



Early Procurement of Lime Saturator Solids Contact Units  
for the Central Water Integration Pipeline Project

SAWS Job No. 18-8616  
Solicitation No. 18- 18098

RELEASED FOR BID  
JULY 2018

DIVISIONS 1, 5, 11, 13



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 5

# METALS



## SECTION 05532

### ALUMINUM GRATING AND COVER PLATE

#### PART 1 GENERAL

##### 1.01 SUMMARY

This section describes materials, fabrication, and installation of aluminum grating and cover plate.

##### 1.02 RELATED SECTIONS

- A. Structural Aluminum: Section 05140.
- B. Aluminum Stairs, Catwalks and Landings: Section 05515.
- C. General Requirements: Division 01

##### 1.03 QUALITY ASSURANCE

- A. Fabricator shall be responsible for design. Design shall be performed by a Professional Engineer licensed in the State of Texas.
- B. Welder Qualifications: Welds shall be made only by welders, tackers and welding operators who have been previously qualified by tests as prescribed in the Structural Welding Code, of the American Welding Society to perform the type of work required.
- C. Review installation procedures under other Sections and coordinate the work that must be installed with, or prior to the grating or cover plate.

##### 1.04 SUBMITTALS

- A. Shop Drawings and Product Data:
  - 1. Fabricator shall submit shop drawings and structural design calculations necessary to show compliance with the plans and specifications. A cover letter shall be included by the design engineer, who is a licensed professional engineer in the state of Texas, stating that the design is in compliance with the project plans and specifications, and applicable code requirements.
  - 2. Include complete information necessary for fabrication and installation. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items.
  - 3. Include manufacturer's descriptive literature and specifications covering products required by plans.

4. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

## **1.05 PERFORMANCE REQUIREMENTS**

- A. Structural Performance of Aluminum Grating for Stairs (Tread), Catwalks, Landings, Sump Pits and Cover Plate: Provide fabricated components capable of withstanding the effects of gravity dead loads and the following loads/stresses within limits and under conditions indicated.
  1. Uniform Live Load: 125 psf, applied vertically.
  2. Concentrated Live Load: 300 lbs distributed on an area 4-inch square, applied vertically at locations to result in maximum stress.
  3. Concentrated Live Load: 500 lbs distributed on an area 2.5-foot square, applied vertically at locations to result in maximum stress.
  4. Uniform and concentrated live loads are not concurrent.
  5. Live Load Deflection: maximum  $L/360$ .
- B. Structural Performance of Aluminum Grating at Trenches: Provide fabricated components capable of withstanding the effects of gravity dead loads and the following loads/stresses within limits and under conditions indicated.
  1. Uniform Live Load: 125 psf, applied vertically. Deflection shall not be greater than  $L/360$  or  $1/4$ -inch.
  2. Concentrated Live Load: 2,000 lbs distributed on an area 2.5-foot square, applied vertically at any location. Deflection shall not be greater than  $L/360$  or  $1/4$ -inch.
  3. Concentrated Live Load (Wheel Load): 1,430 lbs distributed on a 4-inch square wheel print, applied vertically at any location. Deflection shall not be greater than  $1/4$ -inch.
  4. Uniform and concentrated live loads are not concurrent.
- C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

## **1.06 DELIVERY, STORAGE AND HANDLING**

- A. Deliver products in a manner that will prevent material damage and deterioration or contamination from the elements.

- B. Store products above ground on platforms, skids, or other supports. Keep material free from dirt, grease, and other foreign matter and protect from corrosion. Provide protective wrapping on products and maintain such in place until project is ready for final inspection.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Aluminum Grating:
  - 1. Bearing Bars: Aluminum alloy 6061-T6, 3/16-inch thick and conforming to ASTM B221, or equivalent I-bar style.
  - 2. Cross Bars and Bent Connecting Bars: Aluminum alloy 6063-T5 conforming to ASTM B221.
- B. Anchor Clips: stainless steel.
- C. Aluminum Bearing Angle: Aluminum alloy 6061-T6 conforming to ASTM B308.
- D. Bearing Support at Trenches: Beams, Angles and Columns as required by plans, Aluminum alloy 6061-T6 conforming to ASTM B308.
- E. Aluminum Cover Plate: Checkered (Diamond) Pattern Plate, Aluminum alloy 6061-T6 conforming to ASTM B209.
- F. Fasteners: As specified in Section 05140.
- G. Anchor Bolts and Expansion Anchors: As specified in Section 05140.

### **2.02 FABRICATION**

- A. Aluminum Grating shall be slip-resistant.
- B. Fabrication and tolerances shall be in accordance with NAAMM Metal Bar Grating Manual.
- C. Bearing Bar Spacing: As required by design, but no greater than 1-3/16-inch center to center.
- D. Cross Bars Spacing: As required by design, but no greater than 4-inch center to center.
- E. Bar Connection: Mechanically lock cross bars to bearing bars, unless design requires otherwise.
- F. Banding: Grating bar ends banded same depth as bars. Openings cutting two or more bearing bars require banding. Openings for pipes, ducts, conduits, and similar objects require banding.

- G. Openings Through Panels: Split panels in two individual sections to facilitate removal of panels at pipes, ducts, conduits, and similar objects passing through grating panels. Fabricator to coordinate with Process, Mechanical, Electrical, and Plumbing plans for openings.
- H. Provide not less than four (4) saddle clips at all supporting sides for each grating section and at 2'-0" o.c. (max.) at adjoining panels.
- I. Do not notch bearing bars at supports to maintain elevation.
- J. Aluminum Cover Plate: 1/4" Checkered (Diamond) Pattern plate welded to aluminum grating. Drop handles shall be provided. Aluminum Grating depth shall be as required by cover plate performance requirements.
- K. Fasteners: As specified in Section 05140.
- L. Anchor Bolt and Expansion Anchors: As specified in Section 05140.
- M. Aluminum Grating at Trenches shall be removable and fabricated to panel sizes weighing no greater than 120 lbs. each. Drop handles shall be provided.
- N. Bearing Support at Trenches: Beams, Angles and Columns as required by plans, shall be in accordance with Section 05140.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Field Measurements: Verify measurements in the field before fabrication and indicate measurements on shop drawings.
- B. Field Inspection: Prior to beginning the installation, a thorough investigation shall be made of the structure to receive the system to insure that the system can be installed to the indicated alignment.

### **3.02 INSTALLATION**

- A. Clean the surfaces of embedded metalwork to be in contact with concrete of rust, dirt, grease, and other foreign substances before placing concrete.
- B. Set grating seats and frames and cover plate frames and supports accurately in position when concrete is placed and support it rigidly to prevent displacement or undue vibration during or after the placement of concrete. Unless otherwise specified, where metalwork is to be installed in recesses in formed concrete, said recesses shall be made, metalwork installed, and recesses filled with dry-pack mortar.
- C. Dissimilar surfaces isolation shall be in accordance with Section 05140.

**END OF SECTION**



# DIVISION 11

# EQUIPMENT

## SECTION 11220

### LIME SATURATOR SOLIDS CONTACT UNITS

#### PART 1 - GENERAL

##### 1.01 SCOPE

- A. This Section of the Specifications describes the requirements for providing two (2) new lime saturator solids contact units. The units shall be designed for a design flow rate of up to 1.7 million gallons per day (MGD) at a maximum rise rate of 1.0 gallons per minute per square foot (gpm/sf) to produce a solution that is saturated with calcium hydroxide after 10-20 percent lime slurry is added to the reaction zone.
- B. The treatment unit shall include mechanisms and launder systems designed for extra-heavy-duty service (minimum design safety factors of 2.0). The mechanism shall be complete in all respects and ready for installation by the Contractor. The scope of supply shall include the outer steel tank, steel embed for the outer wall for their concrete slab, manways, all interior baffles and supports, all interior launders and weirs, influent pipe to center well, outlet pipe, overflow flare and tank connection, mixer, drive and motor, rake drive, motors and lifting mechanism, sludge rake, center walkway support structure, grating and handrails, drive unit control panel, blowdown control panel, blowdown diaphragm valves, which shall be inclusive of all the equipment, material and piping within the basin, except electrical wiring and conduit, lighting, washdown water, cable trays, lime slurry piping and dosing assemblies.
- C. The Lime Saturator Equipment Supplier shall be responsible for coordinating with the Contractor on all activities required for a complete installation of the lime saturator equipment specified herein. Activities requiring extensive coordination include but are not limited to shop drawing submittals, penetrating items required to be installed during fabrication of the steel tank and construction of the concrete support slab, and fabrication and installation of the lime saturator solids contact units. Fabrication of the lime saturator solids contact units cannot commence until all key dimensions, equipment and pipe locations, and any other interdependent items are approved by the Engineer and any conflicts or ambiguities are resolved.
- D. The solids contact units shall be furnished with geodesic aluminum tank covers as shown on the Drawings and specified in Section 13310. The tank manufacturer shall be responsible for coordinating with the geodesic dome manufacturer to include in the design of the steel saturator shell all structural components required to connect and support the geodesic dome to provide a system which completely encloses and covers the lime saturator units.
- E. Related Work Described Elsewhere:
  - 1. Division 1 – General Requirements.
  - 2. Section 05532 –Aluminum Grating and Cover Plate
  - 3. Section 13310 – Geodesic Aluminum Domes

4. Section 17306-- Vendor Packaged Process Control Systems

**1.02 QUALITY ASSURANCE**

- A. Qualifications: All of the equipment specified herein shall be furnished by WesTech, Walker Process, Ovivo or approved equal. The Supplier of equipment for the lime saturators shall have at least 10 installations of similar equipment design successfully operating as lime saturators or solids contact clarifiers for lime softening having a capacity equal to or greater than 1.0 MGD with rake arms and walkway supported draft tube and hood.
- B. The equipment specified in this Section shall be furnished, coordinated, serviced, and guaranteed by one Lime Saturator Equipment Supplier who shall be experienced in the design, manufacture, coordination, installation, and servicing of equipment of the type, size, and complexity specified in this Section. The Lime Saturator Equipment Supplier shall have a permanent organization of office and field technical personnel and facilities necessary for fulfilling all requirements of this Specification. The Lime Saturator Equipment Supplier shall have an established service organization in the State of Texas capable of providing fully knowledgeable, experienced service personnel and replacement parts at the Project site not later than 24 hours after telephone notification by the Owner. If such a service facility does not exist for the Lime Saturator Equipment Supplier, then the Lime Saturator Equipment Supplier shall guarantee by written notice with their submittal that they shall provide service personnel to the job site upon notification from the Owner within 48 hours and shall provide spare parts within 24 hours after notification by Owner.
- C. The equipment shall comply with the following referenced standards:
1. Anti-Friction Bearing Manufacturer's Association (AFBMA)
  2. American Gear Manufacturer's Association (AGMA)
  3. American National Standards Institute (ANSI)
  4. American Society for Testing and Materials (ASTM)
  5. American Water Works Association (AWWA)
  6. National Electrical Manufacturers Association (NEMA)
  7. American Welding Society (AWS)
- D. Additional Description of Standards:
1. All fabricated structural steel shall conform to the requirements of "Standard Specification for Steel for Bridges and Buildings", ASTM Designation A36. All shop welding shall conform to the latest standards of the American Welding Society.

2. The design of steel plate for the treatment unit exterior steel tankage and interior hood and steel skirt shall be in accordance with AWWA Standard D100, latest revision.
3. Except where specifically indicated otherwise, all carbon steel plates and structural members designated for submerged service shall have a minimum thickness of 1/4 inch. All erection and mounting hardware required for the installation of the lime saturator solids contact units shall be Type 316 stainless steel.
4. Fabricated assemblies shall be shipped in the largest sections permitted by carrier regulations, properly match-marked for ease of field erection. The units shall be erected and lubricated in strict accordance with the instructions of the manufacturer's field engineer.
5. All fabricated steel components for the access walkway and platform and the vertical structural support columns shall be hot-dip galvanized unless otherwise noted on the Drawings or specified herein. All hot-dip galvanizing shall be in accordance with ASTM A123.
6. Welding:
  - a. The equipment manufacturer's shop welding procedures, welders and welding operators shall be qualified and certified in accordance with the requirements of AWS D 1.1 "STRUCTURAL WELDING CODE-STEEL" of the American Welding Society.
  - b. Clearly show complete information regarding location, type, size, and length of all field welds in accordance with "STANDARD SYMBOLS FOR WELDING, BRAZING AND NONDESTRUCTIVE EXAMINATION " AWS A 2.4 of the American Welding Society, and fully explain special conditions by notes or details on the equipment manufacturer's shop drawings.
  - c. The Contractor's welding procedures, welders and welding operators shall be qualified and certified in accordance with the requirements of AWS D 1.1 "STRUCTURAL WELDING CODE-STEEL" of the American Welding Society.
  - d. Perform all field welding in conformance with the information shown on the equipment manufacturer's drawings regarding location, type, size and length of all welds in accordance with "STANDARD SYMBOLS FOR WELDING, BRAZING AND NONDESTRUCTIVE EXAMINATION " AWS 2.4 of the American Welding Society, and special conditions as shown by notes and details.
  - e. No field welding of galvanized steel will be allowed.



### 1.03 SUBMITTALS

- A. Copies of all materials required to establish compliance with these specifications shall be submitted in accordance with the provisions of the Section 01300. Submittals shall follow the following contract schedule:
- B. Pre-Purchase Contract Schedule: It is anticipated that this pre-purchase contract will follow the approximate schedule below:
- |                              |                        |
|------------------------------|------------------------|
| 1. Submittals – Preliminary: | Submitted with the Bid |
| 2. Submittals – Level 1:     | August 24, 2018        |
| 3. Submittals – Level 2:     | September 28, 2018     |
- C. The Lime Saturator Equipment Supplier shall submit the following with the bid:
1. Any exceptions to the requirements of the specifications not covered by any addenda issued during the bidding process.
  2. Preliminary saturator shop or fabrication drawings with all dimensions indicated. Include identification and catalog cuts for purchased components and details for manufactured components.
  3. Internal configuration of equipment (rake mechanism, impeller, launders).
  4. Summary table listing the make and model of all instrumentation field devices, and any other appurtenances to be furnished with the Lime Saturator Equipment Supplier.
  5. Performance guarantee approved by authorized signatory.
- D. The Lime Saturator Equipment Supplier shall submit the following with Level 1 submittals (August 24, 2018):
1. Saturator shop or fabrication drawings with all dimensions indicated. Include identification and catalog cuts for purchased components and details for manufactured components. Identify materials, surface preparation, and finishes. Include ASME calculations of wall thickness for the saturator.
  2. Flow schematic drawing indicating sizes of pipes connecting to and from the saturator, valving, utility (air, water, drain, electric) line sizes and connections.
  3. Structural drawings and calculations for the saturator unit tank and hood, supports, walkway and platform, and launder system. The calculations shall include specified loads and substantiate minimum deflections and stresses as specified. Structural calculations for the launders shall consider both maximum loads when full with the tank water level below the bottom of the launders and maximum buoyant uplift forces when the launder is empty and the tank water level is at the top of the launders. Structural drawings and calculations for the lime saturators

shall be signed and sealed by a Registered Professional Engineer, registered in the State of Texas.

4. A list of any and all parameters, ratings or other characteristics where the proposed system deviates from the requirements set forth in these Specifications.
  5. All Shop Drawings and calculations performed for the structural design of the units shall be certified/stamped by a professional engineer registered in the State of Texas.
  6. Equipment catalog cut sheets.
  7. Motor nameplate data and specifications sheet for all electric motors.
  8. Bill of material.
  9. Piping details of connections to Contractor-supplied piping.
  10. Shop painting specification(s) for ferrous surfaces.
  11. Separate AWS Certificates (certification required within the past year) for all the fabrication shop and field welders performing welds on the equipment. Submit special weld procedures and weld records for stainless steel welding as specified herein. Welders shall be experienced welders for construction of water treatment units and tanks in accordance with AWWA D100 Standards, latest revision.
  12. Handling and storage instructions.
- E. The Lime Saturator Equipment Supplier shall submit the following with Level 2 submittals (September 28, 2018):
1. Complete, dimensioned shop drawings for the geodesic dome showing all details of construction and specifications for all materials and finishes. Provide all submittals and information required to be submitted in Section 13310 Geodesic Aluminum Domes.
  2. Certification by the manufacturer of the output rating of the rotor-impeller mixer selected, including all ratings for the gear drive and the adjustable speed drive unit.
  3. The manufacturer shall submit hydraulic design calculations for the launder system, including substantiating specified velocities, maximum head losses and maximum hydraulic loading rates specified.
  4. Cross sectional drawings of all equipment with parts identification and materials specifications.
  5. Electrical schematics and interconnecting wiring diagrams showing extent of factory prewiring and details of control panels.

6. Manufacturer's drawings with parts list for all accessory equipment.
7. Special tools to be supplied.
8. Recommended spare parts with current pricing.
9. List of local facilities to obtain parts for all equipment.
10. Test data for equipment as specified herein.
11. List of manufacturer-approved service organizations for all equipment.
12. Operation and maintenance manuals in accordance with Section 01730.
13. A complete set of reproducible as-built Shop Drawings for all equipment furnished.
14. Final location and dimensions of the access hatch.
15. Electrical/Instrumentation data including: complete electrical, instrumentation and control, and wiring diagrams in sufficient detail to allow installation of instrumentation and controls and electrical components. The following submittals shall be required:
  - a. The following information shall be submitted with the motor drawings for review.
    - 1) Name of Drive
    - 2) Horsepower of Motor
    - 3) Phase
    - 4) Full Load Efficiency
    - 5) Voltage
    - 6) Full Load Power Factor
    - 7) Speed
    - 8) NEMA Design Starting Torque
    - 9) NEMA Frame and Dimensions
    - 10) Full Load Current
    - 11) Locked Rotor Current
    - 12) Insulation Class
    - 13) Temperature Rise at 1.15 SF
    - 14) Enclosure
    - 15) Bearing life design
    - 16) Special features (i.e., space heater voltage/ wattage, RTDs, oversize conduit box and corrosion resistant features).

- 17) Nameplate Drawing with Information as listed herein.
- 18) Lugs and connectors.

b. Field Instrument Submittal

- 1) Submit complete documentation of all field instruments using ISA-S20 data sheet formats. Submit separate data sheets for each instrument
- 2) Certified calibration data for all flow metering devices
- 3) Refer to Section 17036 for additional specific submittal requirements.

c. Control System Submittal

- 1) The Supplier shall coordinate with the Contractor to schedule all control system submittals in a timely manner, such that the plant control system programming schedule will not be delayed.
- 2) Control System Hardware: This submittal shall provide complete documentation of the proposed hardware (PLCs, communication equipment, cables, and peripherals). The submittal shall include the following:
  - a) System Block Diagram
  - b) Complete Bill of Materials
  - c) Loop Drawings
  - d) Control Panel Layout Drawings
  - e) Equipment Data Sheets
- 3) Lime Saturator Equipment System Control Narrative Submittal: This submittal shall provide the following information:
  - a. System Overview
  - b. Mode of Operation
  - c. Local Manual Control
  - d. Local Automatic Control
  - e. Remote Manual Control
  - f. Remote Automatic Control
  - g. Alarms
  - h. Interlocks
  - i. Tuning Parameters

- j. Equipment Runtimes
- k. Historical Recording
- 4) Input/Output (I/O) List Submittal: This submittal shall provide the following information:
  - a) Field device tag name
  - b) I/O tag
  - c) Description
  - d) Range
  - e) Engineering unit
- 5) Operator Interface Submittal
  - a) Submit all proposed graphic displays, trends, and logs.
  - b) Quantity of graphic displays to be submitted shall be as required to depict all monitoring and control requirements, defined herein and in the contract documents. As a minimum, the following graphic displays and types shall be submitted:
    - Process Overview Displays
    - Unit Process Displays
    - Alarm Summary Display
    - Key Performance Indicators (KPI): provide dedicated graphic displays for system key performance indicators.
    - Control Strategy Setup Displays
    - Equipment Control Pop-up Displays
    - System Diagnostic Displays

**1.04 OPERATING INSTRUCTIONS (COORDINATE WITH DIV 1)**

- A. Operating and maintenance manuals shall be furnished in accordance with Section 01730: Operating and Maintenance Data. The manual shall be prepared specifically for this installation and shall include all required catalog cuts, drawings, equipment lists, descriptions, and necessary information that are required to instruct operating and maintenance personnel unfamiliar with all of the equipment specified herein. A complete, corrected and approved copy of the shop drawing submittal shall be included with each manual provided.

- B. A factory representative who has a complete knowledge of proper operation and maintenance requirements for the equipment shall be provided for a minimum of one (1) eight-hour working day to instruct representatives of the Owner on proper operation and maintenance of the equipment. Provide at least ten (10) days advance notice to the Owner before scheduling the instruction day. This work is in addition to, but may be conducted in conjunction with, the inspection of installation and test run as provided under Part 3. The operation and maintenance manuals shall be provided at a time in advance of the instruction/training period that is approved by the Owner. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, the manuals shall be revised to reflect any information that was changed as a result of the corrective actions taken.
- C. Equipment Certification: The Contractor shall submit to the Engineer copies of a certified report from the factory service representative certifying that the lime saturator solids contact equipment has been properly installed and operates satisfactorily under the specified operating conditions. The certified report shall include all requirements as stated in Paragraph 3.03, Factory Service Representative.

#### **1.05 WARRANTY AND GUARANTEES**

- 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.
- B. Patents and Licenses
  - 1. The Lime Saturator Equipment Supplier shall be responsible for all patents or licenses that exist because of the equipment that may be provided.
  - 2. The Lime Saturator Equipment Supplier shall assume all costs of patent fees or licenses for the equipment or process, and shall safeguard and save harmless the Owner, Program Manager and Engineer from all damages, judgment, claims and expenses arising from license fees, or claimed infringement of any letters, patent or patent rights, or fees for the use of any equipment or process, structural feature or arrangement of any of the component parts of the installation, and the price bid shall be deemed to include payment of all such patent fees, licenses or other costs pertaining thereto.

#### **1.06 SHIPPING REQUIREMENTS**

- A. All fabricated steel assemblies shall be shipped in convenient sections, or as specified herein and permitted by carrier regulations, properly match-marked and identified for ease of field erection.

- B. All equipment shall be handled during delivery, storage, and installation in a manner to prevent damage of any nature in accordance with the manufacturer's approved instructions.
- C. All electrical controls and equipment shall be stored in a clean, dry, weather-tight building upon delivery to the Project site.

## **1.07 MANUFACTURER**

- A. The basis of design for the lime saturator solids contact units that are shown on the Drawings and specified herein are the Solids Contact Clarifier Model SCS71 as manufactured by WesTech, upon which the specification was prepared. Equipment meeting the requirements of the specifications furnished by Walker Process, Ovivo or an approved equal will also be acceptable.

## **PART 2 - PRODUCTS**

### **2.01 GENERAL**

- A. The unit provided shall be manufactured to the dimensions shown on the Drawings and as specified herein. The saturator unit shall include an outer steel tank which shall fully enclose the liquid process and also support the geodesic dome. The mechanism shall be supported by the structural steel walkway bridge supports that are resting on the outer steel tank wall, as shown on the Drawings, with the flow entering through the side of the basin, flowing through the mixing zone of the reaction compartment, mixing with recycled sludge, through the secondary reaction chamber, through the settling zone, and then rising up to the discharge finger-type radial launders. Sludge shall be removed through periodic blowdown of sludge from the center sludge well, as shown on the Drawings.
- B. Equipment furnished and installed under this Section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformance with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the Engineer.
- C. The unit shall be furnished and installed complete with all piers and supports, all mechanical equipment required for proper operation, including complete drive units, all steel, iron, aluminum handrails and walkways, and other metal construction indicated by the Drawings, and any additional materials or construction required by the manufacturer's design.

### **2.02 MATERIALS**

- A. Structural Steel: ASTM A36
- B. Steel Galvanizing: ASTM A123
- C. Structural Aluminum: ASTM B209, ASTM B221, ASTM B308, Alloy 6061-T6
- D. Structural Stainless Steel: ASTM A666, Type 304L, annealed

- E. Castings: ASTM A48, gray iron having a minimum tensile strength of 20,000 pounds per square inch (psi)
- F. Bolting Materials:
  - 1. Anchor Bolts or High Strength Bolting Requirements: ASTM A320, B8M, Class 2, Type 316 stainless steel, high strength bolts.
  - 2. Commercial Strength Bolting Requirements: ASTM F593, Type 316 stainless steel bolts and ASTM F594, Type 316 stainless steel nuts
  - 3. Washers: Type 316 stainless steel
  - 4. Nuts shall have a hardness that is lower than that of the bolts and the washers by a difference of 50 Brinnell hardness to prevent galling.
- G. Welding: According to the latest edition of AWS standards. All welding for mild steel components of the lime saturator solids contact units shall be continuous and seal welded throughout shop fabrication and field erection.

**2.03 FEED WATER SERVICE CONDITIONS**

- A. The basin equipment shall be designed to process potable feed water which will be saturated with a 10 to 20% lime slurry to produce a saturated calcium hydroxide solution for raising the calcium concentration in the project company water. Values for potable feed water parameters are as follows:

<u>Potable Water Parameter</u>	<u>Value</u>
pH	8.0-9.0
Calcium Hardness	12-15 mg/L as CaCO <sub>3</sub>
Alkalinity	160-280 mg/L as CaCO <sub>3</sub>
Turbidity	≤ 2.0 NTU
Temperature Range	≤ 90°F

**2.04 DESIGN REQUIREMENTS AND PERFORMANCE CRITERIA**

- A. The unit shall maximize the mixing of the lime slurry and makeup water to create a saturated calcium hydroxide solution and effectively separate and remove calcium carbonate precipitate formed as a reaction byproduct. The unit shall incorporate a three-stage design which includes a primary mixing zone for chemical mixing, a secondary flocculating zone for flocculation (of formed precipitate), and large-volume internal recirculation in a central reaction compartment, followed by a clarification zone for clarification (by sedimentation), and sludge collection and removal, all accomplished in a single basin, as shown on the Drawings. Potable water and chemicals shall be combined



in the primary mixing and reaction chamber so that reaction shall take place in the presence of recirculating slurry. In the primary mixing and reaction chamber, the turnover shall be at least ten (10) times the throughput of the lime saturator solids contact units. In this way, there shall be formed a slurry pool in the lower portion of the outer, or separation chamber with a clear water zone above. Separation of solids from the water shall take place near the surface of the slurry pool. The surface of the slurry pool shall remain at substantially the same elevation for all treating rates.

B. The equipment for the basin shall be furnished complete with all components and accessories necessary for an operating installation and shall include, as a minimum, a primary mixing and reaction chamber, a secondary reaction chamber, a separation chamber and the radial collecting launder system. The equipment provided shall include: all steel tankage, structural supports and appurtenances; all internal steel work and inlet piping consisting essentially of hood and support structure; inner draft tube; outer draft tube and for the alternate design; rotor-impeller mixer with shaft and gear reducer drive unit with an electric motor suitable for use with a variable speed drive unit; supporting beams and aluminum grating walkway with aluminum handrailing and kickplates across the tank as shown on the Drawings. Also to be included with the equipment shall be sludge discharge timer-controlled electric controlled, pneumatic sludge blowdown diaphragm valves; center drain sump, six (6) stainless steel sample lines with valving and a sludge blowdown control panel.

C. The saturator unit shall be designed for installation as shown on the Drawings and shall be designed to operate having the following dimensions:

Minimum inside top dimension:	43'-0" diameter
Sidewater depth:	15'-3"
Freeboard at treatment capacity:	1'-06"
Diameter of influent pipe:	10"
Diameter of effluent pipe:	12"
Bottom Slope:	1:12

D. The manufacturer shall warrant that the equipment furnished, when operated in compliance with the manufacturer's instructions, will properly saturate the water (subject to the proper addition of lime, and anionic polymer and the proper operation of the unit) and will consistently yield an effluent having the following parameter values, when operated at any flow rate between 30 and 100 percent of the maximum flow rate when the water temperature is less than 90°F. Effluent from the lime saturator solids contact units shall have the following parameters after the addition of the optimum concentrations of lime, and an anionic polymer:

<u>Parameter</u>	<u>Value</u>
Calcium Concentration	≥1,200 mg/L as Ca(OH) <sub>2</sub>

Turbidity <10 NTU

- E. The equipment shall be designed to pass the maximum hydraulic flow rate without excessive head losses. The lime saturator solids contact units shall be designed for the following hydraulic and mechanical parameters:

Design Rate of Flow 1,180 gpm  $\Rightarrow$  1.7 MGD

Maximum Rotor-Impeller Tip Speed 5.0 ft/sec

Minimum rotor pumping capacity in primary mixing/reaction zone 11,800 gpm

Minimum Reaction Time in Mixing/  
Flocculation Zone 20 minutes

Surface loading rate (clarification area only at the solids liquid interface) <1.0 gpm/ft<sup>2</sup>

Maximum weir loading rate 8 gpm/linear foot

Maximum distance from any point on the saturator surface to the nearest weir 10 feet

Minimum Continuous Duty Torque Rating 15,000 ft.-lbs.

- F. The equipment shall effectively divide the basin into an inner flocculating-reaction zone and an outer settling zone. The flocculating-reaction zone shall be equipped with mixing equipment designed to thoroughly and effectively mix the inlet water, chemicals, and recirculated precipitate. The mixing equipment shall be equipped with a draft tube to ensure the recirculation of the precipitated solids.

- G. The structural design for the saturator unit tankage and interior hood shall conform to the criteria in AWWA D100 Standards, latest revision. The system shall be proportioned and designed to resist all loads and stresses when the tank is empty and full of lime solution (specific gravity = 1.1), as well as local wind and seismic conditions. The saturator shall be designed to support the geodesic dome, walkway bridge and walkway supported equipment and structures, a wind load of 130 MPH and for the following seismic design parameters:

1. Site Classification: B
2. Site coefficient (Fa): 1.0
3. Site coefficient (Fv) = 1.0
4. Mapped spectral response acceleration for short periods (Ss): 0.074 g
5. Mapped spectral response acceleration for 1-second period (S1): 0.030 g

Following construction of the tank, final integrity testing shall be completed in accordance with AWWA D100.

- H. For the purpose of stress design calculations, all vertical design loads shall be considered both acting alone and in combination with lateral wind and seismic loadings. Stress design calculations shall be completed for the saturator considering both full and empty conditions. The maximum allowable stress in any structural member shall not exceed those permitted in the latest AISC Design Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings. All structural design shall conform to ASCE 7-10 and 2015 IBC.
- I. All welds to construct the saturator shall be in accordance with the latest edition of the American Welding Society (AWS) standards. All welding shall be by qualified welders certified in accordance with the AWS requirements.
- J. All carbon steel components for the exterior tank, inner draft tube, outer reaction zone hood and support structure, baffles, rotor-impeller mixer, rafter system and sludge concentrator sumps shall be fabricated of all welded construction. Absolutely no bolting for the assembly of carbon steel equipment installed below the bridge will be permitted with the exception of bolted access doors. All mating surfaces shall be continuous seal welded after erection. Any bolts that may be used for temporary assembly shall be removed after all plates have been welded. All bolt holes shall be covered with 1/4-inch steel plates welded to the saturator unit structural plates or members. The inner wall of the circular collecting launder shall be bolted to a structural carbon steel baffle plate which is welded to each steel rafter. Bolting hardware shall be Type 316 stainless steel in accordance with Paragraph 2.02 F. All welds shall be continuous and seal welded throughout shop fabrication and field erection, welded by the approved AWS-certified welders. All welds shall be ground to remove all weld spatter and slag. All sharp edges and corners shall be rounded to a smooth contour by grinding.
- K. Stainless steel shop and field welding of the launder components and center ring shall be in accordance with the submitted and approved Welding Procedure Specifications (WPS's), and submitted Procedure Qualification Records (PQR's) for verification of adherence to the approved WPS's. Shop and field welders shall be certified to these approved procedures.
- L. The ratio of unbraced length to least radius of gyration, slenderness ratio, shall not exceed 200 for any compression member, and shall not exceed 240 for any main tension members, or 300 for lateral bracing members or other secondary members in tension. For angles, the governing radius of gyration is about the Z-Z axis. In addition, all structural members and connections shall be designed so that the unit stresses will not exceed AISC allowable stresses by more than 1/3 when subjected to a loading of twice the running torque of the drive.
- M. Structural members for the exterior tank shell, draft tubes, hood and rafter support structure, skirt, baffles and the rotor-impeller mixer shall be designed so that the unit stresses will be a maximum of 1/2 of AISC allowable stresses when assuming a continuous 4-inch layer of calcium carbonate scale is adhering to all surfaces of the unit in contact with the water, when the unit is completely drained.

