUS FACILITY
STONE OAK PUMP STATION PLAN

PROJ: 200-09308-18001
DESN:
DRWN: WVPJ
CHKD:

D-1401

INCOMPLETE DOCUMENT
ISSUED FOR
INTERIM REVIEW ONLY
NOT RELEASED FOR
REGULATORY APPROVAL
PERMIT OR CONSTRUCTION
JAIME R. KYPUROS, P.E.
TEXAS REGISTRATION NO. 53790
JULY 2018

1 2 3 4 5 6 7



TO BITTERS PUMP STATION, SEE YARD PIPING PLAN FOR CONTINUATION

FROM SAWS GROUND STORAGE TANK, SEE YARD PIPING PLAN FOR CONTINUATION

INCOMPLETE DOCUMENT ISSUED FOR INTERIM REVIEW ONLY
 NOT RELEASED FOR REGULATORY APPROVAL PERMIT OR CONSTRUCTION
 JAIME R. KYPUROS, P.E.
 TEXAS REGISTRATION NO. 53790
 JULY 2018

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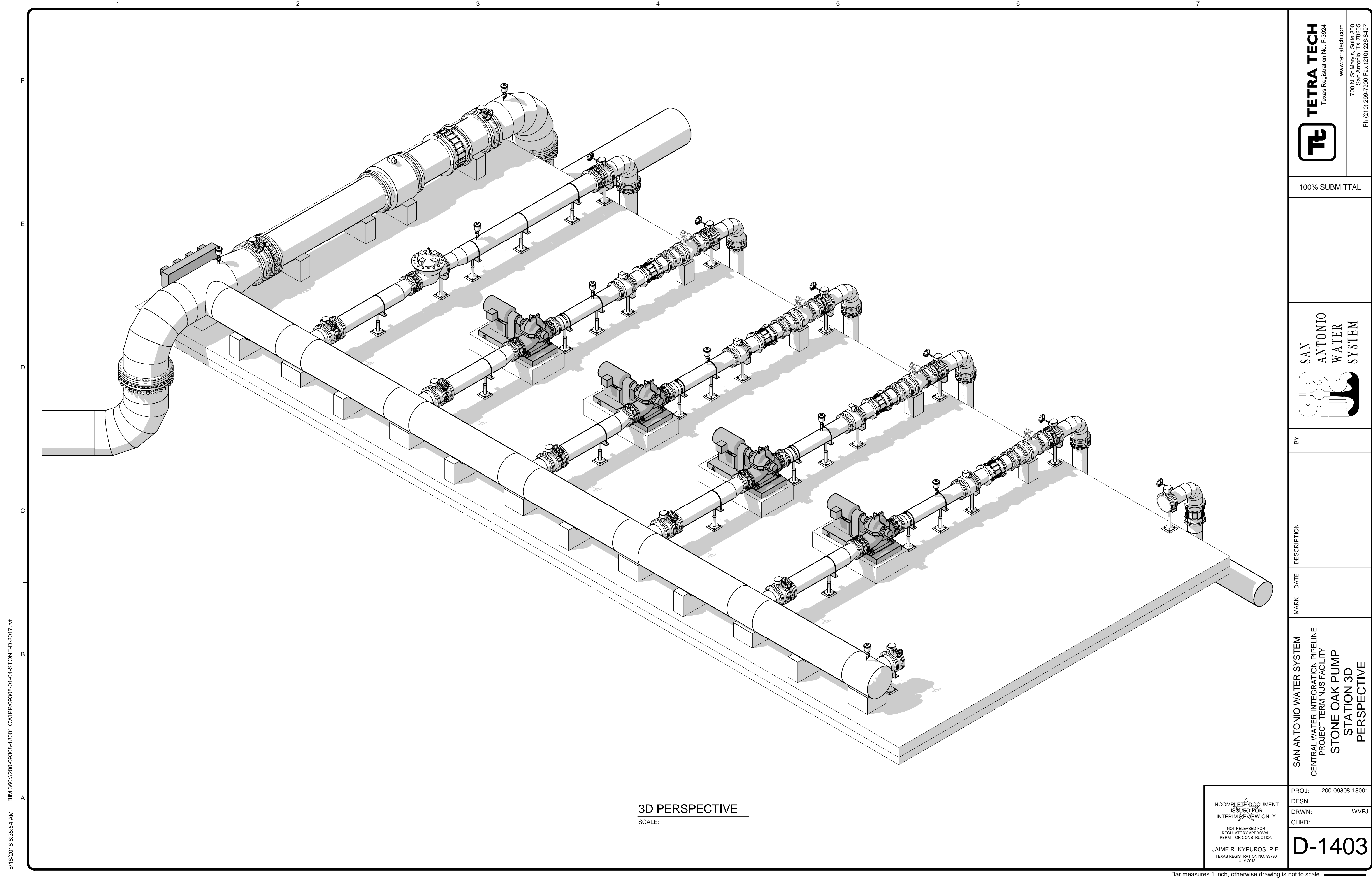
SAN ANTONIO WATER SYSTEM