- N. The Lime Saturator Equipment Supplier shall provide the steel angle or channel to be imbedded by the Contractor in the concrete slab to which the outer steel shell wall will be welded. The supplied steel angle or channel shall be rolled to match the diameter of the tank outer wall and shipped in the minimum number of sections to reduce the amount of field welding required to assemble it.
- O. Structural members for the launder support system shall be designed so that the unit stresses will not exceed AISC allowable stresses by more than 1/3 when subjected to the buoyant forces during filling operation of the basin or to the maximum downward forces occurring when basin water level is drained to below the launder troughs and the troughs are still filled with water.
- P. For maintenance purposes the lime saturator solids contact unit manufacturer shall include the following bolted access hatch into the design of each unit:

- One (1), Outer Shell access manway, bolted and gasketed with hinges,

The access manway shall be designed to withstand all operating stresses anticipated and shall not leak. The access manway shall be located as indicated on the Drawings. The bolt sizes and number of bolts required for the access manway shall be determined by the manufacturer. Outer shell access manways shall be full gasketed using 1/4-inch thick Buna-N gasket material. Hinges and bolting hardware shall be Type 316 stainless steel. The access hatch shall have a minimum diameter of 24" and shall be located 24" to 36" above grade.

## **2.05 REACTION HOOD SECTION AND DRAFT TUBES**

- A. The hood section shall effectively divide the saturator unit basin into an inner flocculating-reaction zone and an outer settling zone. For the alternate design, the hood shall be fabricated from 1/4-inch minimum carbon steel structural plate., except for the portion at the air/water interface which shall be 304 stainless steel. The sloped portion of the hood section shall have a slope of at least 45 degrees from the horizontal plane. The top diameter of the reaction well shall be 15'-0" and provide a detention time of 23.5 minutes.
- B. The hood and hood structure support shall be fabricated to be supported from the walkway bridge with loads transferred to the exterior steel shell to the concrete foundation. Tie rods constructed of 304 stainless steel, hanger rods and steel structural members shall be provided to suspend the draft tube and hood from the walkway support beams. Sufficient supports shall be provided to hold the draft tube and hood rigidly in place. All welds of hood plates to the support rafters shall be complete, continuous seal welds.
- C. Raw water shall enter the primary reaction zone via the influent pipe connection to the center draft tube. Flow will be introduced into the center draft tube so that it is evenly mixed with the flocculated solids from the solids contact zone and lime slurry and polymer before it enters the secondary reaction zone.
- D. A cylindrical inner draft tube shall be provided in the center of the tank suspended from the walkway platform. The inner draft tube shall function as a conduit thru which flocculated solids in the center of the solids contact zone can be drawn upward by the

impeller mixer to recirculate the contents of the solids contact zone and mix the influent water, flocculated solids and chemicals together. Structural steel plates used to fabricate the inner draft tube shall have a minimum thickness of 1/4-inch. All welds to fabricate the draft tubes shall be complete, continuous seal welds.

- E. The reaction hood shall be comprised of a maximum of sixteen (16) shop-fabricated sections. The sixteen (16) sections shall be shipped to the job site and shall require a maximum of fifteen (15) field-welds. The Lime Saturator Equipment Supplier shall furnish the minimum number of sections to reduce the amount of welding to be provided in the field.

## **2.06 ROTOR-IMPELLER MIXER**

- A. There shall be furnished a rotor-impeller mixer complete with cantilevered shaft assembly to provide mixing in the primary mixing zone, recirculation of flow from the bottom of the solids contact zone up the draft tube to the top of the primary mixing zone. The rotor-impeller mixer shall be comprised of a horizontal continuous top plate with a series of inverted "L" blades welded between the top plate and an annular ring to form a semi-shrouded impeller. An external adjustable band shall be incorporated to provide flexibility in mixing to recirculation ratio. The maximum peripheral speed of the rotor-impeller mixer shall be 5.0 fps.
- B. The rotor-impeller mixer shall be attached to the drive unit via a flanged pipe shaft, specifically designed to minimize runout. The shaft shall be selected to maintain design stresses below 6,250 psi based on all dynamic and static loads. The pipe used for the rotor-impeller mixer shaft shall be minimum Schedule 80 steel pipe in accordance with ASTM A53.
- C. The rotor-impeller mixer shall be capable of recirculating flocculated solids from the solids contact zone up thru the draft tube into the primary mixing reaction zone. The mixer shall provide a minimum pumping capacity at maximum speed equal to 10 times the design capacity of the saturator or 11,800 gpm.

## **2.07 ROTOR-IMPELLER MIXER DRIVE UNIT**

- A. The rotor-impeller mixer shall be furnished with a helical gear reducer/electric motor (garmotor) unit which is mounted on a common steel base with the mixer. The drive unit shall be flange-mounted to the rotor-impeller mixer. The drive unit shall be a Unicase Helical Garmotor as manufactured by the Nord Gear Corporation, or an approved equal.
- B. The integral gear reducer gear case shall be constructed of high strength, SAE Class 30, gray cast iron with a high cross section modulus and center wall to provide maximum strength and rigidity. Gears shall be carburized and drop forged for durability to a hardness of 58-62 Rc and shall be finish ground to AGMA 13 quality levels to assure minimum backlash, noise and heat build-up, while maximizing efficiency. The gear reducer shall meet AGMA Service Class III requirements with a service factor of 2.0. Gear reducer shall be oil lubricated. Shaft seals for the gear reducer shall be double-lipped to keep oil in and contaminants out. Bearings for the gear reducer shall be high capacity, anti-friction type

with a B-10 rating of a minimum of 100,000 hours. The gear reducer shall have easily accessible oil fill, weather protected vent plugs, and an oil level indicator.

- C. The integral electric drive motor shall be performance-matched to the gear reducer unit. The motor shall have a NEMA C-Face mounting flange which shall be mounted to the gear reducer unit. The motor shall be provided by the gear-motor unit manufacturer and shall have the characteristics as specified below in Paragraph 2.09. The motor will be powered through a variable frequency drive unit.

## **2.08 RAKE DRIVE UNIT AND MECHANISM**

- A. The rake drive unit shall be completely factory assembled and consist of a primary and final gear reduction unit provided in an enclosed gear housing with anchor bolts and all necessary appurtenances. The main gears, main bearings (with the exception of precision bearings), and drive control that comprise the drive assembly shall be a regularly manufactured in-house product of the solids contact unit manufacturer. Drive assemblies purchased from third party vendors are not acceptable because the drive assembly is a key element in a successful installation.
- B. The drive unit and mechanism shall have a continuous torque rating of 15,000 foot-pounds based upon AGMA and British Standards. The continuous torque rating shall be defined as capable of operating at the specified maximum torque and collection arm maximum speed for 24 hours per day, 365 days per year for 20 years. All parts of the solids contact system and drive mechanism shall be rated in accordance with the latest applicable AGMA standards with a 1.25 service factor applied to the specified AGMA continuous torque rating. The drive unit shall be designed to withstand, without failure or deformation of any part, a minimum momentary peak torque loading of 30,000 foot-pounds. The momentary peak torque rating shall be equal to the yield strength of the main gear for the drive unit.
- C. In addition, a high torque switch shall be provided shall be provided to advise of an impending high torque event and a second high torque switch will be provided to protect the drive, at a load determined by the manufacturer, to shut down the drive at high torque.
- D. The primary speed reducer/motor combination and secondary speed reducers shall be separately and independently mounted at the center gear head drive platform. Mounting configurations that piggyback or otherwise vertically stack these components are also acceptable. Units using lower bearings, feedwell bearings, chains, belts, sprockets, pulleys, or any part of the drive unit below the top of the walkway are not acceptable.
- E. The primary gear reducer shall be a 4:1 ratio helical gear reducer combined with a mechanical traction disc-type, adjustable speed unit as specified below.
- F. The primary reduction gear reducer shall drive the final reduction unit through a traction disc-type arrangement. The timing belt shall be a fiberglass and nylon reinforced, high quality neoprene rubber, gear type timing belt. The drive belt shall be protected with a hot-dip galvanized steel, OSHA approved, removable belt guard. Proper belt tension shall be provided for by an adjustable steel base mounted on the final reduction unit. Drives utilizing cycloidal reduction units directly connected to the pinion shall also be acceptable. Requirements for a cycloidal drive are as follows:

1. Speed Reducing Unit: The speed reducing unit shall consist of cycloidal or helical speed reducers directly connected to a motor without the use of chains or v-belts, and shall be keyed to the pinion.
  2. The main ring gear of cycloidal drives shall be made of high carbon chromium bearing steel and be fixed to the drive casing. An eccentric bearing on the high speed shaft shall roll cycloidal discs of the same material around the internal circumference of this main ring gear. The movement of the cycloidal discs shall be transmitted then by pins to the low speed shaft.
  3. Speed reducer helical gearing shall be manufactured to AGMA standards. The speed reducer shall have a service factor of 1.25.
  4. The reducers shall be fitted with radial and thrust bearings of proper size for all mechanism loads and run in a totally submerged oil bath or be grease lubricated.
- G. The final reduction worm gear, if used, shall be a cut-tooth casting mounted on a separate anti-friction ball bearing assembly. The balls shall be of the finest quality, high carbon alloy steel, running on replaceable hardened alloy steel strip liners or contoured precision bearing races. The bearings shall be mounted in a two-piece housing of high-strength cast iron or ASTM A36 fabricated steel with a minimum base thickness of one (1)-inch. A steel torque tube shall be bolted to an adapter shaft which is free to raise and lower through the keyed torque hub. The torque hub shall be bolted to the main gear and shall rotate the sludge scraper mechanism. Use of a floor-mounted guide bearing shall not be allowed. The final reduction gear and the anti-friction ball bearings shall run in an oil bath within the final gear reduction housing. The housing shall be effectively sealed against contaminants by a felt or rubber strip. A readily accessible oil filling and level pipe with sight gauge shall be furnished.
1. Gears shall be rated to the above requirements in accordance with the latest applicable American Gear Manufacturer's Association Standards for gear durability and strength.
- H. Gear Design and Rating Criteria:
1. Gearing shall be designed and rated to equal or exceed the specified torques and life using the criteria established by the following British or American Gear Manufacturers Association (AGMA) Standards:
    - a. Surface Durability (Pitting) of Enclosed Cylindrical Worm Gear
    - b. Speed Reducers: AGMA 6034-B92.
    - c. British Standard 721: 1963
- I. The output torque rating of the drive shall be based on the smaller of the two (2) values determined from the above AGMA Standards.

1. Prior to unit fabrication, the manufacturer shall submit calculations to the Engineer for approval substantiating the ability of the proposed drive to meet the specified torque requirements. Calculations shall include all worm gears in the drive train.
  - a. The calculations shall clearly specify the design values to be applied for materials used, pressure angle, addendum modifications, and allowable stresses with appropriate re-rating for the life cycles required. The following design parameters shall be included in the drive calculations for Surface Durability ratings:
    - 1) Number of gear teeth.
    - 2) Actual face width.
    - 3) Tooth geometry factor (I and J factors) and tooth pressure angle.
    - 4) Load distribution factor.
    - 5) Allowable contact stress.
    - 6) Allowable bending stress.
    - 7) Pinion pitch diameter.
    - 8) Tooth diametrical pitch.
    - 9) Hardness ratio factor.
    - 10) Elastic coefficient.
    - 11) Life factor.
    - 12) Gear materials and physical properties.
    - 13) Worm material, heat treatment, and finish.
  - b. The load distribution factor from AGMA 6034-B92 shall be calculated as defined. The net face width for surface durability calculations shall not exceed the actual face width of the narrowest of the two mating gears.
  - c. For parameters which are materially dependent, such as allowable contact stress, the calculations shall include a full description of the materials and heat treatment used.
- J. The drive housing shall be designed so that all gears and bearings shall run in an oil bath or be grease lubricated. Oil pumps for lubrication shall not be allowed. Provision shall be made for condensate collection below the main bearing and gear to positively prevent the bearings and gears from running in water.



- K. For worm gear teeth which are not fully submerged in oil, the tooth mesh shall be designed to force lubricant to the upper portion of the tooth face.
- L. The housing shall be provided with readily accessible oil level sight gauges, oil fill and valved drain connections and condensate drain connections from the low points of the oil reservoir. Only food grade oil meeting the requirements of the FDA for indirect food additives and suitable for contact with potable water shall be used. Removal of structures or plates shall not be required for access to sight gauges and drains. The reservoir shall have 1-1/2 inches minimum below the bottom of the main bearing for oil storage.
- M. The main gear shall be solid one (1) piece construction if possible. If a split gear is utilized, mating sections shall be machined and a minimum of two (2) dowels on each side shall be used for proper alignment of gear teeth. All bolts used shall be Type 316 stainless steel and sized for 200 percent of the load imposed.
- N. The final reducer unit shall be constructed using an ASTM A48, Class 40B cast iron housing or an ASTM A36 fabricated steel housing, and shall include a worm gear with a minimum pitch diameter of 34 inches. If a fabricated steel housing is provided, it shall be fabricated using 1-inch thick steel plate stock, minimum. The material from which the saturator drive base is constructed shall be of adequate thickness to provide the rigidity necessary for proper bearing support, but shall not be less than 1-inch thick. Precision bearings used with fabricated steel housings shall have a minimum B10 life of 20 years and shall be located by machined, registered fit. The worm shall be made of AISI 4142 heat-treated alloy steel ground and polished, driving a centrifugally cast manganese bronze worm gear. The worm and worm gear shall be designed based upon the requirements of AGMA 6034-B92 for the torque specified. Planetary gear units shall not be considered equal in design.
- O. The complete drive assembly shall be assembled in the manufacturer's shop and tested to assure the drive is running properly and to calibrate the drive control. The completed test report shall be sent to the Engineer prior to shipping to the project site, verifying the drive meets the quality assurance from the manufacturer and that the torque control has been correctly calibrated.
- P. The main gear shall rotate on a precision ball bearing assembly that is completely separate from the worm gear. The main precision ball bearing assembly shall have a minimum diameter of 28 inches. Bearings shall have a minimum B10 life of 20 years as defined by AFBMA. The precision ball bearing assembly shall be made up of premium alloyed chrome/steel bearing balls and a raceway hardened to at least Rockwell C60 and then ground. Ball bearings shall be minimum 1-inch diameter.
- Q. Drive components shall be located via a machined, registered fit or pilot to insure proper alignment. In order to preserve the alignment of key drive components, no welding on the drive shall be permitted following final machining operations.
- R. A visual torque dial indicator shall be provided and oriented so it may be read from the walkway.

## **2.09 RAKE ARM MECHANISM, MECHANICAL PRIMARY DRIVE UNIT**

- A. The rake arm mechanism drive shall be furnished with an integral electric motor/mechanical primary drive unit which is mounted on a common steel base with the final gear drive. The mechanical primary drive unit shall drive the final gear reduction unit through a timing belt and gear pulley arrangement or the drive shall utilize a cycloidal reduction unit directly connected to the pinion. The mechanical primary drive unit shall be a friction disc type, as manufactured by SEW-Eurodrive, Inc., or an approved equal.
- B. The output shaft speed shall be as required to provide the required torque and rake arm maximum tip speed specified herein. The unit shall include a traction ring and driving disc, all enclosed in a rugged, SAE Class 30 cast iron housing. The unit shall be foot-mounted with parallel, inline, helical gearing. The traction ring shall be of tough phenolic construction, designed with a self-cleaning friction face. The traction case shall be supplied with an environmental seal and drain holes at the lowest position. The conical driving disc shall be precision machined for longer life and chrome plated after machining. The driving disc shall be mounted to the motor drive shaft. Bearings for the adjustable speed drive unit shall be high capacity, anti-friction type with a B-10 rating of a minimum of 100,000 hours.
- C. The integral gear reducer gear case shall be constructed of high strength, SAE Class 30, gray cast iron with a high cross section modulus and center wall to provide maximum strength and rigidity. Gears shall be carburized and drop forged for durability to a hardness of 58-62 RC and shall be finish ground to AGMA 13 quality levels to assure minimum backlash, noise and heat build-up, while maximizing efficiency. The gear reducer shall meet AGMA Service Class III requirements with a service factor of 1.25. The gear reducer shall be oil lubricated. Shaft seals for the gear reducer shall be double-lipped to keep oil in and contaminants out. Bearings for the gear reducer shall be high capacity, anti-friction type with a B-10 rating of a minimum of 100,000 hours. The gear reducer shall have easily accessible oil fill, weather protected vent plugs, and an oil level indicator.
- D. The integral electric drive motor shall be performance-matched to the drive and gear reducer combination. The drive shall have an integral motor which shall be mounted to the drive unit with an adapter provided by the drive unit manufacturer. The motor shall be provided by the drive unit manufacturer.

## **2.10 TORQUE TUBE AND RAKE ARM LIFT MECHANISM**

- A. The automatic arm lift mechanism shall be specifically designed by the solids contact unit mechanism manufacturer for at least a 10 ton capacity and shall consist of a torque tube, main gear mounted driving cylinder, hardened steel worm driven by a right-angle gear motor, worm gear connected to the jack screw, required mechanical linkages, appurtenances, and automatic controls as specified herein below. The unit shall be provided with four (4) NEMA 4X mounted limit switches for indication of the fully raised or lowered lift positions.
- B. The steel driving cylinder shall be mounted on and rotated by the main gear, and keyed to the torque tube shaft which shall be free to move vertically through the main gear and allow the shaft to telescope through the cylinder for a vertical travel of 24 inches. The mechanism

shall be provided with a hand-crank for manual operation of the arm lift mechanism in case of motor failure. The hand-crank shall be properly guarded or removed during normal operation. All required components of the hand-crank mechanism shall be provided by the solids contact unit manufacturer.

- C. The drive shall be equipped with a threaded screw which is attached to the torque shaft for lifting the collector mechanism independently of the drive. The screw shall be drawn-up through a motorized worm gear jackscrew, thus raising the torque shaft, torque tube, and scraper arms. The collector torque shall be transmitted from the final reduction gear to the torque tube through the torque shaft. The solid torque shaft shall be fitted with a lubricated sliding key which will allow the lifting of the collector mechanism while the drive is operating. The lift stand and motorized lift mechanism shall be connected to the drive worm gear and thus rotate with the collector. Field adjustable limit switches shall be provided to limit the up and down travel of lift.
- D. The maximum height for all items requiring maintenance on the torque tube and rake arm lift mechanism, including limit switches and other serviceable items, shall not exceed a maximum of 6'-0" above the platform grating. Designs that incorporate a slip-ring connector shall not be acceptable.

## **2.11 RAKE ARMS**

- A. The solids contact unit shall include two (2) sludge collector rake arms of rigidly braced structural steel construction spaced 180 degrees apart, supported from the torque tube shaft and equipped with adjustable, 18 gauge stainless steel squeegees. The squeegees shall be provided for all blades and shall project 1-1/2 inches below the bottom of the scraper blade. All hardware for mounting the squeegees to the scraper arm blades shall be Type 316 stainless steel. The rake arms shall be installed to conform to the slope of the tank floor. The arms shall rotate within the speed range of 0.05 to 0.075 rpm, corresponding to a maximum rake arm tip speed of 10 feet per minute, respectively. The system shall also include a center cone steel scraper conforming to the geometry of the center cone and supported from the drive shaft. The rake arm and torque tube mechanism structure shall be designed and constructed to withstand a momentary peak torque load of twice the continuous design torque.

## **2.12 OVERLOAD MECHANISM**

- A. Furnish an electro-mechanical overload control device for the thickener rake are drive mechanism in a NEMA 4X stainless steel or aluminum enclosure with an integral conduit box and terminals. Amperage sensing devices shall not be acceptable for torque overload protection due to their inability to react quickly enough to prevent damage to the drive.
- B. The overload device shall be mounted on the drive head at the thrust end of the worm shaft and shall consist of a plate spring assembly, a plunger, indicator dial, and shall actuate three (3) independently adjustable electrical limit switches. The end thrust of the worm shaft against the plate spring shall actuate the plunger, which in turn, shall move the indicator dial. Electrical limit switches shall be SPDT type and rated for 10 amps at 120 VAC. The following switches shall be provided:

1. One (1) torque limit switch for control, set at 100 percent of mechanism design torque for “Torque Alarm”
  2. One (1) torque limit switch for alarm, set at 120 percent of mechanism design torque for “High Torque Alarm”, and to shut down the unit.
  3. One (1) torque limit switch for rake arm lift raise, set at 110 percent of mechanism design torque.
  4. One (1) backup torque limit switch for alarm and equipment shutdown set at 150% of the mechanism design torque.
  5. One (1) operator push button switch for rake arm lower.
- C. The automatic raising of the lift shall be provided by circuitry within the control panel specified herein. Controls, timers, and relays shall be as shown on the Drawings.
- D. Factory adjust the three (3) limit switches to accurately calibrate the impending and overload torque positions and the automatic raising of the rake arm.
- E. Provide a visual torque dial indicator graduated on a 0 to 100 percent scale, in 10 percent increments. Orient the indicators so that it may be read from the walkway.

**2.13 ELECTRIC MOTOR**

- A. General:
1. The motors for the mixer drive, rake drive and lifting mechanisms shall be of the TEFC design with an integral mounting flange.
  2. The motor shall be built in accordance with latest NEMA, IEEE, ANSI, and AFBMA standards where applicable.
  3. Motors shall be as manufactured by Reliance Electric, Baldor Electric Company, U.S. Electrical Motors, or General Electric Company.
  4. The motor shall be non-overloading, without use of the service factor, for the maximum design torque of the equipment.
- B. Performance Requirements:
1. Motors shall be rated for operation on 3 phase, 460-volt power supply.
  2. Each motor shall have a 1.15 service factor and a 1.0 service factor for inverter duty rated motors.
  3. Motors shall be rated at a maximum horsepower, with a nominal premium duty efficiency noted, as follows:

Mixer drive motor	5 HP, 92% efficient
Rake drive motor	0.5 HP, 92% efficient
Lifting mechanism motor	0.5 HP, 92% efficient

4. Motors shall be free of objectionable noise and vibration. Units shall operate with a maximum sound level not to exceed 85 dBA as measured 5 feet from any surface.
5. Maximum temperature rise of motor windings shall not exceed 80°C, as measured by resistance, when motor is operated continuously at service factor horsepower, rated voltage, and frequency in ambient air temperature of 40°C.
6. The mixer- motor shall be inverter duty rated for a 4 to 1 turndown and shall be compatible with the VFD unit provided by the Contractor to drive the mixer.

C. Motor Construction:

1. The motor shall be suitable for operation in moist, outdoor air, corrosive/severe duty.
2. The motor shall be of all cast iron construction for frame, end brackets, conduit box, and fan shroud. Motor shall be of such design and proportions as to hold all motor components rigidly in proper position and provide adequate protection for the type of enclosure employed.
3. The motor shall be of totally enclosed fan cooled (TEFC) construction, suitable for corrosive/severe duty. Motors shall have a Class B nonhygroscopic epoxy sealed insulation system. Class F insulation may be used but shall be limited to Class B temperature rise.
4. Motor windings for stator and rotor leads shall be manufactured using solid copper wire. Windings shall be adequately insulated and securely braced to resist failure due to electrical stresses and vibrations.
5. A neoprene shaft slinger shall be provided and lead wires shall be non-braided and non-wicking to prevent entrance of moisture and contaminants.
6. All leads shall be brought out to a separate terminal box and shall be marked and identified. The terminal box shall be split construction, double gasketed, containing provisions for grounding the motor and shall comply with NEMA standards for minimum volume.
7. The motor shall have stainless steel breather drains at both ends to allow proper drainage of condensation.
8. The shaft shall be made of high-grade machine steel or steel forging of size and design adequate to withstand the load stresses normally encountered in motors of the particular rating.
9. Stator and rotor cores shall be made of low loss, non-aging electrical sheet steel with insulated laminations. Stator coils shall be random wound and of size, shape, insulation and number of turns required. Coils shall be epoxy sealed after fabrication.

10. The motor shall be equipped with shielded, permanently sealed, lubricated for the bearing life, vacuum degassed steel ball bearings made to AFBMA Standards, and be of ample capacity for the motor rating. Bearings shall have a minimum B-10 bearing life of 100,000 hours.
11. Nameplates shall be stainless steel fastened with stainless steel pins or screws. Lifting lugs or "O" type bolts shall be supplied on all motors. Enclosures shall have stainless steel screening and shall be protected from corrosion, fungus and insects.
12. All grease plugs, fittings, bolts, nuts, and screws shall be stainless steel. Bolts and nuts shall have hex heads. Conduit boxes shall be gasketed. Lead wires between motor frame and conduit box shall be gasketed.
13. Each motor shall be provided with a heat overload protection device to protect the motor from overheating during operation. The device shall immediately stop the drive motor in the event of excessive heat buildup. The device shall be normally open and shall close upon detection of a heat overload condition.
14. Each motor 20 horsepower and above shall be provided with a 120 volt single phase, suitably sized, space heater to maintain the motor temperature of at least 40°C, or 10°C above ambient temperature, whichever is greater. The space heater shall operate when the motor is not running to prevent condensation from forming in the motor enclosure.

D. Inverter Duty Motor:

1. Motor provided for the mixer gear reducer drive unit is to be controlled by a variable frequency drive (VFD) unit. The motor provided shall be inverter duty rated with a minimum turndown of 4 to 1 through the use of the VFD. The variable frequency drive unit is specified to be pulse width modulated (PWM) technology. The rotor-impeller mixer manufacturer shall be responsible for coordinating with the motor and VFD unit manufacturers for compatibility of the respective units.

## 2.14 CONTROL PANELS

A. General:

1. Provide each lime saturator solids contact unit with one (1) 480 V drive unit control panel and a single blowdown control panel in materials and rating noted below. The panels shall be sized to adequately dissipate heat generated by equipment mounted inside or on the panel face with minimum dimensions.

B. Lime Saturator Control Panel: The lime saturator control panel shall house all 480V equipment associated with the mixer drive, rake drive and rake lift mechanism including motor starters and variable frequency drives, local controls and indicators. In automatic operation the panel will receive a remote start signal which will cause the mixer and rake motors to be called into service and allow the rake lift mechanism to operate and receive a

remote stop signal which will cause the mixer and rake motors to cease operation and the rake lift mechanism to be deactivated. The mixer drive motor will receive a remote speed signal from the plant control system when in automatic. Each of the three motors will be provided with a hand-off-auto switch on the panel face to allow each of the motors to be started and stopped locally and removed from service. If this function is provided as an integral part of the variable frequency drive, a separate HOA switch will not be required and the VFD will be installed to allow the operator easy access to the VFD controls.

1. Panel Mounted Controls
  - a. Rake Drive HOA switch
  - b. Rake Lift Mechanism HOA switch
  - c. Mixer Drive HOA switch (unless integral part of the VFD)
  - d. Rake Lift Raise-Lower Switch
  - e. Rake Lower Push Button
  - f. High torque reset pushbutton
  - g. Mixer Drive Speed Potentiometer (unless integral part of the VFD)
  
2. Panel Mounted Indicators
  - a. Rake Drive Run Light
  - b. Rake Lift Mechanism Run Light
  - c. Mixer Drive Run Light
  - d. High Torque Alarm Light
  - e. Rake Drive Fault Light (motor high temperature and overload)
  - f. Rake Lift Mechanism Fault Light (motor high temperature and overload)
  - g. Mixer Drive Fault Light (motor high temperature and overload)
  - h. Rake Low Level Light
  - i. Rake High Level Light
  
3. Digital Signals from Plant Control System
  - a. Rake Drive Stop/Start Command
  - b. Rake Lift Mechanism Enable/Disable
  - c. Mixer Drive Stop/Start Command
  
4. Analog Signals from Plant Control System
  - a. Mixer Speed Command
  
5. Digital Signals to the Plant Control System
  - a. Rake Drive Running
  - b. Rake Lift Mechanism Running
  - c. Mixer Drive Running
  - d. Rake Drive in Auto
  - e. Rake Lift Mechanism in Auto
  - f. Mixer Drive in Auto
  - g. Rake Drive Fault
  - h. Rake Lift Mechanism Fault
  - i. Mixer Drive Fault
  - j. High Torque Alarm

- k. Rake Lift at Maximum Height
  - l. Panel Power
6. Analog Signals to the Plant Control System
- a. Mixer Speed
7. Control Interlocks
- a. Rake drive motor shall be stopped upon the occurrence of a high torque alarm. Rake drive motor control will require a manual reset at the local control panel to enable operation after being locked out by a high torque alarm.
- C. Sludge Blowdown Control Panel
1. The sludge blowdown panel will locally control the wasting of sludge from the lime saturator units without any external inputs and will monitor the operation and report the status back to the plant control system. The panel will control the operation of the pneumatically operated 4-inch sludge blowdown valves with a 0-90 minute digital timer control that shall be operator selectable for time between blowdowns and duration of sludge blowdown. The digital timer control shall allow the interval between blowdowns and the duration of the blowdowns to be separately operator adjustable. Each blowdown valve shall be equipped with a three way solenoid valve to control opening and closing of the valve. The solenoid valves will be located within the control panel and air lines will be run to each valve. An HOA switch will be provided for each blowdown valve. In the automatic position the valve operation will be controlled by the digital timer. An interlock shall be provided so that both sludge blowdown valves cannot operate at the same time. A second interlock shall be provided to close the valves in the event that the sludge blowdown pit has reached the alarm level. The interlock will be triggered from a digital signal generated from an output contact on the level transmitter for the sludge pit.
  2. The panel will also contain the sludge blowdown lines flushing controls which shall control the operation of the water flushing valve on top of the sludge blowdown line from each saturator at the sludge pit. An operator selectable digital timer shall be provided to select the duration of the operation of the sludge blowdown water flushing system. When the sludge blowdown valve is closed the sludge line flushing valve shall be opened by energizing the solenoid valve on the flushing valve and shall remain open until the operator adjustable time duration has elapsed. An HOA switch will be provided for the sludge blowdown line flushing valve. In the automatic position the valve operation will be controlled by the digital timer.
  3. The Sludge Blowdown Control Panel shall also house the controls to control the motorized butterfly valve on the water supply line to the water spray down system at the sludge pit. An adjustable time delay relay and digital timer will be provided to control this operation. Upon closing of a sludge blowdown valve the time delay relay will begin an operator adjustable time countdown. When the relay times out the valve on the spray down system will be opened and run until the operator



adjustable spray down duration on the digital timer has elapsed. An HOA switch will be provided for the sludge pit spray system valve. In the automatic position the valve operation will be controlled by the digital timer.

A. Panel Mounted Controls

1. HOA switch for blowdown valve #1 and #2
2. HOA switch for the blowdown line flushing valve #1 and #2
3. HOA switch for the sludge pit spray system

B. Panel Mounted Indicators

1. Blowdown Valve #1 and #2 Open
2. Sludge Blowdown Line Flushing Valve #1 and #2 Open
3. Sludge Pit Spray System Valve Open
4. Panel Power

C. Digital Signals to the Plant Control System

1. Blowdown Valve #1 and #2 Open
2. Sludge Blowdown Line Flushing System Valve #1 and #2 Open
3. Sludge Pit Spray System Valve Open

D. The construction of the control panels shall follow all applicable requirements and use materials and equipment as specified in Section 17306.

1. Panel control layout and wiring interface shall be detailed and shown on the Panel Submittal Drawings. Exceptions to these layouts and wiring requirements shall be noted in the shop drawing review and brought to the attention of the electrical subcontractor.
2. Changes to the field wiring requirements shall be fully coordinated by the Contractor and all modifications to field wiring shown on the Drawings, as a result of these changes, shall be provided by the Contractor at no additional cost to the Owner.

E. Finish:

1. Smoothly finish panel face openings for panel-mounted equipment. Cut with counterboring, and provide with trim strips as required to give a neat finished appearance.
2. Stainless steel surfaces shall not be painted. Finish interior aluminum back plate with two coats of baked enamel, white, ANSI No. 51.

F. Access and Identification:

1. Provide a continuous piano hinge door for ease of access on all control panels. Expose a minimum of 80% of the panel interior for door openings. Panel door openings shall be sealed and fully gasketed. Provide print pockets on each door. Panel doors shall be equipped with quick-release, 3 point contact type latches.

2. All components and terminals shall be accessible without removing other components except for covers.
  3. Panels shall have conduit entry from the bottom only.
  4. Provide laminated plastic nameplates for all front-face panel-mounted controls to completely define their use.
  5. Provide plastic, permanent identification tags and wire number tags for all internal components, wires, and terminals.
- G. Corrosion Control: Protect all panels from internal corrosion by the use of corrosion-inhibiting vapor capsules, Hoffman, model A-HCI, or equal. Provide panels with combination drain/breathers, Crouse-Hinds Model ECD18, or approved equal.
- H. Temperature Control: Provide panels with thermostatically controlled space heaters to maintain internal temperatures above dew point.
- I. Construction: All panels shall be manufactured items, Hoffman Engineering, or approved equal. Panel shall be constructed of Type 316 stainless steel with a minimum metal thickness of 14-gauge. Provide stiffeners as required to prevent deflection under instrument loading and permit lifting without racking or distortion.
- J. Electrical:
1. Provide a main circuit breaker and internal branch circuit breaker for each branch circuit as required to distribute power within each panel from the main power feed. Provide terminal board for termination of all wiring. Provide access to the branch breakers when the panel door is open. Do not exceed an amp capacity of 12 amps for any branch circuit. Panel heater and controls shall be on a separate branch circuit.
  2. Design, furnish, and install all interior wiring within the control panels and furnish complete wiring diagrams showing the electrical circuits inside the panel and interconnections between the panel and the external instruments and components. Identify and number all terminals and wires. Attach plastic, snap-on numbered tags to each panel wire for identification. Inside each panel provide a copy of the panel wiring diagram, laminated in plastic, and affixed to the inside of the door. No power shall be applied until the Lime Saturator Equipment Supplier has approved the installation.
  3. Wiring within panels shall meet the following requirements:
    - a. Discrete wiring shall be 300-volt, type THWN stranded copper, sized for the current carried, but not smaller than No. 16 AWG.
    - b. Power wiring shall be 300-volt, type THWN stranded copper, No. 14 AWG size, for 120V service.

- c. Analog signal wiring shall be 300-volt, stranded copper in twisted shielded pairs, no smaller than No. 16 AWG.
  - d. Restrain wiring with plastic ties or ducts. Hinge wiring shall be secured at each end with bend area protected with a plastic sleeve.
  - e. Separate analog or dc circuits at least six inches from any ac power or control wiring.
4. All relays shall be the compact, general-purpose, plug-in type. Contacts shall be rated for not less than 10 amperes at 120V. Provide relays with neon status lights and test buttons. Time-delay relays shall have integral adjustment knob and rangeability of at least 10:1. All relays shall have permanent, legible identification.
5. Terminal blocks shall meet the following requirements:
- a. Provide 20% unused spare terminals.
  - b. Provide terminal blocks for dc and analog signals separate from ac circuit terminal blocks.
  - c. Screw-type terminal connections shall be with locking, fork-tongue or ring-tongue lugs crimped with proper sized anvil. Terminate no more than two lugs per terminal with no more than one wire per lug.
  - d. Compression clamp terminal connections shall be stripped and prepared per manufacturer's recommendations. Terminate no more than one wire per screw and yoke.
6. Provide all panels with an isolated copper grounding bus to ground all signal and shield connections. Ground analog signal shield. Properly ground all surge and transient protection devices.

**K. Panel Instrument Components**

- 1. Front face and interior instrument components for the lime saturator solids contact unit's system control panel shall be as specified in Section 17306. For instrumentation interfacing with the Plant SCADA System, the panel manufacturer shall comply with the requirements of Section 17306.

**2.15 ACCESS WALKWAYS AND PLATFORMS**

- A. The treatment unit assembly shall provide a center platform for convenient access to the center drive mechanism. The center platform shall span the length of the basin and shall support the outer draft tube, drive unit, draft tube and scrapers. The platform shall have minimum dimensions as shown on the Drawings. Three (3) feet minimum of clear space shall be provided on all sides of the drive unit.

- B. A structural galvanized steel, beam supported, minimum three (3) foot wide walkway, connecting the outer wall to the center platform, as shown on the Drawings, shall be provided for access to the center platform. All structural steel members used for fabrication of walkways and platforms shall be in accordance with ASTM A36. The walkways shall be as shown on the Drawings and shall be floored with 1 1/2-inch aluminum bar grating. The walkways shall be diagonally braced against lateral movement, and shall be designed and constructed so deflection will not exceed 1/360 of the span considering all dead loads plus a live load of 100 pounds per square foot. The walkway beams shall be supported by slide plates or equivalent at the basin walls when required.
- C. Aluminum pipe handrails 42-inches high of double row, fabricated from extruded aluminum alloy 6061-T6 Schedule 40 1-1/2 inch OD pipe clear anodized finish, meeting OSHA requirements, shall be provided along each side of the platform and walkway. All walkways shall be equipped with an aluminum kickplate at least 4" high fabricated from 1/4" thick aluminum alloy 6061-T6 finish clear anodized. Floor grating shall be aluminum bar grating conforming to Section 05532.
- D. All structural connections for the walkways and platform shall be bolted. All bolting materials shall be Type 316 stainless steel in accordance with ASTM A320, Class 2. Brinnell hardness separation between bolts and nuts shall be sufficient to prevent galling during installation, as specified in paragraph 2.02.F. Stainless steel washers of the same stainless steel grade as nuts and bolts shall be used at all bolted connections.
- E. All structural steel members and assemblies for walkways and platforms shall be hot-dip galvanized after fabrication in accordance with ASTM A123. Prior to hot-dip galvanizing, all welds shall be ground to remove all weld spatter and slag. All sharp edges and corners shall be rounded to a smooth contour by grinding. No field welds shall be allowed on members that have been hot-dip galvanized. Walkways and platforms may be fabricated and welded in the shop in major sections or assemblies prior to hot-dip galvanizing, ready for bolted assembly in the field.

## **2.16 EFFLUENT LAUNDERS**

- A. Type 304L stainless steel radial type effluent launders shall be provided as a part of the basin equipment. The launder system shall be designed for the maximum hydraulic flow. Eight (8) collector launders, spaced approximately 45 degrees, each extending from the basin wall to a circular effluent launder along the periphery of the conical baffle wall, shall be provided so that the horizontal travel of water does not exceed 10 gpm per linear foot at any point. Seven (7) of the radial launders shall collect water from the saturator surface and convey it to the center circular collection launder. One (1) radial effluent launder shall serve as a main discharge launder for basin effluent which shall empty into an effluent pipe at the tank wall and be sized to convey the total design flow of the saturator. The discharge launder shall also have v-notches and the discharge end shall be bolted to a support angle welded to the steel tank wall. The circular collection launder shall be 9 inches wide and 16 inches deep and shall be provided with fiberglass v-notch weirs. All launder parts shall be free of winds, warps, local deformations, or unauthorized bends. Minimum stainless steel plate thickness for launder fabrication shall be 3/16 inch. Holes and other provisions for field connections shall be accurate and shop checked, so that proper fit will be provided when the units are assembled in the field.

- B. The Contractor shall install the steel launder troughs and collection ring assembly in the lime saturator solids contact units as shown on the Drawings, and supported by the rafters and at the steel tank side walls as shown on the Drawings.
- C. The troughs shall be designed in accordance with AISC Specifications for the following load conditions while deflection and stress remain within limitations described below.
  - 1. Gravity Load: Vertical load down shall include the unbuoyed metal weight of the trough and any attachments, such as weirs and spreaders, together with the weight of water to fill the trough. Any additional loads which are described herein shall also be considered.
  - 2. Buoyant Load: The buoyant load shall act vertically upward when the clarifier is filled from below with the trough empty. The magnitude is equal to the weight of water displaced by the trough (neglecting the submerged weight of the metal).
  - 3. Lateral Load: Differential water loads acting on the trough sides. The maximum loads occurring when the trough is empty and the clarifier is full to the trough lip elevation or when the clarifier is empty and the trough is full.
  - 4. Point Load: The launder system shall be designed for a point load of 200 pounds to allow for personnel support during cleaning of the units while the basin is empty.
- D. Maximum vertical deflection under load shall not exceed  $L/1000$  (where "L" is the unsupported trough length in inches). Deflection shall be measured at the midpoint between trough supports. Maximum trough side wall horizontal deflection shall not exceed  $D/100$  (where "D" is the inside trough depth).
- E. The maximum bending stress and shear stress under the most severe load conditions shall not be greater than 0.5 of the yield strength and 0.4 of the yield strength time the gross area respectively. The troughs shall be designed to accommodate temperature-induced stresses resulting from differences in thermal expansion between trough and supports. The troughs shall resist oscillations caused by flow of water over the trough. Stabilizers shall be furnished as required.
- F. The entire trough along with all spreaders, hangers, support rods, and appurtenant items shall be Type 304 L stainless steel alloys and in accordance with ASTM A666. All bolting materials for launder assembly and installation shall be Type 316 stainless steel as specified in Paragraph 2.02 F. All welds used for fabrication of the launders shall be continuous and seal welded, in accordance with the approved welding procedure specifications as previously specified. The radial launders shall be shop-fabricated in a single piece for shipment to the job site and the circular collection launder in the minimum number of sections to limit field welding of the launders to the minimum possible number.
- G. All joints in the effluent launder troughs shall be watertight and caulked. Flow velocity in the launders and collection troughs shall not exceed 2 ft/s.

- H. Adjustable ¼ inch thick x 9 inch deep fiberglass v-notch weir plate shall be provided along the top edges of each radial launder. The weir plates shall be fabricated with v-notches in the upper ridge. The weirs shall be spaced to provide uniform collection of the water from the surface area of the basin. The top edge of each weir plate shall be straight within 1/8 inch. The number and size of the v-notches shall be designed to pass the maximum design rate with a maximum of a 2-inch head loss above the v-notches. The maximum launder loading rate shall be 8 gpm/linear foot of trough length with v-notches. All burrs or irregularities on cut edges shall be removed by grinding to a smooth profile. All joints between weir plates and launders shall be caulked. At 5'-0" centers, on both sides of the radial collector launders fabricate 1/4-inch wide by 6-inch high skimming slots. The top of the skimming slots shall be cut 1 inch above the high water elevation for the launders.

## **2.17 PIPING TRAY**

- A. The Contractor shall provide materials for a piping tray supported from the access walkway superstructure as shown on the Drawings and the Lime Saturator Equipment Supplier shall coordinate the walkway support design with the Contractor to allow attachment of the piping support trays. The piping tray shall be suitable for supporting lime and polymer chemical feed lines to the center column.
- B. The piping tray shall be the ventilated type manufactured of extruded aluminum with clear anodized finish. The tray shall be 18-24 inches wide with a 4-inch depth furnished in standard 12-foot lengths. Trays shall be as manufactured by B-Line Systems Inc. or an approved equal by the Engineer.
- C. The piping tray shall be supported from the access walkway using strut supports fabricated from extruded aluminum shapes Alloy 6061-T6. Spacing of supports shall be 4' - 0" on center maximum. Mounting of supports shall be by bolting the end plate of the support bracket to the structural beam supporting the walkway.
- D. All hardware for mounting the trays and the supports, including all nuts, bolts, washers, clips, clamps, hangers, and the like, shall be Type 316 stainless steel.

## **2.20 INFLUENT, EFFLUENT, OVERFLOW PIPING**

- A. Provide a 10-inch diameter Schedule 40 steel side feed influent pipe which shall extend from a point 12 inches outside the basin wall to the inlet zone, as shown on the Drawings. The influent pipe shall be provided with an ANSI 150 lb flange for connection to water supply piping from the main process piping.
- B. Provide a fabricated stainless steel effluent box that is connected to the effluent launders. The saturator unit discharge shall be from the bottom of the effluent box with a 12-inch diameter, 3/8 inch minimum wall thickness pipe nozzle welded to the effluent box. The effluent pipe nozzle shall extend 12 inches outside the solids contact unit and shall be provided with an ANSI 150-lb flange for connection to the piping to the collection box. Orientation of the discharge pipe shall be as shown on the Drawings to match up with the piping to the lime solution tank.

- C. Provide a 12-inch diameter steel side overflow pipe supported on the inside from the tank wall with flare on top with a minimum 3/8 inch wall thickness, extending 12 inches outside the basin wall, as shown on the Drawings. The overflow pipe shall be provided with an ANSI 150 lb flange for connection to overflow process piping to the sludge blowdown pit.

## **2.21 SAMPLE PIPING**

- A. Six (6) sample lines shall be located so that a representative sample can be obtained from four (4) suitable levels in the settling zone and from two (2) locations in the reaction zone. The manufacturer shall furnish all sample piping inside the lime saturator solids contact units and penetrating the steel tank. The sample lines shall be equipped with a stainless steel ball valve on the exterior of the tank. All piping materials shall be Type 304 stainless steel, except for the welded couplings at the steel tank wall. Stainless steel clips and hardware shall be provided to support the sample piping to the interior reaction hood. Adequate pipe supports shall be provided to anchor pipe at 5'-0" on centers maximum.

## **2.22 CHEMICAL FEED PIPING**

- A. Three (3) individual drop pipes (sleeves) constructed of 304 stainless steel shall be provided for feeding lime slurry (2) and polymer (1) at the proper locations to deliver the chemicals to the best location in the reaction zone for maximum effectiveness of the chemical application... The piping/tubing extending from the points of chemical injection to a point on the side of the drive platform as shown on the Drawings shall be supplied by the Contractor. The drop pipes shall terminate above the water surface with a funnel-type fitting to receive chemical tubing from the chemical feed systems. Stainless steel clips and hardware shall be provided to mount the chemical feed drop piping to non-rotating components, or members of the unit.

## **2.23 AUTOMATIC SLUDGE BLOWDOWN**

- A. Provisions shall be made for automatic intermittent removal of sludge from the sludge hopper through the sludge blowdown line(s). Each sludge hopper shall be equipped with a sludge discharge pipe assembly controlled by a pneumatically actuated pinch or diaphragm valve. The sludge blowdown line will be 6 inches in diameter and provide for automatic withdrawal of sludge from each of the sludge hoppers. Each sludge blowdown connection shall be equipped with a sludge discharge pipe assembly controlled by a Type "F" sludge blowdown valve or alternate pinch valve provided by the Lime Saturator Equipment Supplier. The sludge blowdown line and valve shall be 4-inch diameter and provide for automatic withdrawal of sludge from the lime saturators. Each valve shall be pneumatically operated and controlled on time cycle. The sludge withdrawal timer shall be a repeat cycle timer in a NEMA 4X enclosure suitable for panel mounting. One timer shall be provided for each sludge blowdown line. Each three way air control solenoid valve shall operate on an electrical supply of 110 volts, 1 phase, 60 Hertz.
- B. The Type "F" valve shall be double diaphragm angle type with a flanged ductile iron body PVC-lined. The seating diaphragm shall be of a resilient material to reside on a solid seat to assure drop-tight closure. Diaphragms shall have U-shaped loops to permit full travel without stretching to assure positive closure and long life. No packing glands or seals shall

restrict the valve movement. All materials that come into contact with the sludge shall be NSF 61 certified for contact with potable water.

- C. The sludge lines shall have a manual rubber-seated and lined shutoff plug valve that will be supplied by the Contractor.

## **2.24 SHOP COATINGS**

- A. Surface preparation: After fabrication, all surfaces of the lime saturator solids contact units and accessories except galvanized, non-ferrous, undamaged shop primed coated, field welded components or previously finished coated surfaces shall be prepared for shop coating as follows:
  - 1. Remove all weld spatter and slag. All sharp edges and corners shall be rounded to a smooth contour by grinding.
  - 2. All ferrous surfaces shall be white metal abrasive blast cleaned to SSPC-SP5 to remove all visible oil, grease, dirt, dust, mill scale, rust, oxides, corrosion products, and other foreign matter. Blast profile shall be 1 to 3 mils.
- B. Shop Primer: All abrasive blasted surfaces, except plate edges or areas to be field welded shall be coated with a universal high solids, high build, chemical resistant epoxy-polyamide primer. Shop primer shall be applied in one or more coats to achieve a minimum dry film thickness of 5 mils. Shop primer shall be equal to Kop-Coat 340 Gold Primer. Shop primer used shall be compatible with the intended finish coats to be applied in the field. Shop primer on the interior surfaces shall be compatible with an NSF-approved finish coating system for potable water applications.

## **2.25 ANCHOR BOLTS AND HARDWARE**

- A. All anchor bolts, assembly bolts, hanger rods, washers, nuts, clips, and other hardware items for installation shall be provided by the lime saturator solids contact unit manufacturer. All bolt diameters and lengths shall be as required by the manufacturer. All other anchor bolts shall be expansion-type wedge anchors. All threads for nuts and bolts shall be in accordance with ANSI B1.1, Class 2A fit, coarse thread series. All nuts, bolts, and washers for structural anchor bolts and connections shall be manufactured of Type 316 stainless steel (Grade B8M), in accordance with ASTM A320, Class 2. All other nuts, bolts, and washers used for anchors, equipment assembly, hanger rods, etc. for the unit shall be Type 316 stainless steel, Alloy Group 2, Condition "A" in accordance with ASTM F593 for bolts and studs and ASTM F 594 for nuts. Nuts and bolts shall be bright finish. All washers, clips, and other hardware shall be Type 316 stainless steel. Nuts shall have a hardness that is lower than that of the bolts and washers by a difference of 50 Brinnell hardness to prevent galling during installation.

## **2.26 SPECIAL TOOLS AND SPARE PARTS**

- A. One set of all special tools required for normal operation and maintenance shall be provided. All such tools shall be furnished in a suitable non-metallic tool chest complete with lock and duplicate keys.



- B. The Lime Saturator Equipment Supplier shall furnish manufacturer-recommended spare parts necessary for the first two (2) years of operation. As a minimum, the following spare parts shall be provided for each lime saturator solids contact unit furnished for the project.
  - 1. One (1) set seals for mixer drive shaft.
  - 2. One (1) each repair kit for mixer gearmotor drive unit.
  - 3. Ten percent spares for each type and size of indicator lights, fuses, and relays used for control panels.
  - 4. One year supply of each type of lubricant required.
- C. All spare parts shall be properly packaged for long periods of storage and packed in containers which are clearly identified with indelible markings as to the contents including the following: model numbers, parts numbers, manufacturer of part, manufacturer's local representative, and shall be tagged as spare parts. Instructions for preparation and installation of each spare part or group of parts shall be packed with the spare part or parts.
- D. Spare parts and lubricants, as received, shall be turned over to the Owner immediately upon receipt by the Contractor. Verification of delivery to the Owner shall be submitted to the Engineer.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. Installation shall be as shown on the Drawings and in accordance with the manufacturer's recommendations and erection drawings. Erection drawings shall be submitted and approved prior to shipment of equipment. Mechanism parts shall be securely anchored to the steel tank wall and grout filled by stainless steel fastening hardware furnished by the manufacturer, as shown on the Drawings.
- B. All necessary bolts, nuts, washers, hanger rods, clips, and other hardware items for the anchoring and erection of the units shall be included. The manufacturer shall ship anchor bolts, bolting template drawings, and accurate bolt setting patterns to the Contractor in advance of shipping fabricated items and other equipment. The Contractor shall not proceed with preparation of the tank until all anchor bolting materials, templates, and patterns are received.
- C. Edge Grinding. Sharp corners of cut or sheared edges and corners shall be rounded to a smooth contour by grinding.
- D. Fabrication. All welds shall be continuous seal welds. All welds shall be in accordance with current AWS Standards.

### **3.02 FIELD PAINTING (Reserved)**

### 3.03 FACTORY SERVICE REPRESENTATIVE

- A. The Lime Saturator Equipment Supplier shall include in his bid providing the services of a trained, competent, qualified and experienced factory field representative during construction, inspection, testing, and start-up of the equipment. To provide adequate construction, inspection, testing, and start-up services for the lime saturator solids contact units, the factory representative shall have a complete knowledge of proper installation, operation and maintenance of the lime saturator solids contact units. The Lime Saturator Equipment Supplier shall provide factory services a minimum of two (2) visits for a total minimum duration of four (4) days for the project. It is assumed that each visit will be one to two days in duration. One visit shall be during erection and installation of equipment and one visit shall be during checkout, start-up, and training of the Owner's personnel.
- B. The purpose of the services provided by the factory representative will be for the performance of the following work.
1. Verify that the Contractor is proceeding properly during the erection and installation of equipment.
  2. Following installation but before the equipment is operated by others, the representative shall inspect the completed installation for soundness, completeness, correctness, alignment, arrangement, proper lubrication, vibration, control settings, and operation of the mechanical, adjustable speed mixer, rake drive and rake lift mechanism operation. The field engineer shall make or cause to be made any and all adjustments, corrections, or repairs necessary.
  3. Start-up of the equipment in the presence of the Contractor and Owner's operating personnel.
  4. Training of Owner's operating personnel in proper operation and maintenance procedures, lubrication, startup/shutdown procedures, response to emergency conditions, and troubleshooting. The responsibility of the Contractor and the factory service representative with regard to start-up shall be fulfilled when the start-up is complete, the equipment is functioning properly and has been accepted by the Owner.
    - a. The training period for the Owner's operating personnel shall be scheduled at least ten (10) days in advance with the Engineer and shall take place prior to plant start-up and acceptance by the Engineer. The final copies of operation and maintenance manuals specified in Section 01730 shall have been delivered to the Engineer prior to scheduling the instruction period.
- C. Upon completion of his work, the manufacturer's field engineer shall submit to the Engineer, a written report for the lime saturator solids contact units, as a result of his inspection, adjustments, corrections, repairs, start-up and testing. The report shall include descriptions of the inspection, adjustments, corrections and repairs made, testing, start-up and training of the Owner's personnel. The report shall also include a notarized certification signed by the manufacturer's field engineer that the installed equipment:

1. Has been installed and lubricated per manufacturer's requirements.
  2. Has been accurately aligned and proper running clearances set.
  3. Is free from undue stress imposed by piping or mounting bolts.
  4. The equipment has been tested as required below in paragraph 3.04 and is in conformance with nominal operating parameters. Test procedures and results shall be included in the report.
  5. Is ready for permanent operation on a continuous basis, is free from any known defects, and that nothing in the installation will render the manufacturer's warranty null and void.
- D. The Lime Saturator Equipment Supplier's attention is directed to the fact that the services specified for the manufacturer's field engineer represent an absolute minimum acceptable level of service, and are not intended to limit the responsibilities of the Lime Saturator Equipment Supplier to comply with all requirements of the Procurement Documents. The Lime Saturator Equipment Supplier shall procure, at no additional cost to the Owner, all services required, including additional or extended visits to the jobsite by manufacturer's representatives, to comply with all said requirements.

### **3.04 INSPECTION AND TESTING**

- A. The Lime Saturator Equipment Supplier's bid shall include the furnishing of the services of a fully qualified and experienced manufacturer's representative to provide all specified services for inspection and testing of each of the completed solids contact units. Upon completion of installation, the Contractor, in the presence of the Owner and a qualified manufacturer's representative, shall perform a preliminary test on the lime saturator solids contact units to ensure the functioning of all component parts to the satisfaction of the Owner. The Contractor shall furnish all labor, equipment, water and power required to perform each test. The Supplier should provide in his bid for the tests to be performed on each saturator unit separately.
- B. Approval of the preliminary test by the Owner shall not constitute final acceptance of the equipment furnished.
- C. Upon approval of the preliminary test, the Contractor, in the presence of the Owner and a qualified manufacturer's representative, shall perform a field test to demonstrate the ability to meet or exceed the specified design criteria and proper function for the purpose intended.
- D. The field tests on the lime saturator solids contact units shall be undertaken with water in the unit filled up to the high water elevation shown on the Drawings. The Owner shall be responsible for providing sufficient project company water for filling the unit for the test runs. The test runs on the unit shall determine acceptable normal running noise, vibration, speed and direction. The tests shall also be used to initially set and load test the rakes to confirm the torque settings and test the alarms and shutdown controls.

- E. In the event of improper installation, the Contractor and the lime saturator solids contact unit manufacturer shall be responsible for supervising the correction of the work and performing subsequent field tests until all defects are corrected.
- F. **Vibration Analysis Testing:** The manufacturer shall provide the services of a qualified factory representative to perform tests at the installation to verify that the lime saturator solids contact unit's rotor-impeller mixer and rake drive operate within acceptable vibration severity limits and to determine baseline vibration spectra for future use in identifying maintenance actions. These tests shall be performed in the presence of the Engineer using a dual channel, spectrum analyzer. The manufacturer shall also be responsible for determining actions to correct vibrations that exceed acceptable limits. A report with spectral plots shall be submitted to the Engineer documenting all test results and recommended corrective measures, if any.
- G. Within 120 days of initiation of operation of the plant, a full load operating test shall be performed separately on each saturator unit operating at no less than 90% of the design capacity under the direction of the Owner and a qualified manufacturer's representative. The purpose of the full load operating test will be to determine if, under actual operating conditions, the required treatment parameters, as specified in paragraph 2.04, are in compliance. The Contractor shall furnish all labor, materials and equipment required for such test and in coordination with the Supplier shall correct any deficiencies noted, by repairing or replacing the defective component, and retest as required, until the equipment meets the satisfaction of the Owner. A minimum operating time of five (5) consecutive 24-hour days for each unit shall be allocated to satisfy the full load operating test requirements. To successfully pass the full load operating test the unit shall operate continuously thru the 5 day operating period with no loss of utilization due to failure of the saturator equipment, have an effluent turbidity less than 10 NTU 95% of the time and less than 15 NTU 100% of the time based upon hourly turbidity measurements and have a calcium concentration as  $\text{CaCO}_3$  greater than 1,600 mg/L 100% of the time.

### **3.05 DISINFECTION (Reserved)**

**END OF SECTION**



## DIVISION 13

# SPECIAL CONSTRUCTION

## **SECTION 13310**

### **GEODESIC ALUMINUM DOMES**

#### **PART 1 - GENERAL**

##### **1.01 DESCRIPTION**

- A. This section includes design, materials, fabrication, and erection of geodesic clear span aluminum dome roof structure. Dome manufacturer shall coordinate requirements for supporting and attaching equipment with the selected saturator manufacturer.

##### **1.02 RELATED WORK SPECIFIED ELSEWHERE**

- A. Concrete: 03300.
- B. Miscellaneous Structural Steel and Aluminum: 05121.
- C. Painting and Coating: 09900.

##### **1.03 SUBMITTALS**

- A. Submit shop drawings in accordance with the General Provisions and Section 01300.
- B. Submit dimensional drawings. Show dimensions, sizes, thicknesses, gauges, materials of construction, and finishes of panels and structural members.
- C. Submit joint attachment method.
- D. For dome designs other than those utilizing computer programs, submit engineering design calculations for structural and covering components. Design calculations shall be signed and sealed by a professional engineer registered in the state of Texas. For computer-programmed designs, submit the stress values utilized in the analysis and a certificate, signed and sealed by a professional engineer registered in the state of Texas, stating the design criteria and procedures used and attesting to the adequacy and accuracy of design.
- E. Submit certificate that the design meets the International Building Code.
- F. Submit anchor details, anchor bolt sizes, and maximum loads transmitted to supports. Provide certification that design of supports has been coordinated with the saturator manufacturer.

##### **1.04 UNIT RESPONSIBILITY**

- A. The Contractor shall assign the design, fabrication, and erection of the domes to a manufacturer who specializes in such structures. The manufacturer must have installed and had satisfactory service for a period of not less than five years, at least five aluminum roof equal to or larger in size than the unit specified, and shall submit evidence of such.

## **1.05 MAUNFACTURER’S SERVICES**

- A. Provide dome manufacturer’s technical services at the jobsite for the minimum labor days listed below, travel time excluded:
  - 1. Three labor days to check the initial conditions prior to erecting the dome, verify that proper erection procedures have been established, and advise during the initial dome erection.
  - 2. Two labor days to check the installation at approximately the midpoint of the installation and verify that proper erection procedures are being followed.
  - 3. Two labor days to check the final installation and advise during the final erection and completion of the dome.
  - 4. All field work shall be directed by a qualified supervisor who will remain on the jobsite until completion of the work.

## **1.06 WARRANTY**

- A. The roof shall be guaranteed for a period of two (2) years against defective design, materials, construction, and leakage and shall be provided in accordance with Section 01740.

## **PART 2 - MATERIALS**

### **2.01 MANUFACTURERS**

- A. Domes shall be designed, fabricated, and erected by CST Industries, Inc., United Industries Group, or Apex Domes.

### **2.02 DOME DESIGN CRITERIA**

- A. Domes shall be semi-spherical walk-in structures conforming to the dimensions shown in the drawings and having the following characteristics:
  - 1. Fully triangulated space truss structure with noncorrugated closure panels.
  - 2. Design to allow for thermal expansion/contraction.
  - 3. Dome structure deadweight shall not exceed 3.5 psf of surface area.
- B. The design of the domes shall be in accordance with the following standards and codes:
  - 1. "Specifications for Aluminum Structures" as published by the Aluminum Association.
  - 2. AWWA D100-05, Section 15.

3. Welded components shall be in accordance with the Aluminum Structural Welding Code ANSI/AWS D1.2-90.
- C. Design dome surface paneling as a watertight system, except at gutters for rainwater collection, under all design load and temperature conditions.
  - D. Dome surface shall be walkable.
  - E. Dome cover shall be supported by a minimum 8'-0" vertical wall attached to the lime saturator.
  - F. Dome wall shall include one (1) access door with minimum dimensions of 3'-0" wide by 7'-0" tall. Door shall be lockable and provided with a panic exit device.
  - G. Provide aluminum handrail around roof of tank.
  - H. Provide pipe penetrations as required on plans.
  - I. Design dome frame and skin for full dead load plus the following live load conditions:
    1. Symmetrical live loading of 20 psf over the total plan area.
    2. Nonsymmetrical live loading of 20 psf on one-half the dome plan area with zero live load on the other half of the dome.
    3. Using the latest editions, design the tower and anchorage system per the wind loading requirements of the Texas Statutes, Texas Administrative Code, and ASCE 7-10 for the following design criteria:
      - a. Basic Wind Speed, mph: 150
      - b. Risk Category: III
      - c. Exposure: C
    4. Combined Loads: Basic live plus dead load and other combinations for the dome analysis shall be in accordance with AWWA D100-05.
    5. If test data is not available, shear and tension on the anchor at the dome support points on the wall shall not exceed the shear and tension values for bolts in concrete in the table shown below:
  - J. Provide a ventilation system for each dome meeting the following requirements:
    1. The ventilation system shall be a forced mechanical system capable of providing a ventilation rate as required by the manufacturer to mitigate heat buildup within the occupiable space inside the space but not less than 1 CFM per square foot of dome area. Exhaust fan shall be sized with 0.25 inch-wg external static pressure including pressure drop through accessories.



2. The exhaust fan shall be of aluminum construction, direct drive, axial type sidewall propeller fan mounted on the wall of the dome with a gravity back draft damper and a 120V, single phase totally enclosed fan cooled motor. Provide fan with 45 degree weather hood with aluminum bird screen and corrosion resistant epoxy finish on fan and all accessories. Provide remote bulb thermostat with NEMA 4X enclosure in an accessible location (near door).
3. The outside air intake shall be provided by rain resistant aluminum louvers with aluminum insect screens and furnished with 2 coats of 70% kynar finish mounted toward the base of the dome or alternatively by sections of flashing between the tank wall and base of the dome. The total area of the louvers or intake openings shall be sized such that the face velocity through the opening does not exceed 500 FPM when the exhaust fan is operating. If flashing openings are utilized for fresh air intake, provide minimum 50% open area aluminum insect screen over opening.
4. The ventilation controls shall function as follows: "HAND-OFF-AUTO" switch wired to function as follows: "HAND" position causes the exhaust fan to run continuously. "AUTOMATIC" position causes the fan to normally be off or initiated to run via remote bulb room thermostat (Adjustable, set at 85 deg F). "OFF" position shall manually turn the fan off. The controls shall be mounted in a NEMA 4X stainless steel enclosure and shipped loose for mounting outside of the ventilated areas. Provide a separate enclosure and control panel for each fan location. Each ventilation control panel shall consist of the following:
  - a. NEMA 4X stainless steel enclosure with no side clips all around and key lockable handle.
  - b. Three position ventilation fan Hand-Off-Automatic selector switch and nameplate.
  - c. Main circuit breaker and 120 volt feed to panel.
  - d. Numbered terminal strip for local and remote wiring connections.
  - e. Push to test fan run light (green) on front of control panel with nameplate.

Allowable Service Load on Embedded Bolts (Pounds) <sup>1,2,3</sup>									
Bolt Diameter (inches)	Minimum <sup>4</sup> Embedment (inches)	Edge Distance (inches)	Spacing (inches)	Minimum Concrete Strength (psi)					
				f'c = 2,000		f'c = 3,000		f'c = 4,000	
				Tension <sup>5</sup>	Shear <sup>6</sup>	Tension <sup>5</sup>	Shear <sup>6</sup>	Tension <sup>5</sup>	Shear <sup>6</sup>
1/4	2-1/2	1-1/2	3	200	500	200	500	200	500
3/8	3	2-1/4	4-1/2	500	1,100	500	1,100	500	1,100
1/2	4	3	6	950	1,250	950	1,250	950	1,250
	4	5	6	1,400	1,550	1,500	1,650	1,550	1,750
5/8	4-1/2	3-3/4	7-1/2	1,500	2,750	1,500	2,750	1,500	2,750
	4-1/2	6-1/4	7-1/2	2,050	2,900	2,200	3,000	2,400	3,050
3/4	5	4-1/2	9	2,250	2,940	2,250	3,560	2,250	3,560
	5	7-1/2	9	2,700	4,250	2,950	4,300	3,200	4,400
7/8	6	5-1/4	10-1/2	2,550	3,350	2,550	4,050	2,550	4,050
1	7	6	12	2,850	3,750	3,250	4,500	3,650	5,300
1-1/8	8	6-3/4	13-1/2	3,400	4,750	3,400	4,750	3,400	4,750
1-1/4	9	7-1/2	15	4,000	5,800	4,000	5,800	4,000	5,800

<sup>1</sup>Values are for natural stone aggregate concrete and bolts of at least ASTM A307 quality. Bolts shall have a standard bolthead or an equal deformity in the embedded portion.