MARK	DATE	DESCRIPTION

SAN ANTONIO WATER SYSTEM
 CENTRAL WATER INTEGRATION PIPELINE
 PROJECT TERMINUS FACILITY
STONE OAK PUMP STATION SECTIONS

PROJ:	200-09308-18001
DESN:	
DRWN:	WVPJ
CHKD:	
D-1402	

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3D PERSPECTIVE
SCALE:

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JAIME R. KYPUROS, P.E.
TEXAS REGISTRATION NO. 53790
JULY 2018

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SAN ANTONIO WATER SYSTEM
SAWS

MARK	DATE	DESCRIPTION	BY

SAN ANTONIO WATER SYSTEM
CENTRAL WATER INTEGRATION PIPELINE
PROJECT TERMINUS FACILITY
STONE OAK PUMP STATION 3D PERSPECTIVE

PROJ: 200-09308-18001
DESN:
DRWN: WVPJ
CHKD:

D-1403

Bar measures 1 inch, otherwise drawing is not to scale

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GRAPHIC SYMBOL FOR INSTRUMENTATION ITEMS	
	LOGIC IN PLC DISPLAYED ON OIP & SCADA (INCLUDING INPUTS & OUTPUTS)
	LOGIC IN PLC
	FIELD OR LOCALLY MOUNTED DEVICE
	PROGRAMMED FUNCTION NOT NORMALLY ACCESSIBLE TO OPERATOR
	PROGRAMMED FUNCTION ACCESSIBLE THROUGH OPERATOR'S INTERFACE DEVICE
	LOGIC IN PLC DISPLAYED ON OIP (INCLUDING INPUTS AND OUTPUTS)
	INTERLOCKING
	EXCLUSIVE OR
	ALTERNATOR
	OR
	AND
	MOTOR STARTER
	PURGE
	COMPLEX LOGIC
	COMPUTER LOGIC SYSTEM
	TERMINAL OR TRANSITION POINT
	FLOAT SWITCH
	PARSHALL FLUME
	MIXER
	SEAL
	OFF PAGE CONNECTOR
	PROCESS MACHINERY MOTOR
	VENTURI OR INSERT FLOW TUBE
	IN-LINE FLOW ELEMENT (PROPELLER TYPE)
	IN-LINE FLOW ELEMENT (MAGNETIC TYPE)
	IN-LINE FLOW ELEMENT (ULTRA SONIC)
	FLOW ORIFICE
	TURBIDIMETER
	ROTAMETER
	PUMP
	BLOWER
	GENERAL USE DISCONNECTING SWITCH
	TIMED CLOSED CONTACT ON ENERGIZATION
	TIMED OPEN CONTACT ON ENERGIZATION
	TIMED OPEN CONTACT ON DE-ENERGIZATION
	TIMED CLOSED CONTACT ON DE-ENERGIZATION
	FLOAT ACTUATED SWITCH-NO
	FLOAT ACTUATED SWITCH-NC
	PRESSURE ACTUATED SWITCH-NC
	PRESSURE ACTUATED SWITCH-NO
	FLOW ACTUATED SWITCH-NO
	FLOW ACTUATED SWITCH-NC
	TEMPERATURE SWITCH-NO
	TEMPERATURE SWITCH-NC

GRAPHIC SYMBOLS FOR VALVES	
	STROKE OR POSITION ACTUATOR CYLINDER (OPEN-SHUT)
	STROKE OR POSITION ACTUATOR CYLINDER (THROTTLING)
	PNEUMATIC DIAPHRAGM OR POSITIONER (OPEN-SHUT)
	PNEUMATIC DIAPHRAGM OR POSITIONER (THROTTLING)
	MOTOR OPERATED (THROTTLING)
	MOTOR OPERATED (OPEN-SHUT)
	SLIDE-STOP GATE
	SLUICE GATE
	AIR SET ASSEMBLY
	BALL VALVE
	GLOBE VALVE
	GATE VALVE OR KNIFE GATE
	CHECK VALVE
	PLUG VALVE
	BUTTERFLY VALVE, DAMPER OR LOUVER
	TWO-WAY SOLENOID VALVE OPERATOR
	ELECTRONICALLY CONTROLLED CHECK VALVE
	TWO-WAY SOLENOID VALVE OPERATOR-DETENTED
	THREE-WAY SOLENOID VALVE OPERATOR
	FOUR-WAY SOLENOID VALVE OPERATOR

INSTRUMENTATION LINE SYMBOLS	
	ELECTRICAL SIGNAL
	AIR LINE
	HYDRAULIC SIGNAL
	ELECTROMAGNETIC OR SONIC SIGNAL
	SOFTWARE SIGNAL
	CONNECTION TO PROCESS, OR MECHANICAL LINK
	E-NET
	E-FO

I.S.A. STANDARD LETTER FUNCTIONS		
SYMBOL	FIRST LETTER	SUCCEEDING LETTERS
A	ANALYSIS, ANALOG	ALARM
B	BURNER, FLAME	BATCH
C	CONDUCTIVITY, COMMAND	CONTROL (FEEDBACK TYPE)
D	DENSITY, SPECIFIC GRAVITY	
E	VOLTAGE	PRIMARY ELEMENT
F	FLOW RATE	RATIO
G	GAGING	GLASS
H	HAND, MANUAL	HIGH
I	CURRENT	INDICATE
J	POWER	SCAN
K	TIME, TIME SCHEDULE	CONTROL (NO FEEDBACK)
L	LEVEL, LIGHT	LOW
M	MOISTURE, HUMIDITY	MIDDLE, MODULATE
N		
O	OVERLOAD	ORIFICE
P	PRESSURE, VACUUM	POINT
Q	QUANTITY	TOTALIZE, INTEGRATE
R	RADIOACTIVITY	RECORD, PRINT, RECEIVE
S	SPEED, FREQUENCY, SOLENOID	SWITCH
T	TEMPERATURE, TURBIDITY	TRANSMIT, TRANSFORM
U	MULTIVARIABLE	MULTIFUNCTION
V	VIBRATION, VISCOSITY	VALVE, DAMPER, LOUVER
W	WEIGHT, FORCE	
X		
Y		RELAY, COMPUTE
Z	POSITION	DRIVE, ACTUATE