<sup>2</sup>The tabulated values are for anchors installed at the specified spacing and edge distances. Such spacing and edge distance may be reduced 50% with an equal reduction in value. Use linear interpolation for intermediate spacings and edge margins.

<sup>3</sup>The allowable values may be increased for duration of loads such as wind or seismic forces.

<sup>4</sup>An additional 2 inches of embedment shall be provided for anchor bolts located in the top of columns located in Seismic Zones 2, 3, and 4.

<sup>5</sup>Values shown are for work without special inspection. Where special inspection is provided, values may be increased 100%.

<sup>6</sup>Values shown are for work with or without special inspection.

- K. Provide a means of securing panels to the frame to withstand the following vertical loads without exceeding the specified allowable stresses:
1. Two concentrated loads of 250 pounds each, applied simultaneously on two separate 1-square-foot areas of the panel.
  2. A distributed load of 60 psf over the total panel.

## 2.03 MATERIALS OF CONSTRUCTION

Item	Material
Triangulated dome framing struts	6061-T6 aluminum
Structural frame gussets	6061-T6 aluminum
Triangular skylight panels	¼" thick clear acrylic or polycarbonate
Triangular closure panels and flashing	3003-H16 aluminum
Tension ring	6061-T6 aluminum
Fasteners	Type 316 stainless steel
Dormers, doors, vents, hatches	6061-T6, 6005A-T6, 3003-H14, 3003-H16, or 5052-H34 aluminum
Battens to secure triangular closure panels and peripheral flashing to the dome struts	6061-T6 or 6063-T6 aluminum
Columns	316 Stainless steel pipe
Sealants	Silicone: Pecora, Dow, General Electrical Silpruf, or equal
Gaskets	Silicone: Hypalon or equal
Anchor Bolts	Type 316 stainless steel

## 2.04 METAL THICKNESSES

Item	Minimum Thickness (inch)
Structural frame gussets	0.250-0.313 as required per manufacturer MFR design calculations
Triangular closure panels	0.050
Doors, dormers, vents, and hatches	0.090

## PART 3 - EXECUTION

### 3.01 FABRICATION AND ERECTION

- A. Construct dome plumb, level, and in proper alignment. Do not refabricate structural components or panels in the field. Do not force or spring the structure to make fit during construction.
- B. Tool sealant joints concave after installing sealant. Keep sealant confined to joint area. Remove sealant outside of joints. Keep panels free of misplaced sealant.

- C. Cover, seal, and clamp raw edges of panels in an interlocking manner. Prevent slipping or disengagement under all load and temperature conditions.
- D. Where aluminum surfaces come in contact with dissimilar metals, except stainless steel, keep the dissimilar metallic surfaces from direct contact by use of neoprene gaskets or washers.

### **3.02 PAINTING AND COATING**

- A. Coat aluminum in contact with concrete per Section 09900.

### **3.03 INSTALLING GASKETS**

- A. Provide gaskets where dissimilar metals come in contact with aluminum.

### **3.04 SERVICE CONDITIONS**

- A. The dome will be installed over a lime saturator tank containing a saturated solution of calcium hydroxide and water. Assume the air under the domes to have the following characteristics:
  - 1. 100% saturated with water vapor.
  - 2. Temperature inside of the dome of up to 120°F.

### **3.05 FIELD TESTING**

- A. After the dome has been erected and the panels installed, conduct a field test as follows. On four separate panels selected by the Owner's Representative on each dome, apply a uniform load of 90 psf over the entire panel area. The panels shall withstand this load without permanent distortion or buckling.
- B. If any one of the panels on a given dome fails the test, then the Owner's Representative will select another four panels on the dome for testing. If all four panels pass the test, then the first panel failure will be disregarded. If one of the second batch of panels fails the tests, then the dome will be considered defective. The Contractor shall then do one of the following:
  - 1. Replace all the panels on the dome and retest.
  - 2. Test each panel on the dome and replace any panels that fail the test.
- C. Replace any rejected panels and retest.
- D. Spray water over the entire dome and check for leaks. Repair or replace leaking joints or panels. Entire dome shall be leak free including conditions under which the interior side of the dome is under negative pressure as a result of operation of a mechanical ventilation system.

**END OF SECTION**



## DIVISION 17

# INSTRUMENTATION

## SECTION 17306

### VENDOR PACKAGED PROCESS CONTROL SYSTEMS

#### PART 1 GENERAL

##### 1.01 SCOPE OF WORK

- A. Furnish all labor, materials and equipment required to provide, install, test and make operational, a Vendor Packaged Process Control System as specified herein and related specifications, and as shown on the Drawings.
- B. The work shall include furnishing, installing and testing the equipment and materials as specified herein and related Divisions.
- C. Equipment furnished as a part of other Divisions, and shown on the Instrumentation and/or Electrical Drawings shall be integrated into the overall Instrumentation System under the Instrumentation Sections of this Division. Instrumentation specified in other Divisions shall meet the Specification requirements of the Instrumentation Sections of this Division.
- D. The Lime Saturator Equipment Supplier (Supplier) shall provide the services to perform all work necessary to select, furnish, configure, customize, debug, install, connect, calibrate, and place into operation all instrumentation hardware specified herein and related specifications, and as shown on the Drawings, including application software programming, which is specified for Programmable Logic Controllers (PLCs) and Operator Interface Terminals (OIT). The Supplier shall coordinate with the Owner, Engineer, Contractor and Application Services Provider (ASP) for all scheduling, installation, and startup services.
- E. The Supplier shall coordinate with the Process Control System Integrator (PCSI) and ASP for all data transfer, I/O lists and standard OIT graphics.
- F. The Supplier shall be responsible for coordination with the PCSI, and shall assume ultimate responsibility in providing all items required to form a complete and operable control system specific to the Supplier's system whether specified herein or not.
  1. The proposed system shall employ a state-of-the-art, fully automated control system for all normal daily operations including automated sequencing of system start-up, automated control of normal operation at steady state conditions, and automated sequencing of plant shutdowns (both emergency and operator initiated). The Supplier shall be responsible for providing process control strategies that safeguard the system equipment and warranties, and account for specific equipment furnished for the project. The developed control strategies shall be sufficiently detailed to allow use by the PCSI for control system coordination efforts. The Supplier shall be responsible for coordination of control strategies with the PCSI throughout the control system programming effort, and shall assist the PCSI with any changes that are required during startup and testing.
- G. Each panel shall be supplied with full back panels and side panels as necessary.

**Table 17306-1 Supplier Furnished Control Panels**

<b>PANEL ID</b>	<b>ENCLOSURE MATERIAL</b>	<b>ENCLOSURE RATING</b>	<b>PANEL LOCATION</b>	<b>MINIMUM ENCLOSURE SIZE*</b>
25-CP-01 LIME SATURATOR CONTROL PANEL	STAINLESS STEEL	NEMA 4X	LIME SATURATOR	
25-CP-02 LIME SATURATOR CONTROL PANEL	STAINLESS STEEL	NEMA 4X	LIME SATURATOR	
27-CP-01 SLUDGE BLOWDOWN CONTROL PANEL	STAINLESS STEEL	NEMA 4X	LIME SLUDGE BLOWDOWN	

H. The Supplier shall coordinate field devices manufacturers and equipment models with equipment furnished in other process areas by the PCSI. Like items of equipment shall be the product of one manufacturer to facilitate standardization of performance, operation, spare parts, maintenance and manufacturer’s service.

**1.02 RELATED WORK**

- A. Where references are made to the Related Work paragraph in each Specification Section, referring to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or work as may be required in those references, and include such information or work as may be specified.
- B. All Instrumentation work related to Process and Mechanical Divisions equipment that is shown on the Instrumentation Drawings shall fully comply with the requirements as specified herein.
- C. All instrumentation Equipment and work provided under any Division of the Specifications shall fully comply with the requirements as specified herein.
- D. Related Sections
  - 1. Division 1.
  - 2. Section 11220 Lime Saturator Solids Contact Units

**1.03 SUBMITTALS**

A. General

1. Refer to Division 1 for general project submittal requirements.
2. Shop drawings shall be submitted as detailed herein. Shop drawings shall demonstrate that the equipment and services to be furnished comply with the provisions of these specifications and shall provide a complete record of the equipment as manufactured, delivered, installed and placed in service.
3. Submittals shall be complete and shall give equipment specifications, details of connections, wiring, ranges, installation requirements, and specific dimensions. Submittals consisting of only general sales literature shall not be acceptable.
4. Submittals shall be bound in separate three-ring binders, with an index and sectional dividers, and with all included drawings reduced to a maximum size of 11-inches by 17-inches, then folded to 8.5-inches by 11-inches for inclusion inside the binder. Maximum binder thickness shall be 3 inches.
5. The shop drawings title block shall include, as a minimum, the Supplier's registered business name and address, Owner and project name, drawing name, revision level, and shall identify personnel responsible for the content of the drawing.
6. Incomplete submittals not complying with the submittal requirements outlined in this Section will be returned without review.
7. In each submission, include the applicable specification section noted with Supplier's indication of compliance with each requirement.
8. Unless discussed with and approved by the Engineer prior to submission, partial submittals are not acceptable and will be returned un-reviewed.
9. Any reproduction of the Contract Documents or portions thereof, and presentation of these as submittal content to the Owner and Engineer is not acceptable unless it is for indicating compliance with specification requirements and is clearly marked as such.
10. Include project-specific tagging and descriptions as shown in the Contract Documents as well as quantities for all devices and systems being provided to facilitate Owner's and Engineer's cross-referencing with requirements and verification of completeness.

B. Hardware and Software Packages Submittal

1. For each Control Panel listed in Table 17306-1, submit a cover page that lists, at a minimum, date, specification number, product name, manufacturer, model number, location(s), quantities and power required. Preferred format for the cover page is ISA S20, general data sheet; however, other formats will be acceptable provided they contain all required information.
2. Catalog cuts for supplied Programmable Logic Controller (PLC), process controller equipment, including central processing units, memory, input modules, output modules, modems, network interface modules, mounting racks, and power supplies. Submit descriptive literature for each hardware component that fully describes the units being provided. Additional information for PLC shall include:
  - a. Bill of materials for each PLC clearly identifying all components and quantities.



3. Catalog cuts for supplied Operator Interface Terminals (OIT), including network interface modules and power supplies. Submit descriptive literature for each hardware component that fully describes the units being provided.
  4. Catalog cuts for uninterruptible power supplies (UPS), power supplies, and all other network hardware being provided. Submit descriptive literature for each hardware component, which fully describes the units being provided. Additional information for UPS shall include:
    - a. Bill of materials listing all components provided
    - b. Deviation list indicating all proposed exceptions
    - c. Power single line and control schematic drawings. All external connections and their terminal block locations shall be fully detailed. All internal wiring shall include terminal numbers and color coding.
    - d. UPS specifications as follows:
      - (i) kVA rating
      - (ii) Input and output voltage and phase
      - (iii) Run time at full and half load
      - (iv) Voltage (output regulation, input tolerance, unbalance, transfer/retransfer voltage, etc.)
      - (v) Heat rejection
    - e. Instruction and replacement parts manuals
    - f. Name, address, and telephone number of the nearest service facility
    - g. Battery specifications and warranty
    - h. Battery sizing calculations.
  5. Submit details of field instrument and field device digital networks. Submittal shall include details of the field device digital networks technology including type, power requirements, wiring requirements, configuration details, device addressing, and interface to the process control system. Include separate details of the field device digital network configuration(s) for each field level digital network and sub-network.
  6. Submit details for all software packages to be furnished, including specification number, product name, manufacturer, product number, license versions and quantities.
- C. Input/Output (I/O) List Submittal
1. The Supplier shall develop and submit the system I/O list that includes all I/O identified in the project drawing P&IDs. Submittal shall be a complete system I/O list for all equipment connected to the control system under this Contract.
  2. The I/O list shall be submitted in both a Microsoft Excel readable electronic file format and an 8-1/2 inch by 11-inch hard copy.

3. The I/O list shall reflect all active and spare I/O points. Add points to accommodate spare I/O.
4. The I/O list shall be arranged such that each control panel has a dedicated worksheet. At a minimum, I/O worksheet tables shall include the following information:
  - a. TAG NUMBER(S): The identifier assigned to a device that performs a function in the control system. As part of this information, the loop number of the tag shall be broken out to allow for sorting by loop.
  - b. DESCRIPTION: A description of the function of the device (text that includes signal source, control function, etc.) Include the text "Spare Points" for all I/O module points that are not connected to equipment.
  - c. PHYSICAL LOCATION: The Control Panel designation of where the I/O point is wired to.
  - d. Physical POINT ADDRESS: Rack, Slot, and Point (or Channel) assignment for each I/O point.
  - e. LOGICAL POINT ADDRESS: I/O address of each point
  - f. I/O TYPE: use DO - Discrete Output, DI - Discrete Input, AO - Analog Output, AI - Analog Input, PI - Pulse Input, or PO – Pulse Output.
  - g. RANGE/STATE: The range in engineering units corresponding to an analog 4-20 mA signal, or, the state at which the value of the discrete points is "1."
  - h. ENGINEERING UNITS: The engineering units associated with the Analog I/O.
  - i. ALARM LIMITS: Include alarm limits based on the control descriptions and the Drawings.
  - j. P&ID – the P&ID or drawing where the I/O point appears on. Mark as "NA" (Not Applicable) if the I/O point is derived from a specification requirement and is not on the P&IDs.
5. The I/O list shall be sorted in order by:
  - a. Physical location
  - b. I/O Type
  - c. Loop Number
  - d. Device Tag
6. Once the I/O List is approved, the PLC I/O addresses may not be modified without approval by the Design Engineer and ASP.
7. Where multiple mechanical components are provided for process redundancy, their field connections to I/O modules shall be arranged such that the failure of a single I/O module will not disable all mechanical components of the redundant system. This applies to all I/O types.

D. Data Transfer Address List Submittal

1. Submit a complete Data Transfer List defining all software points for communication to/from the plant SCADA.
2. The data transfer points shall be based on the Drawings, the requirements outlined in the Specifications, and coordination meetings with the Owner, Engineer, General Contractor and PCSI.
3. The data transfer list shall be submitted in both a Microsoft Excel readable electronic file format and hard copy.
4. As a minimum, the data transfer list shall include the following information:
  - a. TAG NAME: The identifier assigned to the software point.
  - b. DESCRIPTION: A description of the function of the device
  - c. LOGICAL POINT ADDRESS: Software address of each point.
  - d. POINT TYPE:
    - (i) DO - Discrete Output is written to the Supplier control system by the plant SCADA.
    - (ii) DI - Discrete Input is read from the Supplier control system by the plant SCADA.
    - (iii) AO - Analog Output is written to the Supplier control system by the plant SCADA.
    - (iv) AI - Analog Input is read from the Supplier control system by the plant SCADA.
  - e. DATA FORMAT: For analog points, the data format shall be either Integer or floating point. For discrete points, the data format shall be either maintained or momentary.
  - f. RANGE/STATE: The range in engineering units corresponding to an analog 4-20 mA signal; or, the state at which the value of the discrete point is "1."
  - g. ENGINEERING UNITS: The engineering units associated with the Analog points.

E. Equipment Supplier Control Narrative Submittal

1. This submittal shall provide the following information:
  - a. System Overview
  - b. Mode of Operation
  - c. Local Manual Control
  - d. Local Automatic Control
  - e. Remote Manual Control
  - f. Remote Automatic Control
  - g. Alarms

- h. Interlocks
  - i. Tuning Parameters
  - j. Equipment Runtimes
  - k. Historical Recording
- F. Control System Standards and Conventions Submittal
- 1. Submit system configuration, including network (TCP/IP) addressing. Network addressing shall be defined to enable the plant PLC system to communicate with the Supplier control system.
  - 2. Software tag naming conventions
  - 3. OIT graphic display standards, including color conventions, equipment symbols, display format, and samples of each proposed type of graphic display.
  - 4. Alarm configuration standards, including priorities, logging, and resetting
  - 5. Security configuration standards, including user groups and privileges
  - 6. PLC software templates, including equipment control, sequence control and equipment runtime calculations
- G. Operator Interface Submittal
- 1. Submit all proposed graphic displays, trends, and logs.
  - 2. Quantity of graphic displays to be submitted shall be as required to depict all monitoring and control requirements, defined herein and in the contract documents. As a minimum, the following graphic displays and types shall be submitted:
  - 3. Process Overview Displays
  - 4. Unit Process Displays
  - 5. Alarm Summary Display
  - 6. Key Performance Indicators (KPI): provide dedicated graphic displays for system key performance indicators.
  - 7. Control Strategy Setup Displays
  - 8. Equipment Control Pop-up Displays
  - 9. System Diagnostic Displays
- H. Process Instruments Submittal
- 1. Submit complete documentation of all field instruments using ISA-S20 data sheet formats. Submit a complete Bill of Materials (BOM) listing all instrumentation equipment using project identification, such as tags and descriptions as shown in the Contract Documents.
  - 2. Submit separate data sheets for each instrument including:
    - a. Plant Equipment Number and ISA tag number per the Drawings

- b. Product (item) name used herein and on the Contract Drawings
  - c. Manufacturer's complete model number
  - d. Location of the device
  - e. Input - output characteristics
  - f. Range, size, and graduations in engineering units
  - g. Physical size with dimensions, enclosure NEMA classification and mounting details in sufficient detail to determine compliance with the requirements of the Contract Documents
  - h. Materials of construction for enclosure and wetted parts
  - i. Instrument or control device sizing calculations where applicable
  - j. Certified calibration data for all flow metering devices
  - k. Two-wire or four-wire device type, as applicable
3. Submit index and data sheets in electronic format as well as hard copies on 8 1/2" x 11" formats. Electronic format shall be in Microsoft Excel or Word. Submit electronic copy.
- I. Panel Layout Drawings, Wiring Diagrams and Loop Wiring Diagrams Submittal
- 1. Include a complete Bill of Materials for each individual control panel being furnished.
  - 2. Include manufacturer literature for each item in the Bill of Materials with all required markings indicating exactly what versions, options, etc. are being proposed and indicate compliance with specification requirements. Manufacturer literature for common components need only be included once, for the first panel in the submittal with references to this literature included as applicable thereafter in submittal.
  - 3. Panel Layout Drawings: Drawings shall be furnished for all panels, consoles, and equipment enclosures specified. Panel assembly and elevation drawings shall be drawn to scale and detail all equipment in or on the panel. Panel drawings shall be 11 "x 17" minimum in size. As a minimum, the panel drawings shall include the following:
    - a. Interior and exterior panel elevation drawings to scale
    - b. Nameplate schedule
    - c. Conduit access locations
    - d. Panel construction details
    - e. Include cabinet assembly and layout drawings shown drawn to scale. The assembly drawing shall include a bill of material on the drawing with each panel component clearly defined. The bill of material shall be cross-referenced to the assembly drawing so that a non-technical person can readily identify any component of the assembly by manufacturer and model number.
    - f. Fabrication and painting specifications including color (or color samples)

- g. Submit construction details, NEMA ratings, intrinsically safe barrier information, gas sealing recommendations, purging system details, etc. for panels located in hazardous locations or interfacing to equipment located in hazardous areas.
  - h. Heating and cooling calculations for each panel supplied indicating conformance with cooling requirements of the supplied equipment and environmental conditions. Calculations shall include the recommended type of equipment required for both heating and cooling.
  - i. Submit evidence that all control panels shall be constructed in conformance with UL 508 and bear the UL seal confirming the construction. Specify if UL compliance and seal application shall be accomplished at the fabrication location or by field inspection by UL inspectors. All costs associated with obtaining the UL seal and any inspections shall be borne by the Supplier and included in the Project Bid Price.
4. Panel Wiring Diagrams: Panel wiring diagrams depicting wiring within and on the panel as well as connections to external devices. Equipment external to the control panel and related external connections do not need to be shown on the Panel Wiring Diagrams. Panel wiring diagrams shall include power and signal connections, UPS and normal power sources, all panel ancillary equipment, protective devices, wiring and wire numbers, and terminal blocks and numbering. Field device wiring shall include the device ISA-tag and a unique numeric identifier. The diagrams shall identify all device terminal points that the system connects to, including terminal points where I/O wiring lands on equipment not supplied by the Supplier. Wiring labeling used on the drawings shall match that shown on the Contract Documents or as developed by the Supplier and approved by the Engineer. I/O wiring shall be numbered with rack number, slot number, and point number. Two-wire and four-wire equipment shall be clearly identified and power sources noted. Submit final wire numbering scheme. Panel drawings shall be 11" x 17" minimum in size.
5. ISA Loop Wiring Diagrams: Detailed ISA loop wiring diagrams showing requirements for each loop which is shown on the contract drawings. The Loop Drawings shall be prepared in accordance with ISA Standard S5.4, latest version, and with the layout following Figures 5 and 6 (shown in the S5.4 Standard), titled Minimum Required Items Plus Optional items". Loop drawings shall be 11" x 17" minimum in size. The information required on the Loop Drawings to satisfy the "minimum" and "optional" requirements is as follows:
- a. Minimum Required Items – The following information shall be provided on Loop Drawings to meet this requirement:
  - b. Identification of the loop and loop components shown on the P&IDs Other principal components of the loop to be shown and identified under ISA-5.1, "Instrumentation Symbols and Identification"
  - c. Word description of loop functions within the title. If not adequate, use a supplemental note. Identify any special features or functions of shutdown and safety circuits.

- d. Indication of the interrelation to other instrumentation loops, including overrides, interlocks, cascaded set points, shutdowns and safety circuits.
- e. All point-to-point interconnections with identifying numbers or colors of electrical cables, conductors, pneumatic multitubes, and individual pneumatic and hydraulic tubing and this identification of interconnections includes junction boxes, terminals, bulkheads, ports, and grounding connections.
- f. General location of devices such as field, panel, auxiliary equipment, rack, termination cabinet, cable spreading room, I/O cabinet, etc.
- g. Energy sources of devices, such as electrical power, air supply, and hydraulic fluid supply. Identify voltage, pressure, and other applicable requirements. For electrical sources, identify circuit or disconnect numbers.
- h. Process lines and equipment sufficient to describe the process side of the loop and provide clarity of control action. Include what is being measured and what is being controlled.
- i. Actions or fail-safe positions (electronic, pneumatic, or both) of control devices such as controllers, switches, control valves, solenoid valves, and transmitters (if reverse- acting). These are to be identified in accordance with ISA-5.1, "Instrumentation Symbols and Identification".
- j. References to equipment descriptions, manufacturers, model numbers, hardware types, specifications or data sheets, purchase order numbers.
- k. Signal ranges and calibration information, including set point values for switches, and alarm and shutdown devices.

J. Testing Plan Submittal

- 1. Test Procedures: Submit the procedures proposed to be followed for each test. Procedures shall include test descriptions, forms, and checklists to be used to control and document the required tests. Include sign-off forms for each testing phase or loop with sign-off areas for the Supplier, Engineer, and Owner. Refer to Section 0100 General Conditions for specific testing requirements, and submit separate procedures for each specified test phase including:
  - a. Unwitnessed Hardware Factory Acceptance Testing (UFT)
  - b. System Integration Testing (SIT)
  - c. Witnessed Hardware Factory Test (WHFT)
  - d. Witnessed Software Factory Test (WSFT)
  - e. Unwitnessed Operational
- 2. Test Documentation: Upon completion of each required test, document the test by submitting a copy of the signed off test procedures. Testing shall not be considered complete until the signed-off test procedures have been submitted and favorably reviewed. Submittal of other test documentation, including "highlighted" wiring

diagrams with field technician notes, are not acceptable substitutes for the formal test documentation.

3. Each loop shall have a Loop Status signoff form to organize and track its inspection, adjustment and calibration. These forms shall include the following information and check-off items:
  - a. Project Name
  - b. Loop Number
  - c. Detailed test procedure indicating exactly how the loop will be tested including all required test equipment, necessary terminal block numbers, and simulation techniques required.
  - d. Tag Number for each component.
  - e. Check-offs/sign-offs for each component:
    - Tag/identification
    - Installation
    - Termination - wiring
    - Termination - tubing
    - Calibration/adjustment
  - f. Check-off/sign-off space for each loop:
    - Panel interface terminations
    - I/O interface terminations
    - I/O signal operation
    - Inputs/outputs operational: received/sent, processed, adjusted
    - Total loop operation
    - Space for comments.
    - Sign off and date fields for the Owner, the Engineer, and the Supplier.
4. Each active analog subsystem element shall have a Component Calibration form. These forms shall have the following information including space for data entry:
  - a. Project Name
  - b. Loop Number
  - c. ISA Tag Number and I/O Module Address
  - d. Manufacturer
  - e. Model Number/Serial Number
  - f. Summary of Functional Requirements, for example:
    - For Indicators: Scale ranges
    - For Transmitters/Converters: Scale and chart ranges
    - For Computing Elements: Function
    - For Controllers: Action (direct/reverse) control modes (PID)



For Switching Elements: Unit range, differential (fixed/adjustable), reset (auto/manual)

For I/O Modules: Input or output

g. Calibrations, for example:

For Analog Devices: Required and actual inputs and outputs at 0, 25, 50, 75 and 100 percent of span.

For Discrete Devices: Required and actual trip points and reset points.

For Controllers: Mode settings (PID).

For I/O Modules: Required and actual inputs or outputs for 0, 50 and 100 percent of span.

h. Space for comments

i. Sign off and date fields for the Owner, the Engineer, and the PCSI.

K. Spares, Expendables, and Test Equipment

1. All spares, expendables and test equipment in the listed Sections shall be included in a single submittal.
2. This submittal shall include for each subsystem:
  - a. A list of, and descriptive literature for, spares, expendables, and test equipment as specified under Division 17 specifications
  - b. A list of, and descriptive literature for, additional spares, expendables, and test equipment recommended by the manufacturer
  - c. Unit and total costs for the additional spare items specified or recommended for each subsystem.

L. Final System Documentation

1. The Final System Documentation shall consist of operations and maintenance manuals as specified herein. The manuals shall be bound in three-ring binders, maximum size of three inches, with Drawings reduced to 11 inches by 17 inches, then folded to 8.5 inch by 11 inches for inclusion. Each section shall have a uniquely numbered tab divider, and each component within each section shall have a separate binder tab divider.
2. The Operations and Maintenance manuals shall, at a minimum, contain the following information:
  - a. Table of Contents

A Table of Contents shall be provided for the entire manual with the specific contents of each volume clearly listed. The complete Table of Contents shall appear in each volume.
  - b. Instrument and Equipment Lists

The following lists shall be developed in Excel and provided not only as a hardcopy in O&M.

An instrument list for all devices supplied including tag number, description, specification section and paragraph number, manufacturer, model number, serial number, range, span, location, manufacturer phone number, local supplier name, local supplier phone number, completion year replacement cost, and any other pertinent data.

An equipment list for all non-instrument devices supplied listing description, specification section and paragraph number, manufacturer, model number, serial number, location, manufacturer phone number, local supplier name, local supplier phone number, completion year replacement cost, and any other pertinent data.

- c. Data Sheets with Vendor Operations and Maintenance Information
- d. ISA S20 data sheets shall be provided for all field instruments.

Cover page for each device, piece of equipment, and OEM software that lists, at a minimum, date, specification number, product name, manufacturer, model number, Location(s), and power required. Preferred format for the cover page is ISA S20, general data sheet; however, other formats will be acceptable provided they contain all required information.

Final vendor O&M documentation for each device, piece of equipment, or OEM software shall be either new documentation written specifically for this project, or modified standard vendor documentation. All standard vendor documentation furnished shall have all portions that apply clearly indicated with arrows or circles. All portions that do not apply shall be neatly lined out or crossed out. Groups of pages that do not apply at all to the specific model supplied shall be removed.

For any component requiring dip switch settings or custom software configuration, that information shall be included along with the corresponding data sheets and O&M information.

- e. As-Built Drawings

Complete As-built Drawings, including all Drawings and diagrams specified in this Section under the "Submittals" paragraph. These Drawings shall include all termination points on all equipment the system is connected to, including terminal points of equipment not supplied by the Supplier.

As-built documentation shall include information from submittals, as described in this Specification, updated to reflect the as-built system. Any errors in or modifications to the system resulting from the Factory and/or Functional Acceptance Tests shall be incorporated in this documentation.

- f. Original Licensed Software

Submit original software diskettes or CD-ROMs for all software provided under this Contract. Submit original documentation, both hard copies and in electronic format, for all software provided. Submit license agreement information including serial numbers, license agreements, User Registration Numbers and

related information. All software provided under this Contract shall be licensed to the Owner at the time of purchase. Provide media in original packages provided by manufacturer.

g. Electronic O&M Information

In addition to the hard copy of O&M data, provide an electronic version of all equipment manuals. Electronic documents shall be supplied in Adobe Acrobat format.

Provide electronic files for all custom-developed manuals. Text shall be supplied in both Microsoft Office format and .pdf format.

Provide electronic files for all drawings produced. Drawings shall be in AutoCAD 2007 ".dwg" format and in .pdf format. Drawings shall be provided using the AutoCAD eTransmit feature to bind external references, pen/line styles, and fonts into individual zip files along with the drawing file.

a. Each computer system hardware device shall be backed up onto CDROM or DVD after Substantial Completion and shall be turned over to the Owner.

b. If specified in the training section, provide digital copies of all training videos. Videos shall be in a format that is readable by standard DVD players and by standard PC DVD drives. Format shall be a minimum of 800 by 600 pixels and shall include sound.

3. The cover and edge of each volume shall contain the following information:

4. Project Name (refer to Contract Documents)

5. Contract Number (refer to Contract Documents)

6. Instrumentation and Control Systems

7. Hardware [or Applications Engineering] Operations and Maintenance Manual

8. Specification Sections \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_

9. Subcontractor Name

10. Date

11. Volume X of Y

12. (Where X is the volume number and Y is the number of volumes)

## 1.04 TESTING

### A. General Test Requirements

1. The Supplier shall test all equipment prior to shipment. Unless otherwise specified in the individual specification sections, all equipment provided by the Supplier shall be tested as a single fully integrated system.

2. As a minimum, the testing shall include the following:

- a. Unwitnessed Factory Test (UFT)
  - b. Witnessed Factory Test (WFT)
  - c. Operational Readiness Tests (ORT)
  - d. Functional Demonstration Tests (FDT)
  - e. 30-Day Site Acceptance Tests (SAT)
3. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement shall be satisfied.
  4. All tests shall be conducted in accordance with prior Engineer-approved procedures, forms, and check lists. Each specific test shall be described and followed by a section for sign off by the appropriate party after its status completion.
  5. Copies of these sign off test procedures, forms, and check lists will constitute the required test documentation.
  6. Provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data, provides suitable means of simulation. Define these simulation techniques in the test procedures.
  7. The General Contractor shall require the Supplier to coordinate all testing with the Engineer, all affected Subcontractors, and the Owner.
  8. The Engineer reserves the right to test or retest all specified functions whether explicitly stated in the prior approved Test Procedures.
  9. The Engineer's decision shall be final regarding the acceptability and completeness of all testing.
  10. No equipment shall be shipped to the Project Site until the Engineer has received all test results and approved the system as ready for shipment.
  11. The Supplier shall furnish the services of servicemen, all special calibration and test equipment and labor to perform the field tests as specified in Section 11292.
  12. Correction of Deficiencies
    - a. All deficiencies in workmanship and/or items not meeting specified testing requirements shall be corrected to meet specification requirements at no additional cost to the Owner.
    - b. Testing, as specified herein, shall be repeated after correction of deficiencies is made until the specified requirements are met. This work shall be performed at no additional cost to the Owner.

## **1.05 REFERENCE CODES AND STANDARDS**

- A. Instrumentation equipment, materials and installation shall comply with the National Electrical Code (NEC) and with the latest edition of the following codes and standards:

1. National Electrical Safety Code (NESC)
2. Occupational Safety and Health Administration (OSHA)
3. National Fire Protection Association (NFPA)
  - a. NFPA 79, Electrical Standard for Industrial Machinery
4. National Electrical Manufacturers Association (NEMA)
  - a. NEMA ICS 1-10 Diagrams, Designations and Symbols
  - b. NEMA ICS 4 Terminal Blocks for Industrial Use
  - c. NEMA ICS 6 Enclosures for Industrial Control Systems
  - d. NEMA LS1 Low Voltage Surge Protection Devices
5. American National Standards Institute (ANSI)
  - a. ANSI/ISA-5.06.01-2007 – Functional Requirements Documentation for Control Software Applications
6. Insulated Cable Engineers Association (ICEA)
7. The International Society of Automation (ISA)
  - a. ISA-TR20.00.01-2007 – Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations Updated with 27 New Specification Forms in 2004-2006 and updated with 11 New Specification Forms in 2007
  - b. ISA-5.1-2009 Instrumentation Symbol and Identification
  - c. ISA-5.2-1976 (R1992) Binary Logic Diagrams for Process Operations
  - d. ISA-5.3-1983 Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems
  - e. ISA-5.4-1991 Instrument Loop Diagrams
  - f. ISA-5.5-1985 Graphic Symbols for Process Displays
  - g. ISA-20-1981 Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves
8. Underwriters Laboratories (UL)
  - a. UL 508, the Standard of Safety for Industrial Control Equipment
  - b. UL 508A, the Standard of Safety for Industrial Control Panels
  - c. UL 50, the Standard of Safety for Enclosures for Electrical Equipment.
  - d. UL 1449 Third Edition Surge Protective Devices
9. Factory Mutual (FM)
10. All equipment and installations shall satisfy applicable Federal, State, and local codes.

- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
- C. All material and equipment, for which a UL standard exists, shall bear a UL label. No such material or equipment shall be brought onsite without the UL label affixed.
- D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents shall take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the Contractor, unless otherwise directed by the Owner/Engineer.
- E. In accordance with the intent of the Contract Documents, Supplier accepts the fact that compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time nor limit in any way, the Supplier's responsibility to comply with all Laws and Regulations at all times
- F. All control panels shall be constructed and the labeling shall be affixed in a UL 508 facility.

**1.06 CODES, INSPECTION AND FEES**

- A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.
- B. Obtain all necessary permits and pay all fees required for permits and inspections required for Supplier's system that are not covered by the Contractor's building permit, environmental and overall construction permits obtained by Owner or Contractor for the project.

**1.07 SIZE OF EQUIPMENT**

- A. Investigate each space in the structure through which equipment must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.
- B. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.

**1.08 MATERIALS AND EQUIPMENT**

- A. Materials and equipment shall be new, except where specifically identified on the Drawings to be re-used.
- B. The Supplier shall not bring onsite, material or equipment from a manufacturer, not submitted and approved for this project. Use of any such material or equipment, will be rejected, removed and replaced by the Supplier with the approved material and equipment, at his own expense.
- C. Material and equipment shall be UL listed, where such listing exists.

- D. The Supplier shall be responsible for all material, product, equipment and workmanship being furnished by him for the duration of the project. He shall replace the equipment if it does not meet the requirements of the Contract Documents.

**1.09 WARRANTY**

- A. The Supplier shall provide warranty as specified in Section 11292.

**1.10 DELIVERY, STORAGE AND HANDLING**

- A. Equipment shall be handled and stored in accordance with Section 11292 and as specified herein.
- B. Where space heaters are provided in equipment or control panels, provide temporary electrical power and operate space heaters during jobsite storage and after equipment is installed in permanent location, until equipment is placed in service.

**1.11 EQUIPMENT IDENTIFICATION**

- A. Identify equipment (control panels, control stations, instruments, etc) furnished with the name of the equipment it serves. Control panels, instruments, meters, junction or terminal boxes, etc., shall have nameplate designations as shown on the Drawings.
- B. Nameplates shall be engraved, laminated impact acrylic, black lettering on a white background, matte finish, not less than 1/16-in thick by 3/4-in by 2-1/2-in, Rowmark 322402. Nameplates shall be 316 SS screw mounted to all enclosures except for NEMA 4 and 4X. Nameplates for NEMA 4 and 4X enclosures shall be attached with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X 1/2", no equal. Prior to installing the nameplates, the metal surface shall be thoroughly cleaned, with a 70% alcohol solution, until the metal surface residue has been removed. Epoxy adhesive or foam tape is not acceptable.

**PART 2 PRODUCTS**

**2.01 GENERAL**

- A. All materials that come into contact with the water being treated or the finished water and all chemicals used in water treatment shall be ANSI/NSF Standard 61 certified for use in contact with potable water. Manufacturers shall submit an affidavit with the shop drawings indicating ANSI/NSF Standard 61 conformance for the materials used in products that come in contact with the water.

**2.02 PROCESS INSTRUMENTS**

- A. Flow Instruments
  - 1. Electromagnetic Flow Meter
    - a. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
      - (i) ABB

- (ii) Endress + Hauser
  - (iii) Siemens
- b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- c. General
  - (i) Provide sufficient lengths of manufacturer's specialty cables for installation of power and signal conductors as provided with each instrument.
  - (ii) Provide a hand-held programmer, for each transmitter, where full setup is not available for the instrument directly.
  - (iii) Each electromagnetic flow meter shall be provided according to the Table 17306-2.
- d. Type
  - (i) Microprocessor based intelligent type.
- e. Function/Performance:
  - (i) Output: 4-20 mA DC. Output shall be linear for pressure applications.
  - (ii) Accuracy: 0.5 percent of span (linear output).
  - (iii) Stability: Combined temperature effects shall be less than 0.2 percent of maximum span per 50 degrees F temperature change. Effect on accuracy, due to static pressure changes, shall be negligible.
  - (iv) RFI Protection: 0.1 percent error between 27 and 500 MHZ at 30 v/m field intensity.
  - (v) Drift: 0.10 percent per six months for 4-20 mA output.
  - (vi) Temperature rating: Suitable for process liquid temperature up to 70 degrees C and an ambient of 65 degrees C.
  - (vii) Pressure rating: 240 PSI if 150 lb flanges are used; 700 PSI if 300 lb flanges are used.
  - (viii) Meter shall be capable of running empty indefinitely without damage to any component.
- f. Physical:
  - (i) Metering Tube
    - (a) Carbon steel with 304 Stainless interior unless otherwise indicated.
    - (b) Electrical Classification: Rating shall be FM approved for the location shown on the Drawings



- (c) Tube Flanges: Match piping AWWA rating of the pipe. Minimum AWWA 150# Flange.
  - (d) Tube Liner: Polyurethane or EDPM, certified as ANSI/NSF Standard 61 compliant for direct contact with potable water, unless noted otherwise.
  - (e) Tube Electrodes: ANSI 316 stainless steel or Hastelloy C, bullet nosed or elliptical self-cleaning type unless otherwise noted.
  - (f) Tube Housing: Meters in below grade, vaults, basements, etc., shall be designed for accidental submergence in 30 feet of water for 24 hours. Meters above grade shall be of splash proof/drip proof design unless otherwise noted.
  - (g) Painting: All external surfaces shall be painted with a chemical and corrosion resistant epoxy finish.
- g. Transmitter
- (i) Transmitter Enclosure: NEMA 4X.
  - (ii) Electrical Classification: Rating shall be FM approved for the location shown on the Drawings
  - (iii) Transmitter shall be remotely mounted unless indicated on Drawings.
- h. Power Requirements
- (i) Input Power: 100VAC-230VAC
- i. Options/ Accessories
- (i) Factory calibration: Each meter shall be factory calibrated, with a copy of the Report delivered with the device and in the O&M manual.
  - (ii) Grounding: Meter shall be grounded with rings. Provide 316 Stainless Steel ground rings, ground wires, and gaskets, etc. All materials shall be suitable for the liquid being measured. Where sodium hypochlorite is the liquid being measured provide Hastelloy C grounding materials.
  - (iii) Electrode cleaning: Where listed on the instrument device schedules, or shown on the Drawings, provide an electrode cleaning system. The cleaning system electronics shall be housed in a NEMA 4X wall mounted panel. Provide all necessary cables and connectors. The system shall be powered through the special cables to the magnetic flow meter.
  - (iv) Provide a hand-held programmer for each transmitter, where full setup is not available from the instrument transmitter display directly.

## B. Level Instruments

### 1. Ultrasonic Level Transmitter (Remote Sensor)

- a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
  - (i) Endress + Hauser

- (ii) Siemens HydroRanger 200
  - (iii) Approved Equal
- b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- c. General
  - (i) Provide sufficient lengths of Manufacturer's specialty cables for installation of power and signal conductors as provided with each instrument.
- d. Type:
  - (i) Separate ultrasonic transducer
  - (ii) Dual 4-20ma outputs & 2 Form A & 1 Form C Output
- e. Function/Performance
  - (i) Function: Sense and transmit a variable liquid level.
  - (ii) Principle: Pulse ultrasonic signals from the transducer toward the liquid and receive an echo, measuring the time between sending and receiving the pulse signal, and proportioning that to the measured liquid depth.
  - (iii) Range Capability: 1 feet to 50 feet
  - (iv) Beam Angle: 7 degrees
  - (v) Shall have integral temperature compensation unit.
  - (vi) Accuracy. Current output 1 percent of selected full-scale range.
  - (vii) Repeatability. 0.25 percent full scale.
- f. Physical
  - (i) Transmitter housing: shall be NEMA 4X polycarbonate enclosure. Sensor shall be completely encapsulated PVC and submersible with an aluminum outer cover, suitable for Class I Div 1 locations.
- g. Power Requirements
  - (i) Input Power: 100VAC-230VAC
- h. Options/Accessories
  - (i) Provide span and zero adjustment at each transmitter.
  - (ii) Provide local indication at each transmitter, either analog gauge or LCD readout. Scale shall be in engineering units.
  - (iii) Provide an integral indicator scaled in engineering units.
  - (iv) Provide hand held programmer(s) where full setup is not available for the instrument

2. Ultrasonic Level Transmitter (Integral Sensor)
  - a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
    - (i) Endress + Hauser
    - (ii) Siemens Probe
    - (iii) Approved Equal
  - b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
  - c. General
    - (i) Provide sufficient lengths of any Manufacturer's specialty cables for installation of power and signal conductors as provided with each instrument.
  - d. Type:
    - (i) Microprocessor based intelligent type
    - (ii) The instrument shall measure level.
  - e. Function/Performance
    - (i) Accuracy: +/- 1/4 inch.
    - (ii) Built-in temperature compensation.
    - (iii) Output: 4-20 mA
    - (iv) Repeatability: =< 0.12 in.
  - f. Physical
    - (i) Electrical Classification: Shall be the same as the area as shown on the Drawings.
    - (ii) Enclosure: NEMA 4X and NEMA 6.
  - g. Power Requirements
    - (i) Loop powered two-wire type
  - h. Options/Accessories
    - (i) Provide an integral indicator scaled in engineering units.
    - (ii) Provide hand held programmer(s) where full setup is not available for the instrument directly.
3. Radar Level transmitter
  - a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
    - (i) Vega - VEGAPULS 62

- (ii) Approved Equal
  - b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
  - c. General
    - (i) Principle: Sends out K Band pulse signals from the antenna system toward the liquid and receives the echo measuring the time between sending and receiving the pulse signal and proportioning that to the measured liquid depth.
  - d. Type:
    - (i) 316 SS Antenna sensor
    - (ii) Wetted parts 316L
    - (iii) Horn Antenna
  - e. Function Performance
    - (i) Function: To sense variable liquid level.
    - (ii) Input Power: From transmitter signal wire 4 – 20 mA 24 VDC.
    - (iii) Range Capability: 1 feet to 99 feet
    - (iv) Beam Angle: 8 degrees
    - (v) Shall have integral temperature compensation unit.
    - (vi) Accuracy. Current output 1 percent of selected full-scale range.
    - (vii) Repeatability. 0.25 percent full scale.
  - f. Physical
    - (i) Mounting: flange mounted. Flange shall be as shown on plans", 150 lb. RF. All flanges for chemical tanks shall be coated to match the antennae and flange coatings.
    - (ii) Antennae shall be shaped to optimize reading accuracy and desired location.
  - g. Options/Accessories
    - (i) Provide stainless steel hardware.
4. Submersible Pressure Sensing Level Transmitter
- a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
    - (i) Sitrans P Submersible Transmitters for hydrostatic Level MPS Series.
    - (ii) Approved Equal

- b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- c. General
  - (i) Type: Measuring level by continuously measuring hydrostatic pressure via its sensing element, an ion implanted silicon semiconductor chip. Data is transmitted by an analog, 4 to 20 mA DC output signals.
- d. Performance Requirements:
  - (i) Accuracy:  $\pm 0.25$  percent full scale.
  - (ii) Zero Offset:  $\pm 0.50$  percent full scale.
  - (iii) Span:  $\pm 0.50$  percent full scale.
  - (iv) Operating Temperature Ranges: +14 to 176 degrees F.
  - (v) Storage Temperature Range: -40 to 212 degrees F.
- e. Physical:
  - (i) Sensor: Type 316 stainless steel.
  - (ii) Housing: Type 316 stainless steel.
  - (iii) Cable shall be provided of required length and fully submersible construction.
  - (iv) Power supply: 12 to 28 VDC with surge and lightning protection.
  - (v) Electrical Connection: Attached 3-wire, 20-gauge polyethylene shielded unspliced cable.
  - (vi) Level Digital display shall accept 4-20 ma loop powered, 0.1 % of span, wall mounted and NEMA 4X rated. Preferred Sitrans RD100 or approved equal.

5. Pressure Sensing Level Transmitter

- a. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
  - (i) ABB
  - (ii) Endress + Hauser
  - (iii) Schneider Electric Rosemount
  - (iv) Emerson Foxboro
  - (v) Siemens
  - (vi) Approved equal
- b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions.

Manufacturers listed above are not relieved from meeting these specifications in their entirety.

- c. General
  - (i) Provide surge protection for each instrument.
- d. Type
  - (i) Microprocessor based intelligent type, diaphragm actuated.
  - (ii) The instrument shall measure level in inches or feet of water column.
- e. Function/Performance
  - (i) Accuracy: Plus or minus 0.1 percent of calibrated span.
  - (ii) Over Range Protection: Provide positive over range protection to maximum process pressure.
  - (iii) RFI Protection: 0.1 percent error between 27 and 500 MHZ at 20 v/m field intensity.
  - (iv) Output: 4-20 mA
  - (v) Stability: Combined temperature effects shall be less than 0.2 percent of maximum span per 50 degrees F temperature change.
- f. Physical
  - (i) Electrical Classification: Intrinsically safe or explosion proof for Class I and Class II, Division 1 locations.
  - (ii) Enclosure: Rated NEMA 4X.
  - (iii) Diaphragm Sensor Material: 316 Stainless Steel alloy or Hastelloy C.
  - (iv) Sensor Fill Fluid: Shall be suitable for process fluid being measured. When used for chemical metering service, the fill fluid shall be rated for the chemical being measured.
- g. Power Requirements
  - (i) Loop powered two-wire type
- h. Required Options/Accessories
  - (i) If required to meet the range or suppression/elevation requirements, the Contractor shall supply a differential pressure transmitter.
  - (ii) Provide a shutoff valve and mounting bracket for each transmitter.
  - (iii) Provide an integral indicator scaled in engineering units.
  - (iv) Provide hand held programmer(s) where full setup is not available for the instrument directly.

6. Flange Mounted Pressure Sensing Level Transmitter

- a. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
  - (i) ABB
  - (ii) Endress + Hauser
  - (iii) Emerson Foxboro
  - (iv) Schneider Electric Rosemount
  - (v) Siemens
  - (vi) Approved equal
- 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.
  - (i) Provide surge protection for each instrument.
- c. Type
  - (i) The instrument shall measure level in inches or feet of water column.
  - (ii) Differential pressure type with flanged diaphragm seal(s).
  - (iii) Microprocessor based intelligent type.
- d. Function/Performance
  - (i) Accuracy: Plus or minus 0.1 percent of calibrated span.
  - (ii) Output: 4-20 mA
  - (iii) RFI Protection: 0.1 percent error between 27 and 500 MHZ at 20 v/m field intensity.
  - (iv) Over Range Protection: Positive over range protection.
  - (v) Stability: Combined temperature effects shall be less than 0.2 percent of maximum span per 50-degree F temperature change.
- e. Physical
  - (i) Electrical Classification: Intrinsically safe or explosion proof for Class I and Class II, Division 1 locations.
  - (ii) Enclosure: NEMA 4X.
  - (iii) Diaphragm Sensor Material: 316 Stainless Steel alloy or Hastelloy C.
  - (iv) Connection: Process connection shall be with a 2-in, Class 150, carbon steel flange.
  - (v) Process or atmospheric reference connection shall be a ½-in NPT.

- (vi) Sensor Fill Fluid: Suitable for the process fluid being measured. When used for chemical metering service, the fill fluid shall be rated for the chemical being measured.
  - f. Power Requirement
    - (i) Loop powered two-wire type.
  - g. Options/Accessories
    - (i) Provide an integral indicator scaled in engineering units.
    - (ii) Provide hand held programmer(s) as specified under tools and test equipment.
    - (iii) Provide hand held programmer(s) where full setup is not available for the instrument directly.
7. Float Level Switch
- a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
    - (i) Endress+Hauser FTS20
    - (ii) Flygt Model ENM-10.
    - (iii) Contegra FS-90
    - (iv) Approved Equal
  - b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
  - c. General
    - (i) Provide sufficient lengths of Manufacturer's specialty cables for installation of power and signal conductors as provided with each instrument.
  - d. Type:
    - (i) The switch assembly shall be weighted and suspended on its own cable.
  - e. Function/Performance:
    - (i) Temperature Rating: 0-50 degrees C.
    - (ii) Contact Rating: Up to 150 V AC/DC and 1 amps AC, 1 amps DC.
    - (iii) Contact Arrangement: Form C contact which is field selectable normally open or closed.
  - f. Physical:
    - (i) Contact: Sealed mercury free switch housed in a chemical-resistant polypropylene or stainless-steel casing.



- (ii) Switch shall have a rating for the area in which it is installed.
- (iii) Flexible Support Cable: Synthetic four wire cable, minimum 19 AWG wire.
- (iv) Specific Gravity: Match to fluid being measured.
- g. Power Requirements
  - (i) None
- h. Required Options/Accessories
  - (i) Provide flexible support cable of sufficient length to ensure no splice or connection is required in the wet well.
  - (ii) Provide junction box rated for the area in which it is installed.
  - (iii) Provide stainless steel supports/mounting accessories as required.
- i. Installation
  - (i) Provide all hardware from the manufacture for the installation as described and shown on the plans.
  - (ii) Provide stainless steel wire ties for all cables within the wet well area or exposed to outdoor environments.

C. Pressure Instruments

1. Differential Pressure Transmitter

- a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
  - (i) Endress + Hauser
  - (ii) Schneider Electric Foxboro
  - (iii) Emerson Rosemount
  - (iv) Siemens
  - (v) Approved Equal
- b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- c. General
  - (i) Provide signal surge protection at all transmitters.
- d. Type
  - (i) Microprocessor based intelligent type.
  - (ii) Diaphragm actuated.
- e. Function/Performance:

- (i) Output: 4-20 mA DC. Output shall be linear for pressure applications.
  - (ii) Accuracy: 0.1 percent of span (linear output).
  - (iii) Stability: Combined temperature effects shall be less than 0.2 percent of maximum span per 50 degrees F temperature change. Effect on accuracy due to static pressure changes shall be negligible.
  - (iv) RFI Protection: 0.1 percent error between 27 and 500 MHZ at 30 v/m field intensity.
  - (v) Drift: 0.10 percent per six months for 4-20 mA output.
  - (vi) Sensor Technology: Digital.
  - (vii) Over Range Protection: Provide positive over range protection.
- f. Physical
- (i) Electrical Classification: Intrinsically safe for Class I and Class II, Division 1 locations.
  - (ii) Enclosure: NEMA 4X.
  - (iii) Sensor Diaphragm Material: 316 Stainless Steel alloy or Hastelloy C.
  - (iv) Gaskets: Teflon.
  - (v) Sensor Fill Fluid: Shall be suitable for process fluid being measured. When used for chemical metering service, sensor fill fluid shall be rated specifically for the chemical being measured.
- g. Power Requirements:
- (i) Loop powered, two-wire type.
- h. Required Options/Accessories
- (i) Provide span and zero adjustment at each transmitter.
  - (ii) Provide local indication at each transmitter using LCD readout. Scale shall be in engineering units. With a minimum of 4 digits of precision
  - (iii) For each transmitter provide a manifold as specified herein, with the following Modes:
    - (a) Normal Mode
    - (b) Zeroing Mode
    - (c) Isolation Mode
    - (d) Calibration Mode
    - (e) Blowdown Mode
  - (iv) Provide hand held programmer(s) where full setup is not available for the instrument directly from the display.

2. Pressure Transmitter

- a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
  - (i) ABB
  - (ii) Endress + Hauser
  - (iii) Schneider Electric Foxboro
  - (iv) Emerson Rosemount
  - (v) Siemens
  - (vi) Approved Equal
- b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- c. General
  - (i) Provide surge protection for each instrument.
- d. Type
  - (i) Microprocessor based intelligent type, diaphragm actuated.
  - (ii) The instrument shall measure gage pressure.
- e. Function/Performance
  - (i) Accuracy: Plus or minus 0.1 percent of calibrated span.
  - (ii) Over Range Protection: Provide positive over range protection to maximum process pressure.
  - (iii) RFI Protection: 0.1 percent error between 27 and 500 MHZ at 20 v/m field intensity.
  - (iv) Output: 4-20 mA
  - (v) Stability: Combined temperature effects shall be less than 0.2 percent of maximum span per 50 degrees F temperature change.
- f. Physical
  - (i) Electrical Classification: Intrinsically safe or explosion proof for Class I and Class II, Division 1 locations.
  - (ii) Enclosure: Rated NEMA 4X.
  - (iii) Diaphragm Sensor Material: 316 Stainless Steel alloy or Hastelloy C.
  - (iv) Sensor Fill Fluid: Shall be suitable for process fluid being measured. When used for chemical metering service, the fill fluid shall be rated for the chemical being measured.
- g. Power Requirements

- (i) Loop powered two-wire type
  - h. Required Options/Accessories
    - (i) If required to meet the range or suppression/elevation requirements, the Contractor shall supply a differential pressure transmitter.
    - (ii) Provide a shutoff valve and mounting bracket for each transmitter.
    - (iii) Provide an integral indicator scaled in engineering units.
    - (iv) Provide hand held programmer(s) where full setup is not available for the instrument directly.
3. Flange Mounted Pressure Transmitter
- a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
    - (i) Endress + Hauser
    - (ii) Schneider Electric Foxboro
    - (iii) Emerson Rosemount
    - (iv) Siemens
    - (v) Approved Equal
  - b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
  - c. General
    - (i) Provide sufficient lengths of any Manufacturer's specialty cables for installation of power and signal conductors as provided with each instrument.
    - (ii) .
  - d. Type
    - (i) Differential pressure type with remote flanged diaphragm seal(s).
    - (ii) Microprocessor based intelligent type.
  - e. Function/Performance
    - (i) Accuracy: Plus or minus 0.1 percent of calibrated span.
    - (ii) Output: 4-20 mA
    - (iii) RFI Protection: 0.1 percent error between 27 and 500 MHZ at 20 v/m field intensity.
    - (iv) Over Range Protection: Positive over range protection.
    - (v) Stability: Combined temperature effects shall be less than 0.2 percent of maximum span per 50 degree F temperature change.

- f. Physical
  - (i) Electrical Classification: Intrinsically safe or explosion proof for Class I and Class II, Division 1 locations.
  - (ii) Enclosure: NEMA 4X.
  - (iii) Diaphragm Sensor Material: 316 Stainless Steel alloy or Hastelloy C.
  - (iv) Connection: Process connection shall be with a 2-in, Class 150, carbon steel flange.
  - (v) Process or atmospheric reference connection shall be a ½-in NPT.
  - (vi) Sensor Fill Fluid: Suitable for the process fluid being measured. When used for chemical metering service, the fill fluid shall be rated for the chemical being measured.
- g. Power Requirement
  - (i) Loop powered two-wire type.
- h. Options/Accessories
  - (i) Provide an integral indicator scaled in engineering units.
  - (ii) Provide hand held programmer(s) as specified under tools and test equipment.
  - (iii) Provide all necessary remote seal equipment and accessories to mount the transmitter up to ten feet from the remote seal.
  - (iv) Provide hand held programmer(s) where full setup is not available for the instrument directly.
- 4. Pressure Gauge
  - a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable
    - (i) Ashcroft Model 1279
    - (ii) Ametek/U.S. Gauge Division
    - (iii) Wika
    - (iv) Approved equal
  - b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
  - c. General
    - (i) Ratings shall be equal to or exceed the piping.
  - d. Type:

- (i) Bourdon tube actuated pressure gauge.
  - e. Function/Performance:
    - (i) Accuracy: Plus or minus 1.0 percent of span or better.
  - f. Physical:
    - (i) Case: Phenolic shock resistant or 316 stainless steel for surface/stem mounting with a pressure relieving back. The case shall be vented for temperature/atmospheric compensation. Gauge shall be capable of being liquid filled in the field or at the factory.
    - (ii) Window: Clear acrylic or shatter proof glass.
    - (iii) Bourdon Tube: 316 stainless steel.
    - (iv) Connection: ½-in NPT.
    - (v) Gauge size: Minimum 4.0 inches viewable.
    - (vi) Pointer travel: Not less than 200 degrees nor more than 270-degree arc.
    - (vii) Range: Select range so that maximum design/test pressure is not greater than 80% or less than 50% of full scale.
  - g. Power Requirements
    - (i) None
  - h. Required Options/Accessories
    - (i) Shutoff valve: Each gauge shall have a process shutoff valve which can also be used as an adjustable pressure snubber.
    - (ii) Special scales: The Engineer reserves the right to require special scales and/or calibration if the manufacturer's standard is not suitable for the application.
    - (iii) Gauges listed as liquid filled in the Instrument Device Schedule shall be liquid filled at the Manufacturer's Factory.
5. Pressure Switch
- a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
    - (i) Static-O-Ring (SOR)
    - (ii) United Electric
    - (iii) Ashcroft
    - (iv) Approved equal
  - b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

- c. General
    - (i) Ratings shall be equal to or exceed the piping.
  - d. Type:
    - (i) Diaphragm actuated.
  - e. Function/Performance:
    - (i) Repeatability: Greater than 1.0 percent of pressure.
    - (ii) Setpoint: Field adjustable and set between 30 and 70 percent of the adjustable range.
    - (iii) Dead Band: Adjustable
    - (iv) Reset: Unit shall be of the automatic reset type unless noted otherwise on the Instrument Device Schedules.
    - (v) Over Range Protection: Over range protection to maximum process line pressure.
    - (vi) Switch Rating: 250 V AC at 10 amps; and 30 V DC at 5 amps.
  - f. Physical:
    - (i) Housing: NEMA 4X.
    - (ii) Switching Arrangement: Single pole double throw (SPDT) unless double pole double throw (DPDT) switches are shown on the instrument device schedule.
    - (iii) Wetted Parts: 316 Stainless Steel Alloy, Hastelloy C or Monel diaphragm, viton seals, stainless steel connection port as confirmed compatible with the process fluid by the manufacture.
    - (iv) Connection Size: ½-in NPT.
  - g. Power Requirements
    - (i) None
  - h. Required Options/Accessories
    - (i) Shutoff Valve: Provide process shutoff valve which can be used as an adjustable pressure snubber.
6. Differential Pressure Switch
- a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
    - (i) Dwyer Series 1630
    - (ii) Ashcroft
    - (iii) Approved equal

- b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- c. General
  - (i) Ratings shall be equal to or exceed the piping.
- d. Type:
  - (i) Differential pressure actuated.
- e. Function/Performance:
  - (i) Setpoint: Field adjustable.
  - (ii) Dead Band: Factory set.
  - (iii) Switch Rating: 250 V AC at 10 amps
- f. Physical:
  - (i) Housing: NEMA 4X.
  - (ii) Switching Arrangement: Single pole double throw (SPDT) unless double pole double throw (DPDT) switches are shown on the instrument device schedule.
  - (iii) Connection Size: 1/4-in NPT Minimum.
- g. Power Requirements
  - (i) None
- h. Required Options/Accessories
  - (i) Shutoff Valve: Provide process shutoff valve which can be used as an adjustable pressure snubber.

D. Temperature Instruments

1. Temperature Gauge – Bimetal Type

- a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
  - (i) Ashcroft
  - (ii) Wekslar
  - (iii) Ametek/US Gauge
  - (iv) Approved Equal
- b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.



- c. General
    - (i) Provide gauge with ratings for the area where installed.
  - d. Type
    - (i) Bimetal type.
  - e. Function/Performance:
    - (i) Helical bimetal element enclosed in a metal shield expands when heated.
    - (ii) Range: Refer to the loop diagrams.
    - (iii) Accuracy: +/-1 percent.
    - (iv) Stem Length: One-half (1/2) the pipe diameter.
  - f. Physical
    - (i) Dial Size: 3-1/2-inch minimum.
    - (ii) Case: Painted steel.
    - (iii) Ring/Window: Polycarbonate.
    - (iv) Dial: Steel, white with black markings.
    - (v) Element: 316 stainless steel.
    - (vi) Connection: 1/2-inch NPT.
  - g. Power Requirements
    - (i) None
  - h. Options/Accessories
    - (i) Scale shall be in engineering units.
    - (ii) Swivel Head: Provide adjustable gauge position for viewing from any angle.
    - (iii) Over Range Protection: Provide positive over range protection.
2. Temperature Transmitter – RTD Type
- a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
    - (i) Emerson Rosemount
    - (ii) Schneider Electric Foxboro
    - (iii) Approved Equal
  - b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
  - c. General

- (i) Provide sufficient lengths of Manufacturer's specialty cables for installation of power and signal conductors as provided with each instrument.
  - d. Type:
    - (i) Input: 3-wire, 100 Ohm platinum RTD.
    - (ii) Output: 2-wire, 4-20 mA DC into 750 Ohm
    - (iii) Element mounted
  - e. Function/Performance:
    - (i) Receive input signal from resistance temperature device (RTD) indicated in process units and transmit a 4-20mA DC signal linear proportional to the measured temperature.
    - (ii) Calibrated Accuracy - + 0.25 percent of calibrated span, or, + 0.1 percent, whichever is greater.
    - (iii) Independent Linearity - + 0.05 percent of calibrated span
    - (iv) Speed of Response - 0.5 seconds for 90 percent of step change
    - (v) Stability - + 0.02 percent (1 degree F.) zero and span
  - f. Physical:
    - (i) Case Material: Cast aluminum
    - (ii) Cast Type: NEMA 4X
    - (iii) Mounting: Threaded connection on a thermowell
    - (iv) Indicator: 2-in ARC type
  - g. Power Requirements
    - (i) Loop powered
  - h. Options/Accessories
    - (i) Provide span and zero adjustment at each transmitter.
    - (ii) Provide local indication at each transmitter, either analog gauge or LCD readout. scale shall be in engineering units.
    - (iii) Provide hand held programmer(s) where full setup is not available for the instrument directly.
- 3. Temperature Transmitter – Thermocouple Type
  - a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
    - (i) Moore
    - (ii) Procession Digital
    - (iii) Approved Equal

- b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- c. General
  - (i) Provide sufficient lengths of Manufacturer's specialty cables for installation of power and signal conductors as provided with each instrument.
- d. Type:
  - (i) Input: Thermocouple Type T
  - (ii) Output: 2-wire, 4-20 mA DC into 750 Ohm
  - (iii) Element mounted
- e. Function/Performance:
  - (i) Receive input signal from a Type T thermocouple, converted to process units and transmit a 4-20mA DC signal linear proportional to the measured temperature.
  - (ii) Calibrated Accuracy - + 0.25 percent of calibrated span, or, + 0.1 percent, whichever is greater.
  - (iii) Independent Linearity - + 0.05 percent of calibrated span
  - (iv) Speed of Response - 0.5 seconds for 90 percent of step change
  - (v) Stability - + 0.02 percent (1 degree F.) zero and span
- f. Physical:
  - (i) Case Material: Cast aluminum
  - (ii) Cast Type: NEMA 4X
  - (iii) Mounting: Threaded connection on an thermowell
  - (iv) Indicator: 2-in ARC type
- g. Power Requirements
  - (i) Loop powered
- h. Options/Accessories
  - (i) Provide span and zero adjustment at each transmitter.
  - (ii) Provide local indication at each transmitter, either analog gauge or LCD readout. Scale shall be in engineering units.
  - (iii) Provide hand held programmer(s) where full setup is not available for the instrument directly.

4. Temperature Gauge – Mercury Type

- a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
    - (i) Marshalltown Manufacturing Co.
    - (ii) H. O. Terrace Co.
    - (iii) Palmer Instruments, Inc.
    - (iv) Moeller Instrument Co.
    - (v) Weiss and Son, Inc.
    - (vi) U. S. Gauge, Inc.
    - (vii) Approved Equal
  - b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
  - c. General
    - (i) Provide gauge with ratings for the area where installed.
  - d. Type
    - (i) Industrial thermometer, straight, angle or adjustable, mercury tube type
    - (ii) Function/Performance
    - (iii) Accuracy: + one scale division.
    - (iv) Scale: White background with jet black embossed figures and markings.
    - (v) Range: Shall be selected so that the normal operating temperature of the material being measured will fall approximately in the middle of the scale and shall read to the reasonably expected extremes of the system fluid temperatures.
  - e. Physical
    - (i) Case: 9-in die cast aluminum with metallic blue black finish or brass with suitable finish.
  - f. Power Requirements
    - (i) None
  - g. Options/Accessories
    - (i) Scale shall be in engineering units.
5. Field Mounted Temperature Indicator
- a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
    - (i) Precision Digital

- (ii) Moore Industries
    - (iii) Approved equal
  - b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
  - c. Design and fabrication:
    - (i) Power source: Loop powered by the 4-20 ma signal with a drop of no more than 1 volt.
    - (ii) Input: 4-20 mA DC.
    - (iii) Accuracy (maximum error):  $\pm 0.25$  percent.
    - (iv) Ambient temperature range: 0-120 degrees F.
    - (v) Display shall be in a NEMA 4X Factory Enclosure suitable for wall or pipe mounting.
    - (vi) Three and a half digit one inch high characters shall be the minimum.
    - (vii) Unit shall be field calibratable with operating range suitable for the process value to be indicated.
    - (viii) Minimum size 5.5 inch diameter housing.
6. Temperature Switch
- a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
    - (i) Ashcroft
    - (ii) United Electric
    - (iii) Approved Equal
  - b. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
  - c. General
    - (i) Ratings shall be equal to or exceed the piping.
  - d. Type:
    - (i) Bi-metal actuated.
  - e. Function/Performance:
    - (i) Repeatability: Greater than 1.0 percent of temperature.

- (ii) Setpoint: Field adjustable and set between 30 and 70 percent of the adjustable range.
- (iii) Dead Band: Adjustable
- (iv) Reset: Unit shall be of the automatic reset type unless noted otherwise on the Instrument Device Schedules.
- (v) Over Range Protection: Over temperature protection to maximum process line temperature.
- (vi) Switch Rating: 250V AC at 10 amps; and 30V DC at 5 amps.
- f. Physical:
  - (i) Housing: NEMA 4X.
  - (ii) Switching Arrangement: Single pole double throw (SPDT) unless double pole double throw (DPDT) switches are shown on the instrument device schedule.
  - (iii) Wetted Parts: Teflon coated diaphragm, viton seals, stainless steel connection port.
  - (iv) Connection Size: ½-in NPT.
- g. Power Requirements
  - (i) None
- h. Options/Accessories
  - (i) Provide with thermowell

## **2.03 VENDOR PACKAGE CONTROL PANEL**

### **A. General**

1. Each control panel containing different voltage levels shall be designed and provided with separate enclosures for low and high voltage. The voltage level in the low voltage enclosure shall not exceed 120VAC.
  - a. Control transformers and power supplies with inputs greater than 120VAC shall be installed in the high voltage enclosure and output wired to the low voltage enclosure.
  - b. Control circuits, relays, pilot indicators and selector switches integral to the control and monitoring of utilization equipment shall be permitted in the high voltage enclosure.

### **B. Material Manufacturers**

1. Subject to compliance with the contract documents, the following material manufacturers are acceptable:
  - a. Hoffman
  - b. EMF

c. Approved Equal

2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Materials Manufactures listed above are not relieved from meeting these Specifications in their entirety.
3. Manufactures of all related devices and components shall be as specified elsewhere in related work specifications

C. RATINGS

1. The complete control panel assembly shall be UL certified or carry a UL 508A listing for "Industrial Control Panels".
2. The control panel shall meet all applicable requirements of the National Electrical Code.
3. All devices unless otherwise specified shall be designed for continuous operation at rated current in a 40-degree C ambient temperature
4. For additional ratings and construction notes, refer to the drawings.
5. The service voltage shall be as specified and as shown on the drawings. The overall short circuit withstand and interrupting rating of the equipment and devices shall be equal to or greater than the overall short circuit withstand and interrupting rating of the feeder device immediately upstream of the Control Panel, but not less than 10,000 amperes RMS symmetrical at 120 volts single phase.

D. CONSTRUCTION

1. General:
  - a. Refer to the drawings for: schematics, actual layout and location of equipment and components; current ratings of devices, bus bars, components; protective relays, voltage ratings of devices, components and assemblies; and other required details.
2. Enclosures:
  - a. General:
    - (i) Each enclosure shall incorporate a removable back panel, and side panels, on which control components shall be mounted. Back panel shall be secured to the enclosure with collar studs for wall mounted enclosures, and 316 SS hardware for free standing enclosures.
    - (ii) All free-standing enclosures shall be provided with feet of the same construction as the enclosure.
    - (iii) Back panel shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any components.
    - (iv) All enclosure doors shall have bonding studs. The enclosure interior shall have a bonding stud.
    - (v) Each enclosure shall be provided with a documentation pocket on the inner door.

- (vi) Enclosures shall not have holes or knockouts.
  - (vii) Provide manufacturer's window kits where shown on the drawings.
  - (viii) All panels installed outdoors shall have a factory applied, suitable primer and final coat of weatherproof white paint.
  - (ix) All enclosures shall be pad lockable.
  - (x) Each enclosure shall have one, UPS powered, 150-watt receptacle.
  - (xi) All enclosures shall be lockable, and keyed alike.
  - (xii) All control panels shall have a "Panel Interface Connector" (PIC) as specified in Section 13327 Panel Mounted Equipment.
  - (xiii) All PLC Control Panels shall have an integral folding shelf on the exterior for service / maintenance personnel; shelf shall match panel enclosure in material and color.
- b. NON METALLIC:
- (i) Chemical Rooms NEMA 4X constructed as follows:
    - (a) PVC or Fiberglass reinforced polyester body and door.
    - (b) UV inhibitors
    - (c) Luggage type quick release latches
    - (d) Foam-in-place gasket doors
  - (ii) Manufacturers:
    - (a) Hoffman Polypro
    - (b) Hubbell-Wiegmann Non-Metallic
    - (c) Approved Equal
- c. NEMA 12 Steel:
- (i) NEMA 12
    - (a) Mild grade steel, body and door
    - (b) Stainless steel continuous hinge pin or concealed stainless steel hinges
    - (c) Foam in-place gasket or PORON AquaPro
    - (d) Single point quarter turn latches (20" x 24" and below). All others 3-point latch
  - (ii) Manufacturers:
    - (a) Hoffman Comline
    - (b) EMF Company
    - (c) NEMA Enclosures Company
    - (d) Hammond Company



- (e) Unity Manufacturing
    - (f) Approved Equal
  - d. NEMA 4X All panels not otherwise Defined:
    - (i) Where an enclosure is not otherwise defined or shown on the drawing:
      - (a) NEMA 4X 316 Stainless Steel
      - (b) Type 316 stainless steel, body and door
      - (c) Stainless steel continuous hinge or concealed stainless steel hinges
      - (d) Foam in-place gasket or PORON AquaPro
      - (e) Single point quarter turn latches (20" x 24" and below). All others 3-point latch
    - (ii) Manufacturers:
      - (a) Hoffman Concept Series
      - (b) EMF Company
      - (c) NEMA Enclosures Company
      - (d) Hammond Company
      - (e) Unity Manufacturing
      - (f) Approved Equal
- 3. Environmental Controls:
  - a. Enclosure Condensate Heaters:
    - (i) A self-contained enclosure condensation heater with thermostat and fan shall be mounted inside the control panel, if panel is to be installed outdoors or in a non-air-conditioned space:
      - (a) Enclosure heaters shall be energized from 120 volt, single-phase power supply and sized to prevent condensation within the enclosure.
      - (b) Locate enclosure heaters to avoid overheating electronic hardware or producing large temperature fluctuations on the hardware.
      - (c) Enclosure heaters shall have an internal fan for heat distribution and shall be controlled with adjustable thermostats. The thermostat shall have an adjustment range of 40 degrees Fahrenheit to 90 degrees Fahrenheit. Provide a circuit breaker or fused disconnect switch within the enclosure.
      - (d) Enclosure heaters shall be Hoffman type DAH.
    - (ii) Strip heaters may be provided if they are 240 volt rated, powered at 120 volts AC and do not have a surface temperature higher than 60° C. Strip heaters and thermostats shall be as manufactured by Chromalox:

- (a) Strip heaters shall be Chromalox, Type OT, 1.5-in wide, 240 Volts, single phase, 150 watts, energized at 120 volts, with rust resisting iron sheath, Catalog No. OT-715, Product Code No. 129314. Provide sufficient wattage in heaters to prevent condensation should the interior temperature of the enclosure drop below the dew point.
  - (b) A control thermostat mounted inside the control Panel shall be Chromalox, Type WR, single stage, Catalog No. WR-80, Product Code No.263177
  - (c) The strip heater terminals shall be guarded by a protective terminal cover.
  - (d) High temperature connecting lead wire shall be used between the thermostat and the heater terminals. Wire shall be No. 12 AWG stranded nickel-plated copper with Teflon glass insulation and shall be the product of Chromalox, Catalog No. 6-CFI-12, and Product Code No. 263783.
- b. Enclosure Air Conditioner:
- (i) Enclosures containing electronic devices or electrical equipment to be installed outdoors or in a non-air conditioned space shall have air conditioners that will maintain the internal temperature at or below the equipment rating without violating the NEMA rating of the enclosure.
  - (ii) The panel builder shall provide panel internal heat rise calculations to show that the panel internal temperatures will be maintained below the maximum operating temperatures of the panel components:
    - (a) For enclosures mounted indoors in non-air-conditioned spaces, include an ambient air temperature of 40 degrees C and a humidity of 100% non-condensing.
    - (b) For enclosures mounted in direct sunlight add the appropriate solar heat gain component to the calculation, and raise the ambient temperature to 60 degrees C.
    - (c) The calculation shall show all the internal and external heat gain loads, the expected internal temperature rise in degrees C above the specified ambient without the air conditioner. Provide a calculation showing the expected temperature rise in degrees C above the specified ambient with the air conditioner running.
  - (iii) The air conditioner shall have the following features:
    - (a) Use CFC-free R134a refrigerant.
    - (b) Have fully gasket flanges on all four mounting edges for a watertight seal that maintains NEMA rating of the panel.
    - (c) Thermostatic low temperature control to provide energy efficient operation and prevents over-cooling.

- (d) EMI/RFI suppressor to minimize transient spikes during compressor on/off cycling
- (e) Separated blower-driven evaporator and condenser air systems for closed loop cooling
- (f) UL listed.
- (g) Stainless steel enclosure rated NEMA 4X.
- (h) Internal corrosion resistant coating and/or galvanized steel components
- (i) Low ambient kit
- (j) Short cycle protector
- (iv) Manufacturers:
  - (a) Rittal
  - (b) Cooper B-Line
  - (c) ICE Cube
  - (d) Approved Equal
- c. Corrosion Protection:
  - (i) Provide corrosion protection in each control panel with a Corrosion-Inhibiting vapor capsule as manufactured by Northern Instruments; Model Zerust VC, or Hoffman Engineering; Model A-HCI.

E. Panel Equipment

1. Equipment Requirements:
  - a. The requirements for equipment, controls, meters, converters, etc., for each Control Panel, shall be as shown on the Panel Schedule herein, the drawings, panel schematics, and the functions specified in the control narratives sections of the specifications.
  - b. Provide a main circuit protective device, DIN rail mounted, to protect the panel equipment with an external cable actuated lockable disconnected means.
2. Panel Control Device Requirements:
  - a. Control Devices and Indicators:
    - (i) All operating control devices, indicators, and instruments shall be securely mounted on the panel door. All controls and indicators shall be 30 mm, corrosion resistant, NEMA 4X/13, anodized aluminum or reinforced plastic. Booted control devices are not acceptable. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical and electrical equipment requirements.
    - (ii) Indicator lamps shall be LED type. For all control applications, indicator lamps shall incorporate a push-to-test feature. Lens colors shall be as follows:

- (a) Red for RUNNING, Valve OPENED, and Breaker CLOSED.
  - (b) Green for OFF, Valve CLOSED, and Breaker OPEN
  - (c) Amber for FAILED
  - (d) Blue for READY
  - (e) White for POWER ON
- (iii) Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, etc.) shall be as shown on the drawings. Units shall have the number of positions and contact arrangements, as required. Each switch shall have an extra dry contact for remote monitoring.
- (iv) Pushbuttons shall be as follows:
- (a) Red for RUNNING, Valve OPEN, Breaker CLOSE, and mushroom Red for EMERGENCY STOP
  - (b) Green for STOP, Valve CLOSE, and Breaker OPEN
  - (c) Black for RESET
- (v) Furnish nameplates for each device. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. Device mounted nameplates are not acceptable.
- b. A failure alarm with horn and beacon light shall be provided when required or specified. Silence and reset buttons shall be furnished. Alarm horn and beacon shall be by Federal Signal or Crouse-Hinds, NEMA 4X for all areas except for NEMA 7 areas, which shall be NEMA 7/4X cast aluminum.
- c. Control and Instrument Power Transformers:
- (i) Control power transformers shall be provided where shown on the drawings. Transformer shall be sized for the entire load, including space heaters, plus 25% spare capacity, and shall be not less than 100 VA.
  - (ii) Control power transformers shall be 120 volt grounded secondary. Primary side of the transformer shall be fused in both legs. One leg of the transformer secondary shall be solidly grounded while the other leg shall be fused.
3. Equipment Installation
- a. Equipment Mounting:
- (i) The location of the installed equipment shall be as shown on the Panel Layouts on the drawings.
  - (ii) Each piece of equipment shall be securely mounted to the back plate or side plate in accordance with the manufacturer's installation instructions. All mounting hardware shall be from the front of the back plate or side plate with threaded screws. Attaching hardware shall not be installed from the rear of the back plate or side plate. Removal of any piece of equipment shall not require the removal or loosening of any other piece of equipment.

- (iii) Operator interface equipment installed on the door shall be arranged as shown on the drawings in accordance with the manufacturer's installation instructions. No penetrations of the door shall be made except for equipment mounting. Provide adequate clearance between pieces of equipment and door latching mechanisms.
- b. Nameplates:
  - (i) External:
    - (a) Nameplates shall be engraved, laminated impact acrylic, matte finish, not less than 1/16-in thick by 3/4-in by 2-1/2-in, Rowmark 322402. Nameplates shall be 316 SS screw mounted to all enclosures except for NEMA 4 and 4X. Nameplates for NEMA 4 and 4X enclosures shall be attached with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X 1/2". Prior to installing the adhesive nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residues has been removed. Epoxy adhesive or foam tape is not acceptable:

There shall be a master nameplate that indicates supply voltage equipment ratings, short circuit current rating, manufacturer's name, shop order number and general information. Cubicle nameplates shall be mounted on the front face, on the rear panel and inside the assembly, visible when the rear panel is removed.

Provide permanent warning signs as follows:

"Danger- High Voltage- Keep Out" on all doors where any voltage over 125 volts AC is present.

"Warning- Hazard of Electric Shock - Disconnect Power Before Opening or Working On This Unit" on main power disconnect or disconnects.
  - (ii) Internal:
    - (a) Provide the panel with a UL 508A label.
    - (b) Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification, corresponding to appropriate designations on the submitted and reviewed wiring diagrams.
  - (iii) Special:
    - (a) Identification nameplates shall be white with black letters, caution nameplates shall be yellow with black letters, and warning nameplates shall be red with white letters.
- c. Wiring Trough and Terminal Block Installation:
  - (i) Space between wiring troughs and equipment shall be such that space for terminal blocks is provided for termination of each conductor or group of

conductors before connection to the equipment. Removal of equipment for service shall not leave any exposed conductors hanging unconnected.

- (ii) Install the wiring troughs such that one may be removed without interference from the other. Troughs shall be installed such that trough covers may be removed without cover interference.
  - (iii) Install terminal blocks on DIN rail with adequate space for access to the terminal with clear view of the wire identification label. All incoming or outgoing wiring shall enter or leave the panel on terminal blocks. Terminal blocks or wiring troughs shall not be installed on the doors. Provide terminal blocks on side plates and back plates for all door mounted equipment.
  - (iv) In no case shall internal and external wiring share a wiring trough.
  - (v) Provide 600 volt rated terminal blocks for any conductor carrying any voltage over 120 volts to ground.
  - (vi) Provide 600 volt rated strap screw terminal blocks for any power conductors carrying over 20 amps, at any voltage. Terminals shall be double sided and supplied with removable covers to prevent accidental contact with live circuits.
  - (vii) Power conductors carrying over 20 amps, at any voltage shall be terminated to strap-screw type terminal blocks with crimp type, pre-insulated, ring-tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated. Do not terminate more than one conductor in any lug, and do not land more than two conductors under any strap- screw terminal point.
  - (viii) Terminals shall have permanent, legible identification, clearly visible with the protective cover removed. Each terminal block shall have 20 percent spare terminals, but not less than two spare terminals.
  - (ix) Do not land more than two conductors per terminal point. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating common or ground conductors.
  - (x) Twisted shielded pair or triad cables shall have each individual conductor and shield drain wire landed on individual terminal blocks. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating the shield drain wire conductors.
  - (xi) Provide an AC ground bar bonded to the panel enclosure, if metal, with 20 percent spare terminals.
  - (xii) Provided ground terminal blocks for each twisted-shielded pair drain wire.
- d. Internal Panel Wiring:
- (i) Power and control wiring shall be tinned stranded copper, minimum size No. 14 AWG, with 600 volt, 90-degree C, flame retardant, Type MTW thermoplastic insulation. Line side power wiring shall be sized for the full

fault current rating or frame size of the connected device, and as shown on the drawings.

- (ii) Analog signal wires shall be 600 Volt Class, insulated stranded tinned copper, twisted shielded #16 AWG pair.
  - (iii) All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks. Field wiring shall not be terminated directly on any panel-mounted device.
  - (iv) All wiring shall be tagged and coded with an identification number as shown on the drawings. Coding shall be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire. The marking shall be permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE.
  - (v) All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover. Plan wire routing such that no twisted shielded pair cable conducting analog 4-20 mA signals or low voltage analog signals are routed in the same wire trough as conductors carrying discrete signals or power.
  - (vi) Control panel wire color code shall be as follows:
    - (a) Black: AC power at line voltage
    - (b) Red: switched AC power
    - (c) Orange: May be energized while the main disconnect is in the off position
    - (d) White: AC neutral
    - (e) Orange/white stripe or white/orange stripe: separate derived neutral
    - (f) Red/white stripe or white/red stripe: switched neutral
    - (g) Green or green w/ yellow tracer: ground/earth ground
    - (h) Blue: Ungrounded DC power
    - (i) Blue/white stripe or white/blue stripe: DC grounded common
    - (j) Brown: 480 V AC 3 phase - phase A
    - (k) Orange: 480 V AC 3 phase - phase B
    - (l) Yellow: 480 V AC 3 Phase - phase C
    - (m) Purple: common for analog signal wiring
    - (n) Brown: positive leg of an analog signal
- e. Field Entrance Internal Wiring:
- (i) Field entrance internal wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit

terminations are not stressed. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.

(ii) All field wiring shall be tagged and coded with an identification number. Coding shall be typed on a heat shrinkable tube applied to each end of the wire. The marking shall be a permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE.

(iii) All conduit entering or leaving equipment shall be coordinated, in advance with the panel installer, so that the conduit entrances to the enclosure are directly below the termination area for immediate termination. Conduits shall not enter the top or side of the panel unless approved in writing by the Owner and Engineer.

f. Fusing of PLC Inputs and Outputs:

(i) All PLC analog inputs and outputs shall be individually fused for each channel. All discrete inputs and outputs shall be buffered with relays from the field connections. Discrete points shall be fused for each circuit group with no less than one fuse per PLC I/O card.

## **2.04 PANEL MOUNTED CONTROL DEVICES**

### **A. Mode Selector Switches, Pushbuttons and Indicating Lamps**

1. Subject to compliance with the contract documents, the following manufacturers are acceptable:
  - a. Rockwell Automation Allen Bradley
  - b. Eaton Cutler Hammer
  - c. General Electric
  - d. Schneider Electric Square D
  - e. Approved Equal
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
3. Construction:
  - a. 30 mm Diameter
  - b. Corrosion resistant
  - c. NEMA 4/4X/13 without booted covers
  - d. "Finger safe" contact blocks, 10A rating
  - e. Function indicating colors per NFPA 79 unless otherwise shown on the drawings
  - f. Engraved corrosion resistant nameplates
  - g. LED lamps



- h. Mode selector switches shall have 1 spare set auxiliary contacts
- i. Indicator lights to be Push-to-Test
- j. Potentiometer ratings to match I/O devices connected

B. Terminal Blocks:

1. Subject to compliance with the contract documents, the following manufacturers are acceptable:
  - a. Phoenix Contact
  - b. Entelec
  - c. Weidmuller
  - d. Rockwell Automation Allen Bradley
  - e. Approved Equal
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
3. Terminal Blocks:
  - a. Terminal blocks shall be DIN-rail-mounted one-piece molded plastic blocks with tubular-clamp-screw type, with end barriers, dual side terminal block numbers and terminal group identifiers. Terminal blocks shall be rated for 600 volts except for control and instrumentation circuits, or 4-20 mA analog signal conductors.
  - b. Provide 600 volt rated terminal blocks for any conductor carrying any voltage over 120 volts to ground.
  - c. Provide 600 volt rated strap screw terminal blocks for any power conductors carrying over 20 amps, at any voltage. Terminals shall be double sided and supplied with removable covers to prevent accidental contact with live circuits.
  - d. Power conductors carrying over 20 amps, at any voltage shall be terminated to strap-screw type terminal blocks with crimp type, pre-insulated, ring-tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated. Do not terminate more than one conductor in any lug, and do not land more than two conductors under any strap-screw terminal point.
  - e. Terminals shall have permanent, legible identification, clearly visible with the protective cover removed. Each terminal block shall have 20 percent spare terminals, but not less than two spare terminals.
  - f. Do not land more than two conductors per terminal point. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating common or ground conductors.
  - g. Twisted shielded pair or triad cables shall have each individual conductor and shield drain wire landed on individual terminal blocks. Use the manufacturer's

provided bridge connectors to interconnect terminal blocks terminating the shield drain wire conductors.

- h. Control circuits, 120 volts and below, and 4-20 mA analog signal conductors shall be terminated with manufacturer's recommended ferrules. Ferrules shall be provided with plastic sleeves.
- i. Provide an AC ground bar bonded to the panel enclosure, if metal, with 20 percent spare terminals.
- j. Provided ground terminal blocks for each twisted-shielded pair drain wire.

C. Wire Troughs:

- 1. Subject to compliance with the contract documents, the following manufacturers are acceptable:
  - a. Panduit
  - b. Taylor
  - c. Approved Equal
- 2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

D. Din Rails:

- 1. Subject to compliance with the contract documents, the following manufacturers are acceptable:
  - a. Phoenix Contact
  - b. Entrelec
  - c. Weidmuller
  - d. Approved Equal
- 2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

E. Signal Isolators, Boosters, Converters

- 1. Subject to compliance with the contract documents, the following manufacturers are acceptable:
  - a. Phoenix Contact
  - b. Acromag Inc.
  - c. Moore Industries
  - d. Approved Equal

2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety:
  3. Type:
    - a. Externally powered solid state electronic type/ Loop powered devices are not acceptable.
  4. Functional/Performance:
    - a. Accuracy: 0.15 percent
    - b. Inputs: Current, voltage, frequency, temperature, or resistance as required
    - c. Outputs: Current or voltage as required
    - d. Isolation: There shall be complete isolation between input circuitry, output circuitry, and the power supply
    - e. Adjustments: Zero and span adjustment shall be provided
    - f. Protection: Provide RFI protection
    - g. 24 VDC power input
  5. Physical:
    - a. Mounting Suitable for DIN Rail mounting in an enclosure or instrument rack
  6. Options/Accessories Required:
    - a. Mounting rack or general purpose enclosure as required.
- F. Potentiometer / RTD Transmitters
1. Subject to compliance with the contract documents, the following manufacturers are acceptable:
    - a. Phoenix Contact
    - b. Moore Industries
    - c. Approved Equal
  2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
  3. Design and fabrication:
    - a. Solid state electronics
    - b. Transmit analog signal directly proportional to measured impedance input.
    - c. Power source: 24 VDC.
    - d. Input: 0-1000 ohms.
    - e. Output signal: 4-20 mA DC.

- f. Accuracy (maximum error):  $\pm 0.25$  percent.
- g. Ambient temperature range: 0-140 Degrees F.

#### G. Panel Displays

1. Subject to compliance with the contract documents, the following manufacturers are acceptable:
  - a. Precision Digital
  - b. Red Lion
  - c. Moore Industries
  - d. Approved Equal
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
3. Design and fabrication:
  - a. Input: analog 4-20 mA
  - b. Rating: NEMA 4X, IP65
  - c. Shallow Depth Case 3.6" Behind Panel
  - d. Power Supply: 24 VDC or 120 VAC as shown on drawings
4. Optional features to be supplied: Four separate contacts
  - a. Output: analog 4-20 mA
  - b. Display: minimum digit height of 1"; sunlight readable

#### H. Relays and Timers

1. Subject to compliance with the contract documents, the following manufacturers are acceptable:
  - a. Schneider Electric Square D
  - b. IDEC
  - c. Potter-Broomfield
  - d. Rockwell Automation Allen-Bradley
  - e. Approved Equal
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
3. Type:
  - a. Relays shall be double pole, double throw (form C) type, except for PLC I/O buffer relays, which shall be single pole, double throw (form C) type; and shall be

the spade plug in style with a transparent dust cover included. The relays shall be equipped with an indicating light to indicate when its coil is energized.

- b. Units shall be the general purpose plug-in type.
4. Functional/Performance:
- a. Coil voltage shall match supply voltage.
  - b. Contact arrangement/function shall be as required to meet the specified control function.
  - c. Mechanical life expectancy shall be in excess of 10,000,000 cycles.
  - d. Duty cycle shall be rated for continuous operation.
  - e. Units shall be provided with integral indicating light to indicate if relay is energized.
  - f. Solid state time delays shall be provided with polarity protection (DC units) and transient protection.
  - g. Time delay units shall be adjustable and available in ranges from .1 second to 4.5 hours.
  - h. Plug-in general purpose relay.
  - i. Blade connector type
  - j. Contact material: Silver cadmium oxide
  - k. Relay sockets are DIN rail mounted
  - l. Internal neon or LED indicator is lit when coil is energized
  - m. Clear polycarbonate dust cover with clip fastener
  - n. Operating temperature: -20 to +150 Degrees F
  - o. UL listed or recognized
5. Ratings:
- a. For 120 VAC service provide contacts rated 10 amps at 120 VAC, for 24 VDC service provide contacts rated 5 amps at 28 VDC, for electronic (milliamp/millivolt) switching applicator provide gold plated contacts rated for electronic service.
  - b. Relays shall be provided with dust and moisture resistant covers.
6. Physical:
- a. DIN Rail mounting base
  - b. Screw Terminals
7. Options/Accessories Required:

- a. Provide mounting sockets with pressure type terminal blocks rated 300 volt and 10 amps.
- b. Provide mounting rails/holders as required.

I. Analog Signal Surge Protective Devices

1. Subject to compliance with the contract documents, the following manufacturers are acceptable:
  - a. AGM Electronics
  - b. Acromag Inc.
  - c. Moore Industries
  - d. Phoenix Contact
  - e. EDCO
  - f. Approved Equal
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
3. Type:
  - a. For devices to be located in control or termination panels, provide DIN Rail mountable type
  - b. For devices to be mounted at loop-powered transmitters, provide pipe mountable type

J. Power Supplies

1. Subject to compliance with the contract documents, the following manufacturers are acceptable:
  - a. PULS Silverline
  - b. Phoenix Contact
  - c. Sola
  - d. Approved Equal
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
3. Design and fabrication:
  - a. Converts 120 VAC input to DC power at required voltage.
  - b. Sized as required by the load/ Minimum 2.4 A output
  - c. AC input: 120 VAC +10 percent -13 percent; 47 to 63 HZ
  - d. Provision for output failure alarm contact

- e. DIN rail mountable
  - f. All power supplies shall be furnished in redundant pairs
- K. Surge Protective Devices (SPD) (Spd UI 1449 Type 3)
1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable (Type 3):
    - a. EDCO SLAC Series
    - b. Phoenix Contact
    - c. Brick Wall Model PWOM20
    - d. Approved Equal
  2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
  3. Construction of Type 3.SPD
    - a. Fully Integrated Component Design: All of the SPDs components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality will not be accepted.
    - b. Maintenance Free Design: The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries are not acceptable. SPDs requiring any maintenance of any sort such as periodic tightening of connections are not acceptable.
    - c. Electrical Noise Filter: Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method.
    - d. Internal Connections: No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
    - e. Power and ground connections shall be prewired within the protected equipment.
    - f. Local Monitoring: Visible indication of proper SPD connection and operation shall be provided. The indicator light shall indicate that the module is fully operable. The status of each SPD module shall be monitored on the front cover of the module.
    - g. SPD shall be listed in accordance with UL 1449 Third Edition and UL 1283, Electromagnetic Interference Filters.
    - h. SPD shall be tested with the ANSI/IEEE Category C High exposure waveform (20 kV-1.2/50  $\mu$ s, 10 kA-8/20  $\mu$ s).
  4. Individual Control Panel and Related Equipment Protection (Type 3) Installation

- a. Locate the SPD on the load side of the ground and neutral connections.
- b. The SPD shall be connected through a disconnect circuit breaker or fuse as shown on the drawings. The disconnection means shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
- c. All monitoring and diagnostic features shall be visible from the front of the equipment.

L. Panel Interface Connector (PIC)

- 1. Subject to compliance with the contract documents, the following manufacturers are acceptable:
  - a. Automation Direct
    - (i) Model: Zip Port Series
  - b. Grace Engineered Products, Inc.
    - (i) Model: GracePort Series
- 2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- 3. For all PLC control panels, provide a Panel Interface Connector (PIC) pass-through unit to be mounted to the exterior of the control panel to give the capability to interface with the PLC without the need to open the enclosure door.
- 4. Design and fabrication:
  - a. Interface shall include the following:
  - b. UL Recognized and RoHS compliant
  - c. Housing rating shall match or be of higher NEMA rating than control panel
  - d. Gasket: thermo-plastic (TPE)
  - e. One GFCI power outlet with rating of 120 VAC
  - f. One Ethernet RJ-45 type 10/100 port connected to control panel switch.
  - g. Cover shall be attached with a continuous hinge and lockable.
  - h. Provide locks for all interfaces keyed alike.

M. Nameplates

- 1. Furnish nameplates for each device as indicated in drawings. Nameplates shall be engraved, laminated impact acrylic, matte finish, black lettering on a white background, not less than 1/16-in thick by 1/2-in by 1-1/2-in, Rowmark 322402. Nameplates shall be attached to the back plate with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X 1/2". Prior to installing the nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residues has been removed. Epoxy adhesive or foam tape is not acceptable.



## 2.05 PROGRAMMABLE LOGIC CONTROLLER (PLC)

### A. Programmable Logic Controller System

1. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
  - a. Rockwell Automation CompactLogix Series using Studio 5000 ENU software
  - b. No others Approved
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
3. Programming Languages
  - a. Each PLC shall support IEC Standard 61131-3 including the following programming languages:
    - (i) Ladder (LD)
    - (ii) Function Block Diagram (FBD)
    - (iii) Sequential Functional Chart (SFC)
    - (iv) Structured Text (ST)
    - (v) Instruction List (IL)
  - b. Provide one (1) copy of the manufacturer's programming software for this class of PLC, with the highest-level capability, fully licensed in the Owner's name. Request Owner's contact information during the first PCSI construction meeting.
  - c. PLC shall support user defined functions for customization and user defined tag structures
  - d. PLC shall have application-specific instructions for process, drive, batch, motion and safety applications built into the controller.
4. Central Processor Unit
  - a. Field PLC processors shall be Allen Bradley 1769-L30ER.
  - b. Provide hardware employing identical revisions of software and firmware as applicable.
5. Physical Construction (Rack)
  - a. The PLC shall be of modular construction, consisting of a back plane, plug in modules for the processor, communications modules, I/O modules and expansion modules.
  - b. Provide appropriate PLC I/O end cap / terminators as required.
  - c. Provide Allen Bradley blank filler modules in empty rack slots as required.
  - d. Provide the ability to monitor and override I/O.