CONTROL PANEL LIST				
TAG	NAME	LOCATION	RESPONSIBLE	PLC
10-LCP-01	CO ₂ BULK STORAGE TANK NO. 1 REFRIGERATION LOCAL CONTROL PANEL	CO ₂ FACILITY (SHEET E-1101)	11300	N
10-LCP-02	CO ₂ BULK STORAGE TANK NO. 2 REFRIGERATION LOCAL CONTROL PANEL	CO ₂ FACILITY (SHEET E-1101)	11300	N
15-CP-11	CO ₂ PRESSURIZED SOLUTION CONTROL PANEL	CO ₂ FACILITY (SHEET E-1101)	11300	Y
20-CP-01	LIME SLURRY CONTROL PANEL	LIME FACILITY (SHEET E-1102)	11249	Y
20-LCP-01	LIME SLURRY FILL PANEL	LIME FACILITY (SHEET E-1102)	11249	N
20-LCP-02	LIME SLURRY BULK STORAGE TANK NO. 1 LOCAL CONTROL PANEL	LIME FACILITY (SHEET E-1102)	11249	N
20-LCP-03	LIME SLURRY BULK STORAGE TANK NO. 2 LOCAL CONTROL PANEL	LIME FACILITY (SHEET E-1102)	11249	N
20-LCP-04	LIME SLURRY DILUTION TANK NO. 1 LOCAL CONTROL PANEL	LIME FACILITY (SHEET E-1102)	11249	N
20-LCP-05	LIME SLURRY DILUTION TANK NO. 2 LOCAL CONTROL PANEL	LIME FACILITY (SHEET E-1102)	11249	N
30-CP-01	PRESSURE FILTER CONTROL PANEL NO. 1	PRESSURE FILTERS (SHEET E-1201)	11200	Y
30-CP-02	PRESSURE FILTER CONTROL PANEL NO. 2	PRESSURE FILTERS (SHEET E-1201)	11200	Y
30-ISP-01	PRE-FILTER INSTRUMENT AND SAMPLE PANEL	PRESSURE FILTERS (SHEET E-1201)	11200	N
30-ISP-02	FILTER INSTRUMENT AND SAMPLE PANEL NO. 1	PRESSURE FILTERS (SHEET E-1201)	11200	N
30-ISP-03	FILTER INSTRUMENT AND SAMPLE PANEL NO. 2	PRESSURE FILTERS (SHEET E-1201)	11200	N
30-ISP-04	FILTER INSTRUMENT AND SAMPLE PANEL NO. 3	PRESSURE FILTERS (SHEET E-1201)	11200	N
30-ISP-05	FILTER INSTRUMENT AND SAMPLE PANEL NO. 4	PRESSURE FILTERS (SHEET E-1201)	11200	N
40-ISP-20	POST FILTER INSTRUMENT AND SAMPLE PANEL	PRESSURE FILTERS (SHEET E-1201)	17325	N
40-ISP-60	TERMINUS POINT OF ENTRY PANEL	STONE OAK PUMP STATION (SHEET E-1401)	17325	N
60-LCP-01	HYDROGEN DILUTION LOCAL CONTROL PANEL	OSG BUILDING (SHEET E-1501 - OSG SKID ROOM)	11360	N
60-LCP-02	HYDROGEN DILUTION STARTER PANEL (SHEET E-1501)	OSG BUILDING (SHEET E-1501 - ELECTRICAL ROOM)	11360	N
60-LCP-03	OSG COMMON PANEL	OSG BUILDING (SHEET E-1501 - ELECTRICAL ROOM)	11360	N
60-CP-01	OSG CONTROL PANEL NO. 1	OSG BUILDING (SHEET E-1501 - OSG SKID ROOM)	11360	Y
60-CP-02	OSG CONTROL PANEL NO. 2	OSG BUILDING (SHEET E-1501 - OSG SKID ROOM)	11360	Y
67-LCP-01	PRESSURE FILTER POLYMER FILL PANEL	POLYMER STORAGE AREA (SHEET E-1104)	17325	N
69-LCP-01	FLUORIDE FILL PANEL	FLUORIDE STORAGE AREA (SHEET E-1104)	17325	N
85-LCP-01	CENTRIFUGER NO. 1 LOCAL CONTROL PANEL	CENTRIFUGE AREA (SHEET E-1602)	11363	N
85-LCP-02	CENTRIFUGER NO. 2 LOCAL CONTROL PANEL	CENTRIFUGE AREA (SHEET E-1602)	11363	N
85-CP-01	CENTRIFUGER NO. 1 CONTROL PANEL	CENTRIFUGE ELECTRICAL ROOM (SHEET E-1602)	11363	Y
85-CP-02	CENTRIFUGER NO. 2 CONTROL PANEL	CENTRIFUGE ELECTRICAL ROOM (SHEET E-1602)	11363	Y
86-LCP-01	TRUCK LOADOUT LOCAL CONTROL PANEL	TRUCK LOADOUT FACILITY (SHEET E-1602)	13250	N
86-CP-01	TRUCK LOADOUT CONTROL PANEL	TRUCK LOADOUT FACILITY (SHEET E-1602)	13250	Y
01-CP-01	PLC - MASTER	CONTROL BUILDING (SHEET E-1801)	17325	Y
01-CP-02	PLC - CHEM	FLUORIDE STORAGE AREA (SHEET E-1104)	17325	Y
01-CP-03	PLC-SOLIDS	DEWATERING BUILDING (SHEET E-1603)	17325	Y
50-CP-01	PLC - STONE OAK PUMP STATION	STONE OAK PUMP STATION ELECTRICAL ROOM (SHEET E-1701)	17325	Y

NOTES:

- THIS IS A STANDARD LEGEND, NOT ALL OF THE INFORMATION SHOWN HERE MAY BE APPLICABLE TO THIS PROJECT.
- PROVIDE SURGE SUPPRESSION ACROSS RELAYS, SOLENOIDS, CONTRACTORS, STARTERS, ETC. AS RECOMMENDED BY PLC MANUFACTURER.
- TERMINAL BLOCKS TO BE 12" MINIMUM ABOVE FLOOR. HIGH DENSITY TERMINAL BLOCKS MAY BE USED.