- e. Provide I/O modules in the base bid.
  - f. Provide the ability to preselect the failure mode of each output point in the event of CPU failure.
  - g. I/O modules shall support wiring interface devices that allow the removal and reinstallation of I/O modules without removing wires from terminals. All required wiring interface devices shall be included in the bid.
6. Power Supply (PS)
- a. The Field PLC power supply shall be 120 Volt 60 Hz, and shall be Allen Bradley 1769- PA4. Provide additional power supplies as required for specific I/O requirements.
7. Analog Input and Output Modules (AI and AO)
- a. Field PLC
    - (i) Analog Input Modules shall be Allen Bradley 1769 CompactLogix 8 Channel Analog Input Modules 1769-IF8 (Current).
      - (a) Provide Allen Bradley Bulletin 1492 wiring system pre-wired cables and Interface Modules (IFMs) appropriate for the 1769-IF8 module.
    - (ii) Analog Output Modules shall be Allen Bradley 1769 CompactLogix 8 Channel Analog Output Modules 1769-OF8 (Current).
      - (a) Provide Allen Bradley Bulletin 1492 wiring system pre-wired cables and Interface Modules (IFMs) appropriate for 1769-OF8 module.
8. Discrete Input Modules (DI)
- a. Field PLC
    - (i) Discrete inputs shall be Allen Bradley 1769 Compact 32 Channel Digital DC Input Model 1769-IQ32.
      - (a) Provide Allen Bradley Bulletin 1492 wiring system pre-wired cables and Interface Modules (IFMs) appropriate for the 1769-IQ32 module. Interface module should be supplied with integral channel status LEDs.
9. Discrete Output Modules (DO)
- a. Field PLC
    - (i) Discrete outputs shall be Allen Bradley 1769 Compact 32 Channel Digital DC Output module 1769-OB32.
      - (a) Provide Allen Bradley Bulletin 1492 wiring system pre-wired cables and Interface Modules (IFMs) appropriate for the 1769-OB32 module. Interface module should be supplied with integral channel status LEDs.
10. Communications Modules

- a. All PLCs shall include an integral Ethernet interface or a communications adapter module with at least one Ethernet interface port. Ethernet interface ports shall accept a standard Ethernet patch cable via RJ-45 connector.

11. Active Spare Requirement

- a. Provide a minimum of 20 percent wired spare I/O channels of each type furnished. All I/O points provided shall be wired to DIN rail mounted terminals.

**2.06 OPERATOR INTERFACE TERMINAL (OIT)**

A. Operator Interface Terminal

1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
  - a. Rockwell Automation/Allen Bradley PanelView 5500 Touchscreen with Keypad and Studio 5000 software
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
3. Environmental
  - a. Operating Temperature 32 – 113 Degrees F
  - b. Relative Humidity 10% - 90% Non-condensing
  - c. Shock (Operating) 15 G for 11 ms.
  - d. NEMA 4
4. Physical
  - a. Sizes 15 “
  - b. ColorTFT LCD Touch screen and keypad
  - c. Cooling fans as required
  - d. Embedded Operating System
  - e. Two serial and USB ports
  - f. Minimum 64 MB of battery backed memory
  - g. Programmable keys as required.
  - h. Power Supply 120 VAC
5. Protocol Interfaces
  - a. Rockwell Automation Ethernet/IP
  - b. Modbus TCP
  - c. Allen Bradley DF1
  - d. Modbus RTU

6. Programming Capability
  - a. Provide Manufacturer's software package for programming the OIT.
  - b. Alarm and event management.
  - c. Bar graphs.
  - d. Multi colored background and objects.
  - e. Multi-level password security.

## **2.07 UNINTERRUPTABLE POWER SUPPLY (UPS)**

### **A. General Requirements**

1. External Battery Enclosure: A separate enclosure shall be provided for housing the additional batteries required to provide the minimum run time as specified. The battery enclosure shall match the main UPS enclosure in style and color.
2. All cabling required to interconnect all components of the UPS system (including but not limited to the maintenance bypass, external battery enclosure, etc) shall be provided by the UPS manufacturer.
3. Battery protection shall be provided an internal circuit breaker disconnect. Battery cabinets shall be protected by an internal circuit breaker.
4. Current limiting circuitry shall protect the inverter output under any load condition. High speed semiconductor fusing shall protect the static bypass in the event of an output short circuit.
5. The AC output neutral shall be electrically isolated from the UPS chassis. The UPS chassis shall have an equipment ground terminal. Provisions for installation of a bonding connector shall be provided.
6. The UPS shall be suitable for installation at the location as shown on the Drawings.

### **B. Performance Requirements**

1. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
  - a. APS Online Smart UPS Series
2. Ratings
  - a. Output power: 120 VAC
  - b. Battery runtime: 2 hours at constant load.
3. The UPS shall comply with the following requirements:
  - a. Environment:
  - b. Ambient temperature: 0 to 40° C.
  - c. Elevation: Up to 500-ft above mean sea level

- d. Relative humidity: 0 to 95 percent non-condensing
4. System Input – Primary source:
    - a. Single input: 120 VAC
    - b. Frequency: 60 Hertz plus or minus 5 percent.
    - c. Input Power Factor: 0.96 lag minimum, 50 to 100 percent load.
    - d. Input Current Total Harmonic Distortion (THD): <33 percent.
    - e. Input Surge Withstand Rating: Per IEEE 587/ANSI C62.41. Category A and B, (6 kV)
  5. System Output:
    - a. 120 VAC
    - b. Frequency: 60 Hertz plus or minus 3 Hertz.
    - c. 100 percent load with 3:1 Crest Ratio
    - d. Frequency Slew Rate: 1 Hz/second. (Adjustable at startup)
    - e. AC to AC Efficiency: (100 percent load @ rated PF): 91 percent
  6. Acoustical Noise: Noise generated by the UPS under normal operation shall not exceed 65 dBA (60 dBA typical) at one meter from any surface, measured at 25 degrees C (77 degrees F) and full load.
  7. EMI Suppression: The UPS shall meet FCC Rules and Regulation 47, Part 15, Subpart J, for Class A devices.
- C. Modes of Operation
1. The UPS shall operate as a double conversion on-line, fully automatic system in the following modes:
    - a. Normal: The critical load shall be continuously supplied with filtered and regulated AC power by the inverter. The rectifier/battery chargers shall derive power from the preferred AC source and supply DC power to the inverter while simultaneously floats charging the batteries.
    - b. Emergency: Upon failure of the preferred AC power source, the critical load shall continue to be supplied by the inverter. Inverter power shall be supplied without switching from the storage battery. There shall be no interruption to the critical load upon failure or restoration of the preferred AC sources. If neither AC source can be restored before the battery discharges to its low voltage dropout value, the UPS shall automatically shut itself down in an orderly manner.
    - c. Recharge: Upon restoration of the preferred AC source, the rectifier/battery charger shall power the inverter and simultaneously recharges the batteries. This shall be an automatic function causing no interruption to the critical load.

- d. Bypass Mode: The automatic bypass shall transfer the critical load to the commercial AC source, bypassing the UPS' inverter/rectifier, in the case of an overload, load fault, or internal failure.
- e. Maintenance Mode: If the UPS is taken out of service for maintenance or repair, the external manual bypass switch shall be operated to transfer the load to the alternate source. This transfer shall occur without interruption.
- f. Downgrade: If the batteries alone are taken out of service, they shall be disconnected by battery circuit breakers. The UPS shall continue to function and meet all the performance criteria specified herein, except for the reserve time capability.

D. Rectifier/Charger

- 1. The term rectifier/charger shall denote the solid-state equipment and controls necessary to convert incoming AC power to regulated DC power for input to the inverter and for battery charging. The rectifier/charger shall be a solid-state SCR/IGBT power transistor type with constant voltage/current limiting control circuitry.

E. Inverter

- 1. The inverter shall include all solid-state equipment and controls to convert DC power from the rectifier/charger or battery to a regulated AC power for powering the critical load. The inverter shall use Insulated Gate Bipolar Transistors (IGBTs) in a phase-controlled, pulse width modulated (PWM) design capable of providing the specified AC output.
- 2. The inverter shall be capable of supplying current and voltage for overloads exceeding 100 percent. The inverter is to provide 150 percent of full load for 30 seconds and 125 percent of full load for 2 minutes. A status indicator and audible alarm shall indicate overload operation. The UPS shall transfer the load to bypass when overload capacity is exceeded.
- 3. The output voltage shall be maintained to within plus or minus 4 percent.
- 4. The output voltage total harmonic distortion shall not be greater than 5 percent for all loads. For 100 percent rated load of 3:1 crest factor nonlinear loads, the output voltage total harmonic distortion shall not be greater than 4 percent. The output rating shall not be derated in kVA or kW due to the 100 percent nonlinear load with 3:1 crest factor.
- 5. The inverter shall use software control to adjust the output voltage from plus or minus 5 percent of the nominal value.

F. Batteries

- 1. The batteries shall be VRLA (valve-regulated lead-acid), sealed, maintenance-free, high- rate discharge, lead-acid cells suitable for use indoors with no off gassing, water addition requirements. Batteries shall not require special ventilation. The battery shall consist of one or more battery banks with the number of cells required to meet the requirements of the rest of these specifications.
- 2. Battery Design Life: 5 years.

3. Run time operation of the UPS shall be accomplished using batteries mounted within the UPS enclosure and supplemented as required with an external battery enclosure to provide the battery runtime specified.

#### G. Static Transfer Switch

1. A static transfer switch and bypass circuit shall be provided as an integral part of the UPS. The static switch shall be a naturally commutated high-speed static (SCR-type) device rated to conduct full load current continuously. The switch shall have an overload rating adequate to clear a 20-ampere load branch circuit breaker.
2. The static transfer switch control logic shall contain an automatic transfer control circuit that senses the status of the inverter logic signals and operating and alarm conditions. This control circuit shall provide an uninterrupted transfer of the load to an alternate bypass source, without exceeding the transient limits specified herein, when an overload or malfunction occurs within the UPS, or for bypassing the UPS for maintenance.
3. The transfer control logic shall automatically turn on the static transfer switch, transferring the critical AC load to the bypass source, after the transfer logic senses any of the following conditions:
  - a. Inverter overload
  - b. Critical AC load over voltage or under voltage
  - c. Battery protection period expired
  - d. UPS fault condition
4. The transfer control logic shall inhibit an automatic transfer of the critical load to the bypass source if any of the following conditions are present:
  - a. Inverter/bypass voltage difference exceeding preset limits
  - b. Bypass frequency out of limits
  - c. Bypass out-of-synchronization range with inverter output
5. Retransfer of the critical AC load from the bypass source to the inverter output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter if one of the following conditions exists:
  - a. Bypass out of synchronization range with inverter output
  - b. Inverter/bypass voltage difference exceeding preset limits
  - c. Overload condition exists in excess of inverter full load rating
  - d. UPS fault condition present

#### H. Maintenance Bypass

1. Internal Maintenance Bypass Switch

- a. A manually operated make-before-break maintenance bypass switch shall be incorporated into the UPS cabinet to directly connect the critical load to the bypass AC input power source, bypassing the rectifier/charger, inverter, and static transfer switch.
- b. All energized terminals shall be shielded to ensure that maintenance personnel do not inadvertently come in contact with energized parts or terminals. A means to de-energize the static switch shall be provided when the UPS is in the maintenance bypass mode of operation.
- c. With the critical load powered from the maintenance bypass circuit, it shall be possible to check out the operation of the rectifier/charger, inverter, battery, and static transfer switch.

2. External Maintenance Bypass Switch

- a. A matching external make-before-break maintenance bypass switch installed in a separate cabinet shall be provided to enable the UPS module to be completely isolated from the electrical system while the critical load is powered through the external maintenance bypass line.
- b. This maintenance bypass switch shall provide make-before-break operation for transfers to and from the external maintenance bypass line with a single rotary switch.
- c. The following components shall be included: input and output circuit breakers, single rotary switch with auxiliary contacts, inter-cabinet wiring, casters, and leveling feet. Voltage matching transformers and isolation transformers shall be included as required for proper system operation.
- d. This matching cabinet shall bolt to the side of the UPS module with a barrier shield to separate the two cabinets. Only front access shall be required for installation and service.

I. Monitoring and Control

- 1. Microprocessor-controlled circuitry: Fully automatic operation of the UPS shall be provided through the use of a microprocessor-based controller. All operating and protection parameters shall be firmware-controlled. The logic shall include system test capability to facilitate maintenance and troubleshooting. Startup, battery charging, and transfers shall be automatic functions. The UPS shall be capable of being programmed for auto-restart.
- 2. Graphical Display: The UPS control panel shall utilize an LCD graphical display for all UPS control, monitoring, alarming, configuration and diagnostic functions. The graphical display shall have the following features:
  - a. System mimic diagram with an outlined power path and current operating mode.
  - b. Menu driven display with pushbutton or soft key navigation
  - c. Real time clock display (time and date)



- d. Alarm history display (with time and date stamp) for displaying a historical log of the latest 500 system events
  - e. Configuration, setup and system information: Display serial communication port configuration, firmware revision and other system setup and statistic information.
3. Controls: As a minimum, the following operational controls and indicators shall be provided on the UPS control panel:
- a. UPS On/Off control
  - b. Emergency Power Off control
  - c. Alarm reset control
  - d. Battery in operation status
  - e. Rectifier / charger in operation status
  - f. Load on Inverter status
  - g. Load on By-Pass status
  - h. UPS malfunction alarm
4. Metering: The following parameters shall be provided with 1 percent minimum accuracy metering on the UPS control panel:
- a. AC input voltage (line to line)
  - b. AC input current (each phase)
  - c. AC input power (kW, kVA and power factor)
  - d. DC battery voltage
  - e. Battery current (charge and discharge)
  - f. AC output voltage (line to line and line to neutral)
  - g. AC output current (each phase)
  - h. AC output frequency
  - i. AC output power (kW, kVA and power factor)
5. Diagnostic Alarms: Specific details for all UPS alarms and status parameters shall be indicated on the graphical panel for diagnosis. As a minimum, the following parameters shall be provided in user friendly text format:
- a. Input power out of tolerance
  - b. Battery charger problem
  - c. Battery failed test
  - d. Low battery warning
  - e. Low battery shutdown
  - f. DC bus over voltage

- g. Bypass frequency out of range
  - h. Load transferred to bypass
  - i. Excessive retransfers
  - j. Static bypass switch failure
  - k. UPS output not synchronized to bypass power
  - l. Output under voltage
  - m. Output over voltage
  - n. Output over current
  - o. System overload
  - p. Over temperature
  - q. AC input current (each phase)
  - r. External shutdown control activated
6. Remote alarm and status indication:
- a. Individual contacts shall be provided on the external service bypass panel for separate annunciation of the following alarm and status conditions as shown in the drawings:
    - (i) Loss of Incoming Power
    - (ii) On Bypass
    - (iii) UPS on Battery
    - (iv) UPS Alarm
- J. Battery Runtime/Health Monitoring
- 1. Battery Runtime Monitoring: UPS shall monitor battery and provide status to end user of battery run time via front panel, serial communications, or both. Run time calculation to be based on load demand and analysis of battery health.
  - 2. Battery Health Monitoring: UPS shall continuously monitor battery health and the UPS will provide warnings visually, audibly and/or via serial communications when battery capacity falls below 80% of original capacity. Battery testing may also be user-initiated via the front panel or serial communications.
- K. Factory Testing
- 1. Prior to shipment, the complete UPS system shall undergo the manufacturer's standard factory test.
  - 2. Certified factory tests shall be submitted for review and approval before shipment. Certified tests shall include the UPS equipment serial number.

## **2.08 PROCESS INSTRUMENT SUPPORT HARDWARE**

### **A. Anchoring Systems**

1. Acceptable Manufacturers
    - a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
    - b. Hilti Kwik Bolt 3
    - c. Approved Equal
    - d. 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. Product Description
    - a. Torque controlled expansion anchor consisting of anchor body, expansion element (wedges), washer and nut. Anchor shall be used for anchor sizes less than 3/8 inch.
    - b. All parts and materials shall be manufactured of 316 stainless steel and conform to SAE 316 standards.
    - c. UL 203 Rated.
- B. Adhesive Anchoring Systems
1. Acceptable Manufacturers
    - a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
      - (i) Hilti HIT-RTZ with HIT-HY 150 MAX
      - (ii) Approved Equal
    - 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. Product Description

- a. Anchor body with helical cone shaped thread on the embedded end and standard threads on the exposed end, with washer and nut, inserted into Injection adhesive. Anchor shall be used for anchor sizes 3/8 inch and larger.
- b. All parts and material shall be manufactured of 316 Stainless Steel and shall conform to SAE 316 standards.

C. Strut Support Systems

1. Acceptable Manufacturers

- a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
  - (i) Tyco Unistrut
  - (ii) Cooper B-Line
  - (iii) Approved Equal
- 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. Product Description

- c. Metal framing system for use in the mounting or support of electrical systems, panels and enclosures, and including lighting fixture supports, trapeze hangers and conduit supports.
- d. Components shall consist of telescoping channels, slotted back-to-back channels, end clamps all threads and conduit clamps.
- e. Minimum sizes shall be 13/16" through 3-1/4"
- f. Components shall be assembled by means of flat plate fittings, 90 degree angle fittings, braces, clevis fittings, U-fittings, Z-fittings, Wing-fittings, Post Bases, channel nuts, washers, etc.
- g. Field welding of components will not be permitted.
- h. Unless otherwise specified or shown on the Drawings, all parts shall be manufactured of 316 stainless steel and conform to SAE 316 standards.
- i. Framing systems for chlorine and ammonia rooms shall be manufactured of structural fiberglass.

D. Instrument Pipe Stand

1. Acceptable Manufacturers

- a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
  - (i) O'Brien Saddlepak
  - (ii) Approved Equal

- 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. Product Description

- a. Floor mount pipe stand for use in the mounting or support of Instrumentation Transmitters.
- b. Stand shall consist of a 10 by 10-inch base plate of 1/4 inch steel with a minimum 40 inch long 2 inch steel tube center welded with a minimum of two 8 inch long gussets fully welded for maximum strength. The base plate shall have slotted mounting holes near all four corners.
- c. The stand shall be fully zinc metallized or hot dip galvanize coated.
- d. Field welding of components will not be permitted.

E. Instrument Sunshield

1. Acceptable Manufacturers

- a. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
  - (i) International Metal Engineering
  - (ii) Approved Equal
- 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. Product Description

- a. Pipe stand or structure mounted sunshield for use in the protection of instrument(s) from direct sunlight.
- b. Sunshield shall consist of a minimum 10-inch overhang with a clear view of the instrument display and working space for service of the instrumentation without removal. The sunshield shall be made of stainless steel unless shown otherwise on the drawings. All mounting hardware shall be fabricated of 316 stainless steel. Include hinged display shield as shown in the Drawings.
- c. All edges of all metal steel sunshields shall be ground smooth without burrs or sharp edges.

**2.09 NETWORK AND COMMUNICATION EQUIPMENT**

A. Industrial Ethernet Media Converter

- 1. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
  - a. B & B Electronics

2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
  3. Environmental
    - a. Operating temperature: 32° F to 104° F
    - b. Operating humidity: 20 – 95% Non-condensing
    - c. Storage Temperature: -40° F to 158° F
  4. Physical
    - a. Power Supply: 24 VDC
    - b. Microprocessor based managed type.
    - c. DIN Rail mountable.
  5. Functional Performance
    - a. Per Port status LED indication
    - b. Wire Speed switching.
    - c. 10/100BaseT ports with RJ-45 connectors for Category 6 cabling; provide with PoE as shown on the drawings.
    - d. ST or SC type Fiber Optic Connectors for 100BaseFX, 1000BaseSX for Multimode Fiber and 1000BaseLX for Single Mode fiber as shown on the drawings.
  6. Options and Accessories Required:
    - a. Provide minimum 3 year warranty.
- B. Industrial Protocol Converter
1. Subject to compliance with the contract documents, the following manufacturers are acceptable:
    - a. Digi One IAP Series
    - b. Moxa MGate 5105-MB-EIP Series
  2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
  3. Environmental
    - a. Operating temperature: 32° F to 104° F
    - b. Operating humidity: 20 – 95% non-condensing
    - c. Storage temperature: -40 to 158° F
  4. Physical
    - a. Power supply: 24 V DC

- b. Microprocessor based managed type.
  - c. DIN rail mountable.
  - d. Class 1 Division 2 rated
5. Functional Performance
- a. Per port status LED indication
  - b. Wire speed switching.
  - c. 10/100BaseT ports with RJ-45 connectors for Category 6 cabling.
  - d. ST or SC type fiber optic connectors for 100BaseFX, 1000BaseSX for multimode fiber and 1000BaseLX for single mode fiber as shown on the drawings
  - e. RS-485 ports with terminals. Selectable link termination (100 ~120 Ohms)
6. Options and Accessories Required:
- a. The protocol interface shall implement the following:
    - (i) Transfer of basic I/O data via User Datagram Protocol (UDP)-based implicit messaging
    - (ii) Uploading and downloading of parameters, set points, programs and recipes via TCP (i.e., explicit messaging)
    - (iii) Polled, cyclic and change-of-state monitoring via UDP, such as RPI and COS in Allen Bradley's CompactLogix control systems
    - (iv) One-to-one (unicast) and one-to-all (broadcast) communication via TCP
    - (v) Use of well-known TCP port number 44818 for explicit messaging and UDP port number 2222 for implicit messaging
  - b. The protocol converter shall meet the following additional criteria:
  - c. The converter shall support 10/100Base-T Ethernet. The serial port speed (baud rate) shall support 230 kbps. The protocol shall support Modbus TCP, EtherNet/IP, DF1, and Modbus RTU/ASCII. Protocol shall be Web Browser configurable.

C. Industrial Serial to Fiber Media Gateway

- 1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
  - a. Moxa Mgate Series
  - b. B&B Electronics MESR900 Series
  - c. Approved Equal
- 2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

3. Environmental
  - a. Operating temperature: - 32 Degrees F to 140 Degrees F Minimum
  - b. Operating humidity: 20 – 95% Non-condensing
  - c. Storage Temperature: -40 to 158 Degrees F
4. Physical
  - a. Power Supply: 12 VDC to 48 VDC Range
  - b. Microprocessor based managed type.
  - c. DIN Rail mountable.
  - d. Class 1 Division 2 rated
  - e. UL Listed
5. Functional Performance
  - a. Configurable from supplied utility or via Web Interface.
  - b. Media and protocol conversion as further defined elsewhere in the contract documents.
  - c. Fiber Optic Connectors for Multimode or Single Mode Fiber as shown on the drawings.
  - d. RS-485 Ports with terminals. Selectable link termination (100 ~120 Ohms)
  - e. Low Latency, High Throughput.
  - f. Pass-through Ethernet Port
6. Protocol requirements
  - a. The System shall communicate utilizing the Native Protocol of the Master device as required. Ethernet/IP as defined by ODVA and/or Modbus TCP Protocol as defined the Modbus Organization
  - b. Modbus shall have the minimum capabilities as follows:
    - (i) All data shall be available and/or mirrored within the Modbus 4x or "Holding Register" memory area. The other areas can be optionally supported, but all 0x, 1x, and 3x data shall be readable and writable in the 4x memory area. For digital writes, supports of single-bit writes (function 5) to the 0x area are acceptable on a case by case basis. Products that require access to the 1x and 3x area to operate are not acceptable; access to 1x/3x area shall be optional.
    - (ii) Register 4x00001 shall exist and be readable to allow simple, predictable "communications tests".
    - (iii) Software tools shall function properly with slaves' only supporting Modbus functions 3, 4 and 16. Requiring support of diagnostic function 8 is not acceptable.



- (iv) Software tools shall be configurable to write a single register as either function 6 or 16.
  - (v) Software tools shall allow setting the Modbus/TCP "Unit Id" to be a value other than zero. This is required for Ethernet-to-Serial bridging.
- c. Ethernet/IP Protocol with the following as minimum capabilities:
- (i) Transfer of basic I/O data via User Datagram Protocol (UDP)-based implicit messaging
  - (ii) Uploading and downloading of parameters, set points, programs and recipes via TCP (i.e., explicit messaging.)
  - (iii) Polled, cyclic and change-of-state monitoring via UDP, such as RPI and COS in Allen Bradley's ControlLogix control systems.
  - (iv) One-to-one (unicast), one-to-many (multicast), and one-to-all (broadcast) communication via TCP
  - (v) Use of well-known TCP port number 44818 for explicit messaging and UDP port number 2222 for implicit messaging.
7. Options and Accessories Required:
- a. Provide minimum 5-year warranty.
  - b. The System shall communicate utilizing the Native Protocol of the Master device as required. Ethernet/IP as defined by ODVA and / or Modbus TCP Protocol as defined the Modbus Organization.
- D. Industrial Ethernet PoE Injector
1. Subject to compliance with the contract documents, the following manufacturers are acceptable:
    - a. Cambium 450i with internal antenna
  2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
  3. Environmental
    - a. Operating temperature: -40° F to 167° F
    - b. Operating humidity: 10 – 95% non-condensing
    - c. Storage temperature: -40 to 167° F
  4. Physical
    - a. Power supply: redundant 48 VDC inputs
    - b. Microprocessor-based, unmanaged
    - c. DIN rail mountable.
    - d. Class 1 Division 2 rated

5. Functional Performance
  - a. Per port status LED indication
  - b. Wire speed switching.
  - c. Power over Ethernet 15.4 watts per port with auto detection
  - d. 10/100BaseT ports with RJ-45 connectors for Category 6 cabling, as indicated in the drawings
  - e. ST or SC type fiber optic connectors for 100BaseFX, 1000BaseSX for single mode fiber and 1000BaseLX for single mode fiber as shown on the drawings

E. Communication Cables

1. Cables for Ethernet and serial communications shall be rated and shall be:
  - a. Category 5e above Grade shielded Cable  
 Conductors: 4 bonded pair 24AWG Bare  
 Copper Insulation: Polyolefin  
 Shield: 100 percent aluminum foil polyester tape with drain wire  
 Jacket: PVC with 600 volts rated and manufacturer's identification  
 Misc.: UL21047 and UL1666 listed for indoor and dry locations use  
 Manufacturers: Belden 7957A or approved equal
  - b. Category 5e above Grade un-shielded Cable  
 Conductors: 4 bonded pair 24AWG Bare  
 Copper Insulation: Polyolefin  
 Jacket: PVC with 300 volts rated and manufacturer's identification NEC CMR  
 Misc.: UL1666 listed for indoor and dry locations use  
 Manufacturers: Belden 7923A or approved equal
  - c. Category 6 above Grade shielded Cable  
 Conductors: 4 bonded pair 23 AWG Bare  
 Copper Insulation: Polypropylene  
 Shield: 100 percent aluminum foil polyester tape with drain wire  
 Jacket: PVC with 600 volts rated and manufacturer's identification  
 Transmission Standards: Category 6 - TIA 568.C.2 NEC CMR  
 Flame Test Method: UL1666 Vertical Riser listed for indoor and dry locations use  
 Manufacturers: Belden 7953A or approved equal
  - d. Category 6 above Grade un-shielded Cable  
 Conductors: 4 bonded pair 23 AWG Bare  
 Copper Insulation: Polyolefin  
 Jacket: PVC with 300 volts rated and manufacturer's identification  
 Transmission Standards: Category 6 - TIA 568.C.2  
 Nominal Velocity of Propagation: 72 %  
 Flame Test Method: UL1666 Vertical Riser listed for indoor and dry locations use  
 Manufacturers: Belden 7940A or approved equal

- e. Category 5e below Grade shielded Cable  
 Conductors: 4 pair 24AWG Bare Copper  
 Insulation: Polyolefin  
 Shield: 100 percent aluminum foil polyester tape with drain wire  
 Jacket: LLPE (Linear Low Density Polyethylene) with 300 volts rated and manufacturer's identification  
 Misc.: NEMA WC-63.1, listed for outdoor and wet locations use Manufacturers: Belden 7937A or approved equal
  - f. 485 Communications Cable  
 Conductors: 1 pair 24AWG Tinned Copper  
 Insulation: Polyethylene  
 Shield: 100 percent aluminum foil polyester tape with tinned copper drain wire  
 Jacket: PVC with 300 volts rated and manufacturer's identification  
 Misc.: UL2919 listed for indoor and dry locations use  
 Manufacturers: Belden 9841 or approved equal
2. Color code for Ethernet communications cables shall be as follows.
- a. Green – Phone
  - b. Red – FIRE / Security
  - c. Blue – Administrative Network
  - d. Yellow – SCADA

F. Ethernet Communication Copper Patch Panels

- 1. Subject to compliance with the contract documents, the following manufacturers are acceptable:
  - a. Panduit
  - b. Belden
  - c. Approved Equal
- 2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- 3. Ethernet: Patch Panels shall be used within all rack type panels, office spaces and where otherwise shown on the drawings. All components of the patch panels shall be of the same manufacture.
  - a. 19" Rack type
  - b. Modular type mountable on standard 19" equipment panels
  - c. Shall include number of spaces as shown or directed by the Engineer
  - d. Modules for UTP cables in the Category Rating to match wire, which snap in and out of panel shall be color coded to match SAWS IS color code as specified above.
  - e. Pre-printed numbers above each port for identification

4. Single Gang wall plate type
    - a. Modular type mountable on standard single gang wall mounted enclosure
    - b. Shall include number of spaces as shown or directed by the ENGINEER
    - c. Modules for UTP cables in the Category Rating to match wire, which snap in and out of panel shall be color coded to match SAWS IS color code as specified above.
    - d. Pre-printed numbers above each port for identification
    - e. Provide blank covers for all unused spaces.
- G. Ethernet Surge Protectors
1. Subject to compliance with the contract documents, the following manufacturers are acceptable:
    - a. Transtector
    - b. PolyPhaser
    - c. Phoenix Contact
    - d. Cooper Bussman
  2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
  3. Environmental
    - a. Operating temperature: -40° F to 176° F
    - b. Operating humidity: 95% non-condensing for indoor applications
    - c. Storage Temperature: -40 to 176° F
  4. Physical
    - a. DIN rail mountable indoors
    - b. I/O connectors: RJ-45
    - c. Power over Ethernet POE+ to IEEE802.3 at up to 57 VDC
  5. Functional Performance
    - a. Protection: handles 100 or more lightning strikes at surge levels of 8/20uSec at 6kV/3kA
    - b. Standard: Compliant to IEC61000-4-5.

## **PART 3 EXECUTION**

### **3.01 COORDINATION MEETINGS**

- A. The Supplier shall be required to attend up to four (4) coordination meetings and/or ASP workshops scheduled by the PCSI. The Supplier's Project Engineer responsible for the

control system including the I/O List, Data Transfer List and Control System Standards and Conventions shall at a minimum attend. Additional representatives from the Supplier may attend. All costs of attendance shall be included in the Contract Price.

### **3.02 TESTING**

#### **A. Unwitnessed Test (UFT)**

1. The entire system, except primary elements, final control elements, and field mounted transmitters, shall be interconnected and tested to ensure the system operates as specified. All analog and discrete input/output points not interconnected at this time shall be simulated to ensure proper operation of all alarms, monitoring devices/functions, and control devices/functions.
2. All panels and assemblies shall be inspected and tested to verify that they are in conformance with related submittals, specifications, and Contract Drawings.
3. During the tests, all digital system hardware and software shall have operated continuously for five days without a failure to verify the system is capable of continuous operation. The un-witnessed test results shall be submitted to the Engineer for approval prior to the start of the Witnessed Test (WFT).

#### **B. Witnessed Factory Test (WFT)**

1. Before scheduling the Witnessed Test, the Supplier must determine through his own test and quality assurance program that the equipment is ready for shipment to the jobsite.
2. All system tests specified for the UFT shall be repeated.
3. After receiving Un-witnessed Test approval, the Supplier shall notify the Engineer and Owner in writing that the system is ready for the Witnessed Test. The Engineer and/or Owner shall schedule a test date within 30 days of receipt of the "Ready to Test" letter. At the time of notification, the Supplier shall submit any revisions to the detailed test procedure previously approved by the Engineer.
4. This test shall verify the functionality, performance, and stability of the hardware and software. The system must operate continuously for 72 hours without failure before the test shall be judged successful. Successful completion of this test, as determined by the Engineer, shall be the basis for approval of the system to be shipped to the site.
5. The various tests performed during the Witnessed Factory Test shall be designed to demonstrate that hardware and software fulfill all the requirements of the Specifications and Contract drawings. The test conditions shall resemble, as closely as possible, the actual installed conditions. Any additional hardware or software that may be required to successfully verify system operation shall be supplied at no cost to the Owner.
6. The Supplier shall be responsible to simulate the I/O signals for any equipment or device communicating with any new or existing PLC through peer-to-peer network by using a computer system with appropriate simulation software to implement the

memory map in the protocol as specified elsewhere. Simulating the I/O signals by forcing them from the PLC programming software will not be acceptable.