INCOMPLETE DOCUMENT ISSUED FOR INTERIM REVIEW ONLY

NOT RELEASED FOR REGULATORY APPROVAL PERMIT OR CONSTRUCTION

TIMOTHY D. GOBROGGE
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 JULY 2018

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SAN ANTONIO WATER SYSTEM

MARK	DATE	DESCRIPTION

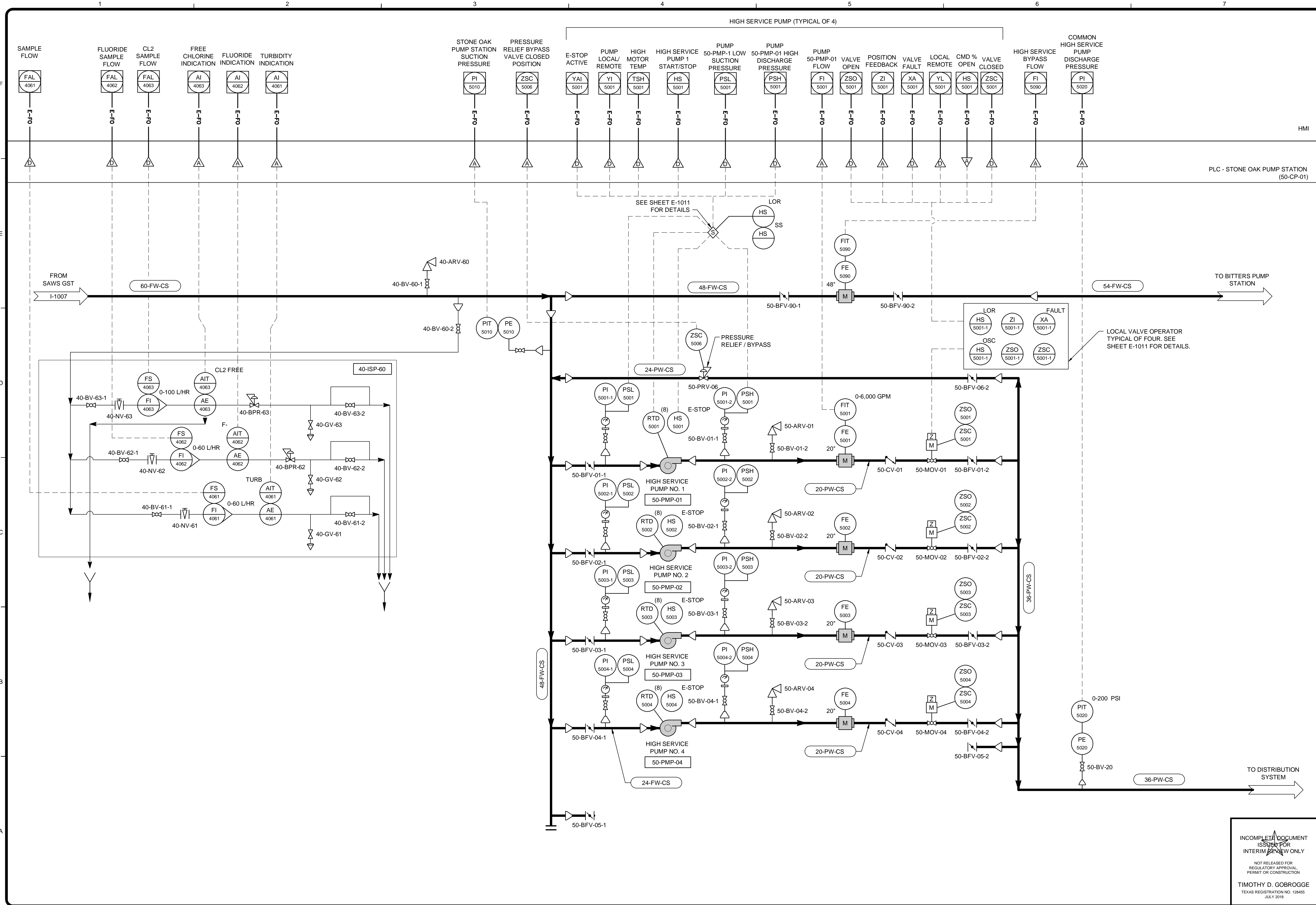
SAN ANTONIO WATER SYSTEM
 CENTRAL WATER INTEGRATION PIPELINE PROJECT TERMINUS FACILITY

INSTRUMENTATION LEGEND & ABBREVIATIONS

PROJ: 200-09308-18001
 DESN: BRW
 DRWN: JTE
 CHKD: TG

I-1001

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PLC - STONE OAK PUMP STATION (50-CP-01)

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EP-2 BID SET

SAN ANTONIO WATER SYSTEM

MARK	DATE	DESCRIPTION

SAN ANTONIO WATER SYSTEM
CENTRAL WATER INTEGRATION PIPELINE
PROJECT TERMINUS FACILITY
STONE OAK PUMP STATION & SURGE TANK
P&ID

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I-1008

Bar measures 1 inch, otherwise drawing is not to scale