7. Tests to be performed shall include, but not be limited to, the following:
  - a. Demonstrate operability of all equipment
  - b. Demonstrate operability of the control data communication network under anticipated full load conditions
  - c. 100 percent point check of I/O, including wiring
  - d. Demonstrate the ability to monitor and change at least 20 pieces of digital and analog data in each PLC/RIO from the OIT software at all operator workstations
  - e. Demonstrate the ability for each workstation to read and write to and from designated files from other workstations on the LAN
  - f. Demonstrate the operability of all mass storage equipment
  - g. Demonstrate communication failure and system restart
  - h. Demonstrate total power failure and recovery. NOTE: The UPS shall call for server shutdown and on power restoration the servers shall restart.
  - i. Demonstrate a catastrophic failure and recovery of a server, workstation, and PLC.
  - j. Demonstrate procedure for backing up the computer system (including PC and PLC); reload using a backup; and completely restoring a PC and/or PLC from a backup.
  - k. Demonstrate the ability of each workstation to print alarm/events on the local printer. During the test for a period of time equal to at least 20 percent of the test duration, the Engineer's and/or Owner's representative shall have unrestricted access to the system.
8. All analog control panels shall be included in these tests.
9. All deficiencies identified during these tests shall be corrected and retested prior to completing the Witnessed Test as determined by the Owner/Engineer.
10. The following documentation shall be made available to the Engineer at the test site both before and during the Witnessed Test:
  - a. All Contract Drawings and Specifications, addenda, and change orders
  - b. Master copy of the test procedure
  - c. List of the equipment to be tested including make, model, and serial number
  - d. Design-related hardware submittal applicable to the equipment being tested
  - e. Software license
11. The daily schedule during these tests shall be as follows:

- a. Morning meeting to review the day's test schedule
  - b. Scheduled tests and signoffs
  - c. Evening meetings to review the day's test results and to review or revise the next day's test schedule
  - d. Unstructured testing period by the witnesses
12. All test data and procedures followed during testing shall be logged and certified copies of the logs shall be provided to the Engineer and Owner.

C. Operational Readiness Tests (ORT)

- 1. Prior to startup and the Functional Demonstration Test, the entire system shall be certified (inspected, tested, and documented) that it is ready for operation. The Supplier shall be responsible for the calibration, inspection and testing of equipment and instruments that are furnished by the Supplier and connected to the Supplier's control panel(s). The ORT test may be witnessed by the Owner and/or Engineer at their discretion. If the ORT is not to be witnessed, the Owner and/or Engineer may, at any time they choose, conduct spot checks of test progress during testing activities.
- 2. Loop/Component Inspections and Tests: The entire system shall be checked for proper installation, calibrated, and adjusted on a loop-by-loop and component-by-component basis to ensure that it is in conformance with related submittal's and these Specifications.
  - a. The Loop/Component Inspections and Input / Output Tests shall be implemented using Engineer-approved forms and check lists.
    - (i) Each loop shall have a Loop Status Report to organize and track its inspection, adjustment, and calibration. These reports shall include the following information and check off items with space for sign off by the Supplier.
      - (a) Project Name
      - (b) Loop Number
      - (c) Tag Number for each component
      - (d) Check offs/sign offs for each component
    - (ii) Tag/identification
    - (iii) Installation
    - (iv) Termination – wiring
    - (v) Termination – tubing
    - (vi) Calibration/adjustment – Check offs/sign offs for the loop
    - (vii) Panel interface terminations

- (viii) I/O interface terminations
  - (ix) I/O signal operation
  - (x) Inputs/outputs operational: received/sent, processed, and adjusted.
  - (xi) Total loop operation – Provide space for comments
  - (xii) Each active Analog Subsystem element and each I/O module shall have a Component Calibration Sheet. These sheets shall have the following information, spaces for data entry, and a space for sign off by the PCSI:
    - (a) Project Name
    - (b) Loop Number
    - (c) Component Tag Number of I/O Module Number
    - (d) Component Code Number Analog System
    - (e) Manufacturer (for Analog system element)
    - (f) Model Number/Serial Number (for Analog system)
    - (g) Summary of Functional Requirements:
      - Indicators and Recorders: Scale and chart ranges
      - Transmitters/Converters: Scale and chart ranges
      - Computing Elements: Function
      - Controllers: Action (direct/reverse) control Modes (PID)
      - Switching Elements: Unit range, differential (FIXED/ADJUSTABLE), Preset (AUTO/MANUAL)
      - I/O Modules: Input or output
- b. Calibrations:
- (i) Analog Devices: Required and actual inputs and outputs at 0, 25, 50, 75, and 100 percent of span, rising and falling
  - (ii) Discrete Devices: Required and actual trip points and reset points
  - (iii) Controllers: Mode settings (PID)
  - (iv) I/O Modules: Required an actual inputs or outputs for 0, 25, 50, 75, and 100 percent of span, rising and falling.
    - (a) Provide space for comments
    - (b) Space for sign off by the Supplier.



- c. The General Contractor shall require the PCSI to maintain the Loop Status Reports and Component Calibration Sheets at the job-site and make them available to the Engineer/Owner at any time.
- d. These inspections and tests require witnessing by the OWNER/ENGINEER. The Engineer will review and initial all Loop Status Sheets and Component Calibration Sheets and spot-check their entries periodically and upon completion of the Operational Readiness Test. Any deficiencies found shall be corrected.

D. Functional Demonstration Test (FDT)

- 1. Prior to startup and the 30-Day Test, the entire installed instrument and control system shall be certified that it is ready for operation. All preliminary testing, inspection, and calibration shall be complete as defined in the Operational Readiness Tests. The FDT will be a joint test by the PCSI and the Equipment suppliers.
- 2. Once the facility has been started up and is operating, a witnessed Functional Demonstration Test shall be performed on the complete system to demonstrate that it is operating and in compliance with these Specifications. Each specified function shall be demonstrated on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
- 3. Loop-specific and non-loop-specific tests shall be the same as specified under Functional Demonstration Tests except that the entire installed system shall be tested and all functionality demonstrated.
- 4. Updated versions of the documentation specified to be provided for during the tests shall be made available to the Engineer at the job-site both before and during the tests. In addition, one (1) copy of all O&M Manuals shall be made available to the Engineer at the job-site both before and during testing.
- 5. The daily schedule specified to be followed during the tests shall also be followed during the Functional Demonstration Test.
- 6. The system shall operate for 72 continuous hours without failure before this test shall be considered successful.
- 7. Demonstrate communication failure and recovery

E. 30-Day Site Acceptance Test (SAT)

- 1. After completion of the Operational Readiness and Functional Demonstration Tests, the Contractor shall be responsible for operation of the entire system for a period of 30 consecutive days, under conditions of full plant process operation, without a single non-field repairable malfunction.
- 2. During this test, plant operating personnel shall be present as required and Supplier personnel shall be on call. For this test, the Supplier is expected to provide personnel who have an intimate knowledge of the system hardware and software if an equipment issue arises that cannot be remotely assessed and corrected by Contractor's on-site personnel with Supplier's remote support.

3. While this test is proceeding, the Owner shall have full use of the system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes.
4. Any malfunction during the tests of Supplier's equipment shall be analyzed and corrected by the Supplier. The Engineer and/or Owner will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.
5. During this 30-consecutive day test period, any malfunction which cannot be corrected within 24 hours of occurrence by Supplier personnel, or more than two similar failures of any duration, will be considered a non-field-repairable malfunction.
6. Upon completion of repairs by the Supplier, the test shall be repeated as specified herein.
7. In the event of rejection of any part or function, the Supplier shall perform repairs or replacement within 90 days.
8. The total availability of the system shall be greater than 99.5 percent (99.5%) during this test period. Availability shall be defined as:  

$$\text{Availability} = (\text{Total Testing Time} - \text{Down Time}) / \text{Total Testing Time}$$
9. Down times due to power outages or other factors outside the normal protection devices or back-up power supplies provided shall not contribute to the availability test times above.
10. Upon successful completion of the 30-day site acceptance test and subsequent review and approval of complete system final documentation, the system shall be considered substantially complete, and the warranty period shall commence.

### **3.03 INSTALLATION**

- A. Any work not installed according to the Drawings and this Section shall be subject to change as directed by the Owner/Engineer. No extra compensation will be allowed for making these changes.
- B. All dimensions shall be field verified at the job site and coordinated with the work of all other trades.
- C. Equipment shall be protected at all times against mechanical injury or damage by water. Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters as required by each Specification Section. Do not install equipment in its permanent location until structures are weather-tight. If any apparatus has been subject to possible injury by water, Equipment shall be thoroughly dried out and tested as directed by the Owner/Engineer, or shall be replaced at no additional cost at the Owner/Engineer's discretion.
- D. Equipment that has been damaged shall be replaced or repaired by the equipment manufacturer, at the Owner/Engineer's discretion.

<b>CALIBRATION CERTIFICATE</b>					
Tag Number/Loop Number:					
Loop Description					
Instrument Location					
Manufacturer					
Model Number					
Adjustable Range					
Calibrated Range					
Remarks					
<b>Installation Per Manufacturer's Requirements?</b>			<b>Yes</b>		<b>No</b>
<b>Installation Per Contract Documents?</b>			<b>Yes</b>		<b>No</b>
If "No", explain					
<b>Calibration Test:</b>					
	Input (Units)		Output (Units)		Accuracy
0%					
25%					
50%					
75%					
100%					
<b>Switch Test</b>	Switch Point Upscale		Switch Point Downscale		Setting Deadband
Setpoint 1					
Setpoint 2					
Setpoint 3					
<p>I hereby certify that the above information is correct and accurate, to the best of my knowledge, and that the instrument indicated above has been supplied, installed, calibrated, and tested in accordance with the manufacturer's recommendations and the Contract Documents, unless otherwise noted.</p> <p>Receipt of this Calibration Certification shall in no way imply acceptance of any work or instrument</p>					
Contractor's Signature:			Date:		

- E. Repaint any damage to the factory applied paint finish using touch-up paint furnished by the equipment manufacturer. If the metallic portion of the panel or section is damaged, the entire panel or section shall be replaced, at no additional cost to the Owner.

**3.04 MANUFACTURER'S SERVICE**

- A. Provide manufacturer's services for testing and start-up of the equipment as listed Specification Section 11292.
- B. Testing and startup shall not be combined with training. Testing and start-up time shall not be used for manufacturer's warranty repairs.
- C. Check interlocking, control and instrument wiring for each system and/or part of a system to prove that the system will function properly as indicated by schematics, wiring diagrams and Control Descriptions.
- D. Testing shall be scheduled and coordinated with the Owner/Engineer at least six months in advance. Provide qualified test personnel, instruments and test equipment.

**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 SERIAL NO.: \_\_\_\_\_  
EQPT TAG NO.: \_\_\_\_\_ EQPT/SYSTEM: \_\_\_\_\_  
PROJECT NO.: \_\_\_\_\_ 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.

**END OF SECTION**

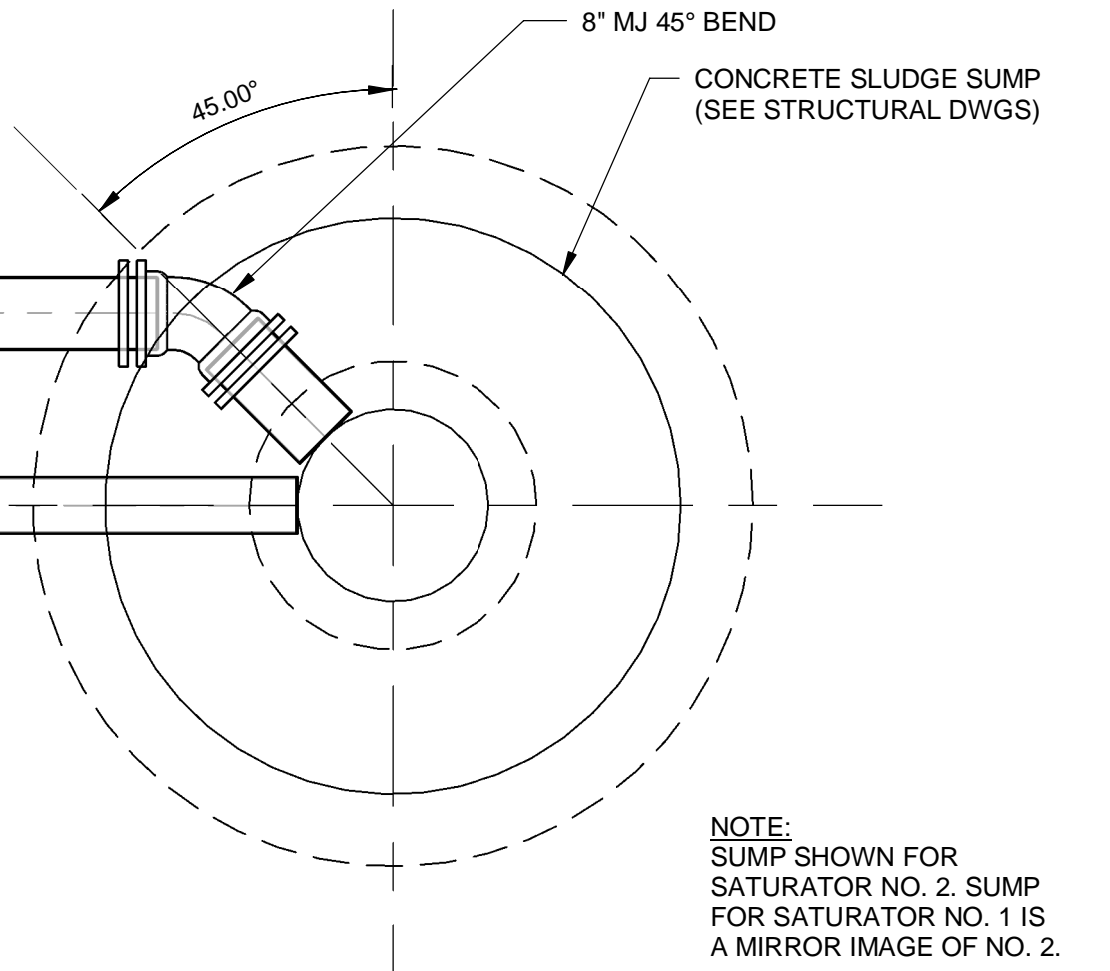
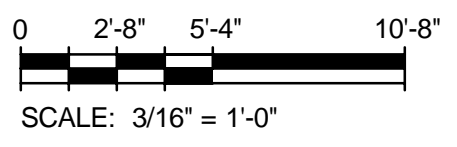
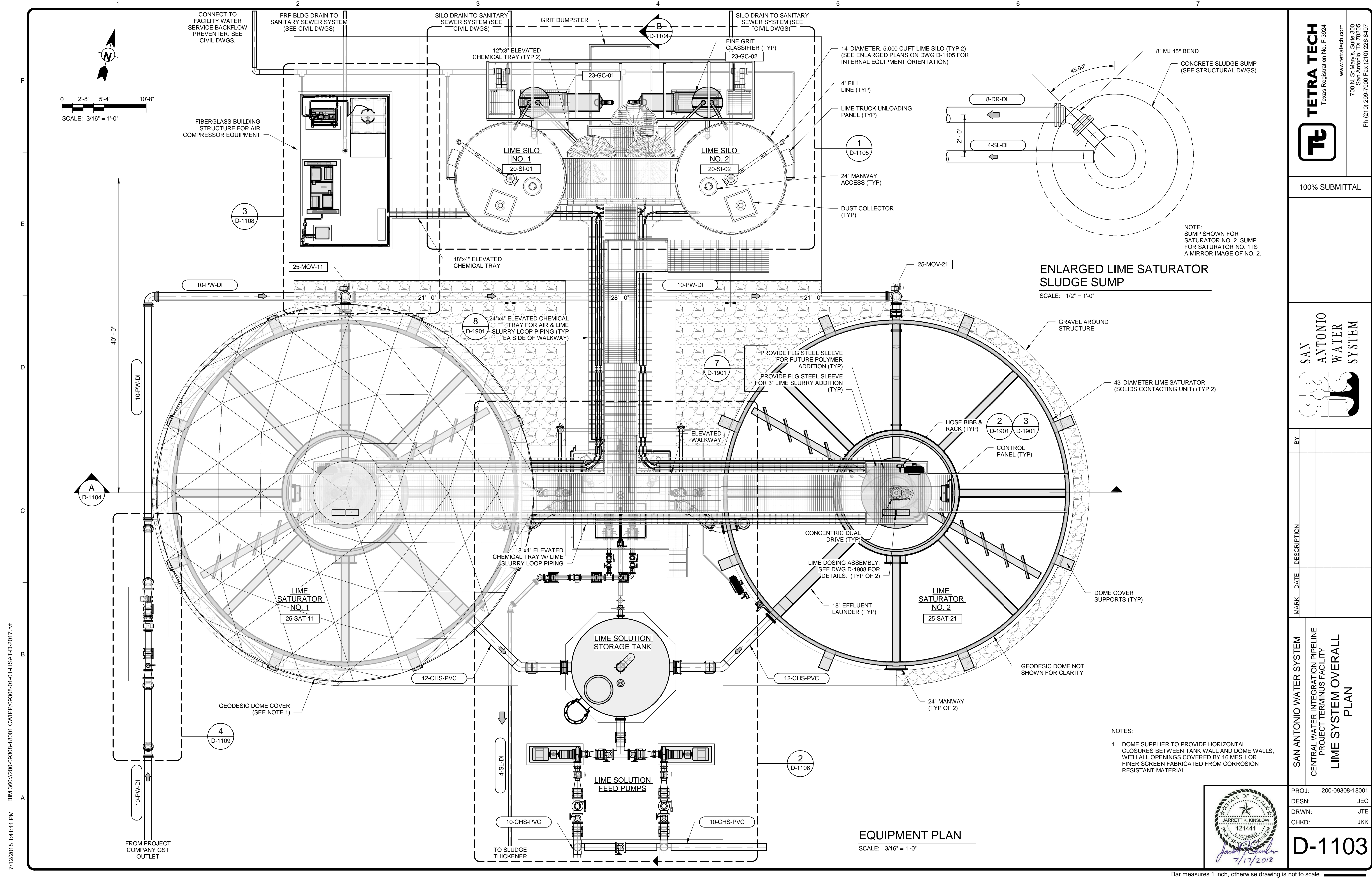




# APPENDIX B

# DRAWINGS





NOTE:  
SUMP SHOWN FOR  
SATURATOR NO. 2. SUMP  
FOR SATURATOR NO. 1 IS  
A MIRROR IMAGE OF NO. 2.

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

- NOTES:**
1. DOME SUPPLIER TO PROVIDE HORIZONTAL CLOSURES BETWEEN TANK WALL AND DOME WALLS, WITH ALL OPENINGS COVERED BY 16 MESH OR FINER SCREEN FABRICATED FROM CORROSION RESISTANT MATERIAL.



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**SAN ANTONIO WATER SYSTEM**

MARK	DATE	DESCRIPTION

SAN ANTONIO WATER SYSTEM  
CENTRAL WATER INTEGRATION PIPELINE  
PROJECT TERMINUS FACILITY  
**LIME SYSTEM OVERALL PLAN**

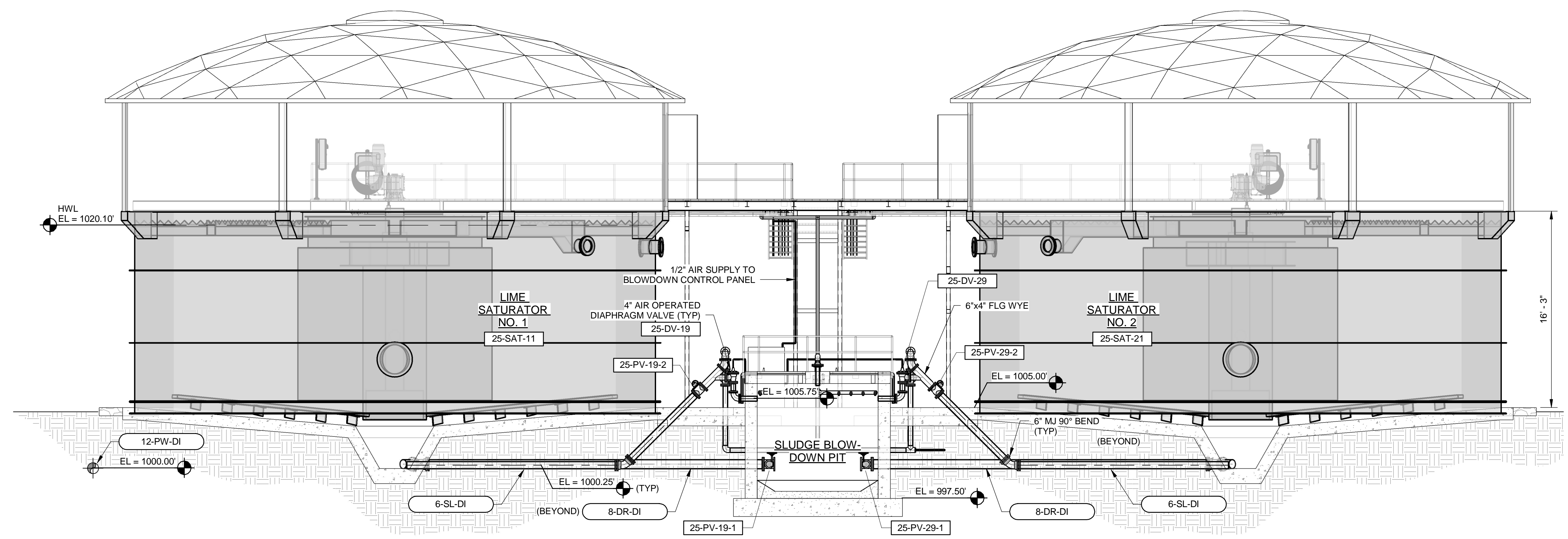
PROJ:	200-09308-18001
DESN:	JEC
DRWN:	JTE
CHKD:	JKK

**D-1103**

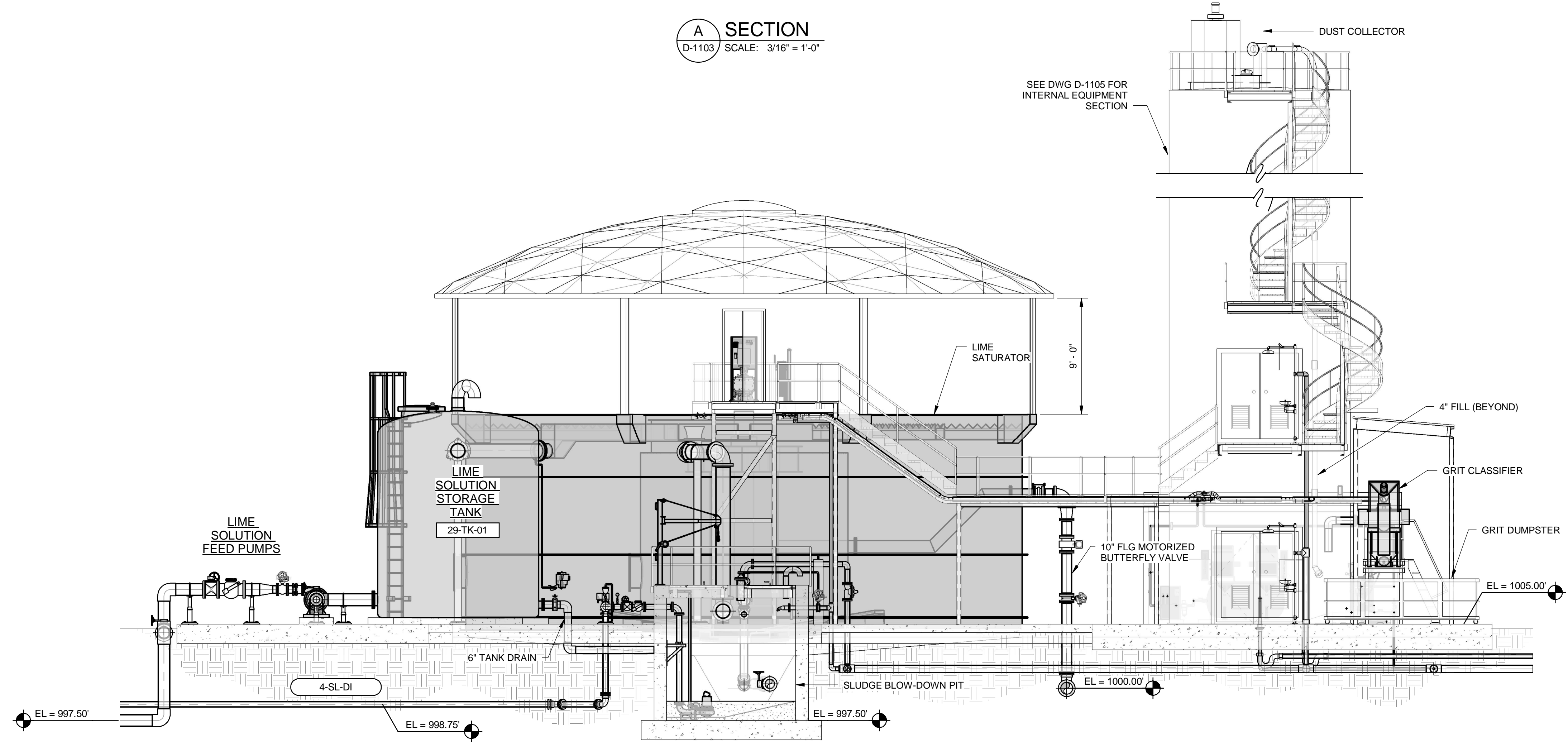
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1 2 3 4 5 6 7



**A SECTION**  
D-1103 SCALE: 3/16" = 1'-0"



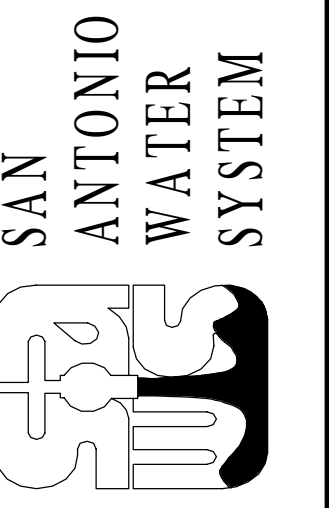
**B SECTION**  
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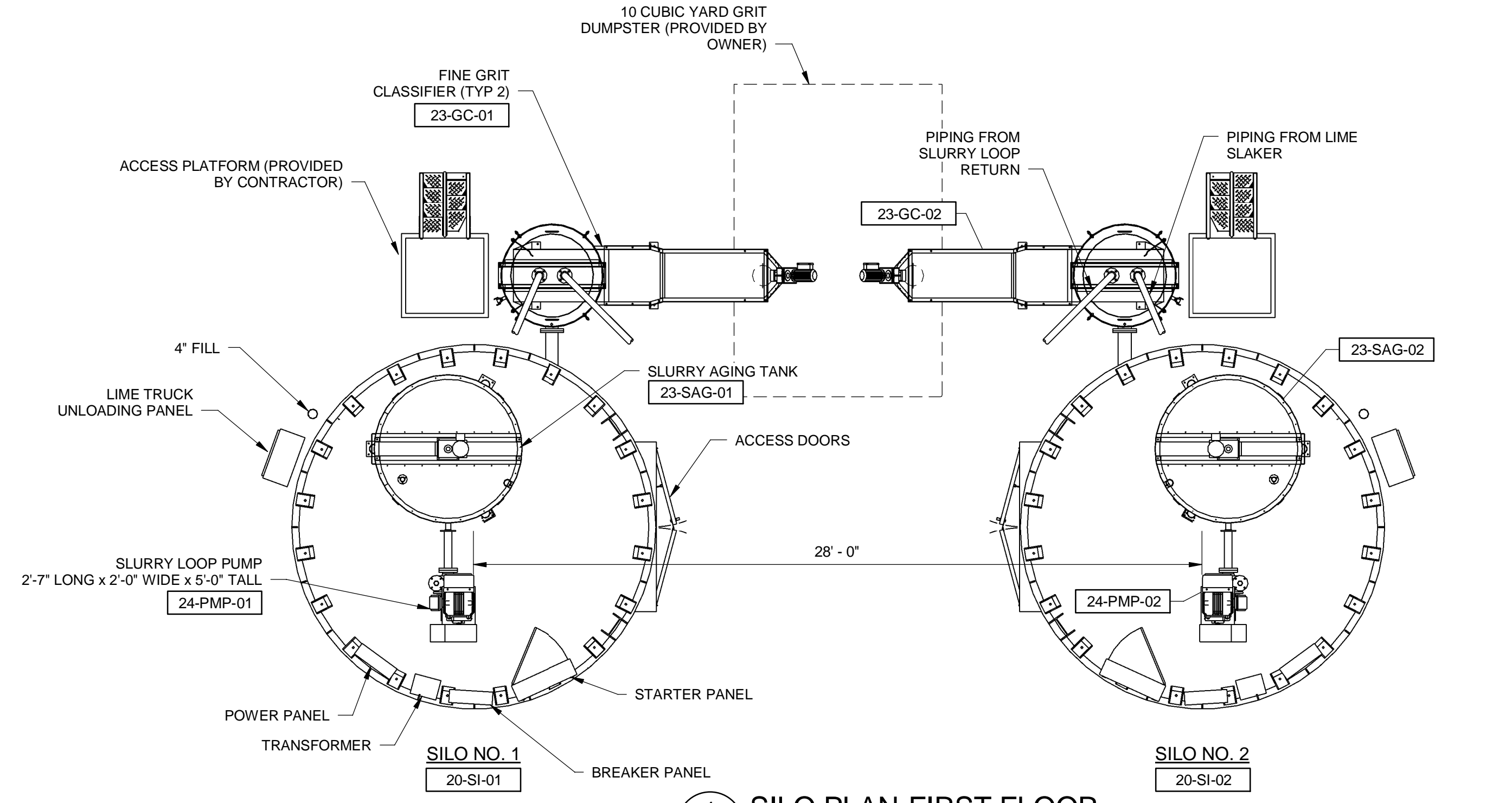
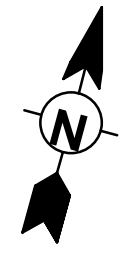
SAN ANTONIO WATER SYSTEM  
CENTRAL WATER INTEGRATION PIPELINE  
PROJECT TERMINUS FACILITY  
**LIME SYSTEM OVERALL SECTIONS**

PROJ:	200-09308-18001
DESN:	JEC
DRWN:	JTE
CHKD:	JKK

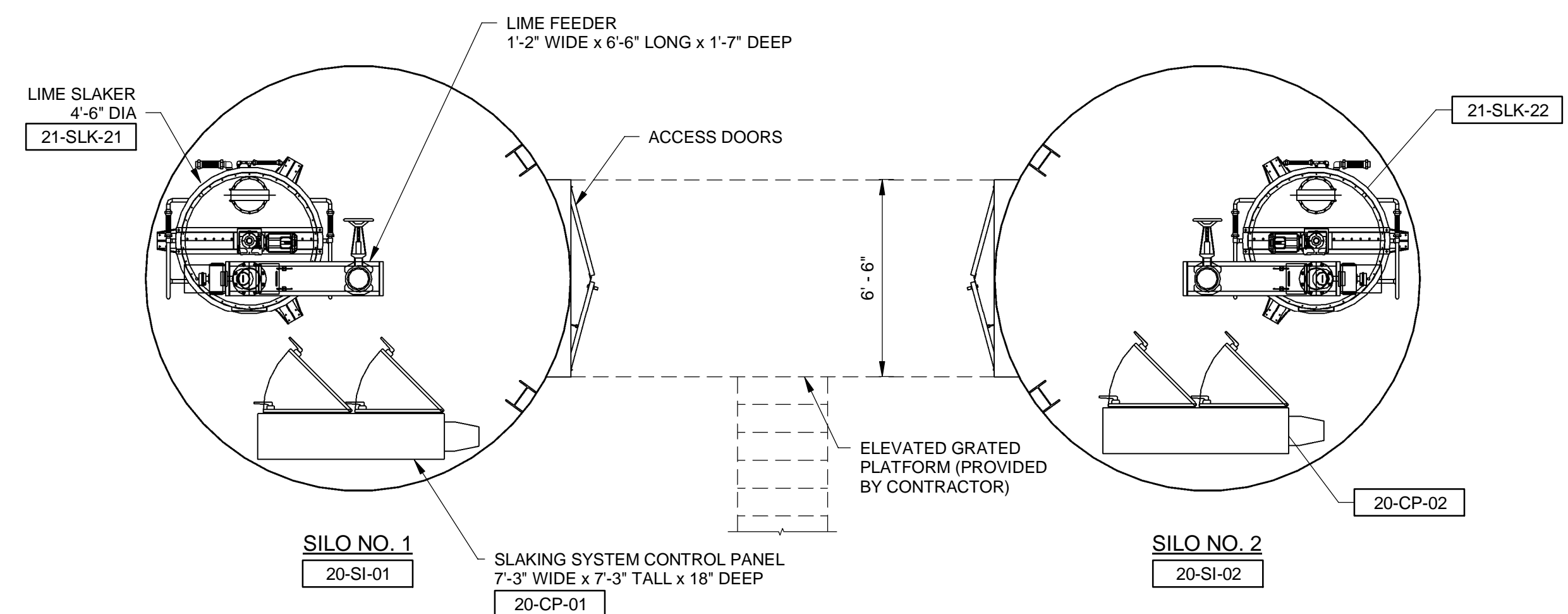
**D-1104**

Bar measures 1 inch, otherwise drawing is not to scale

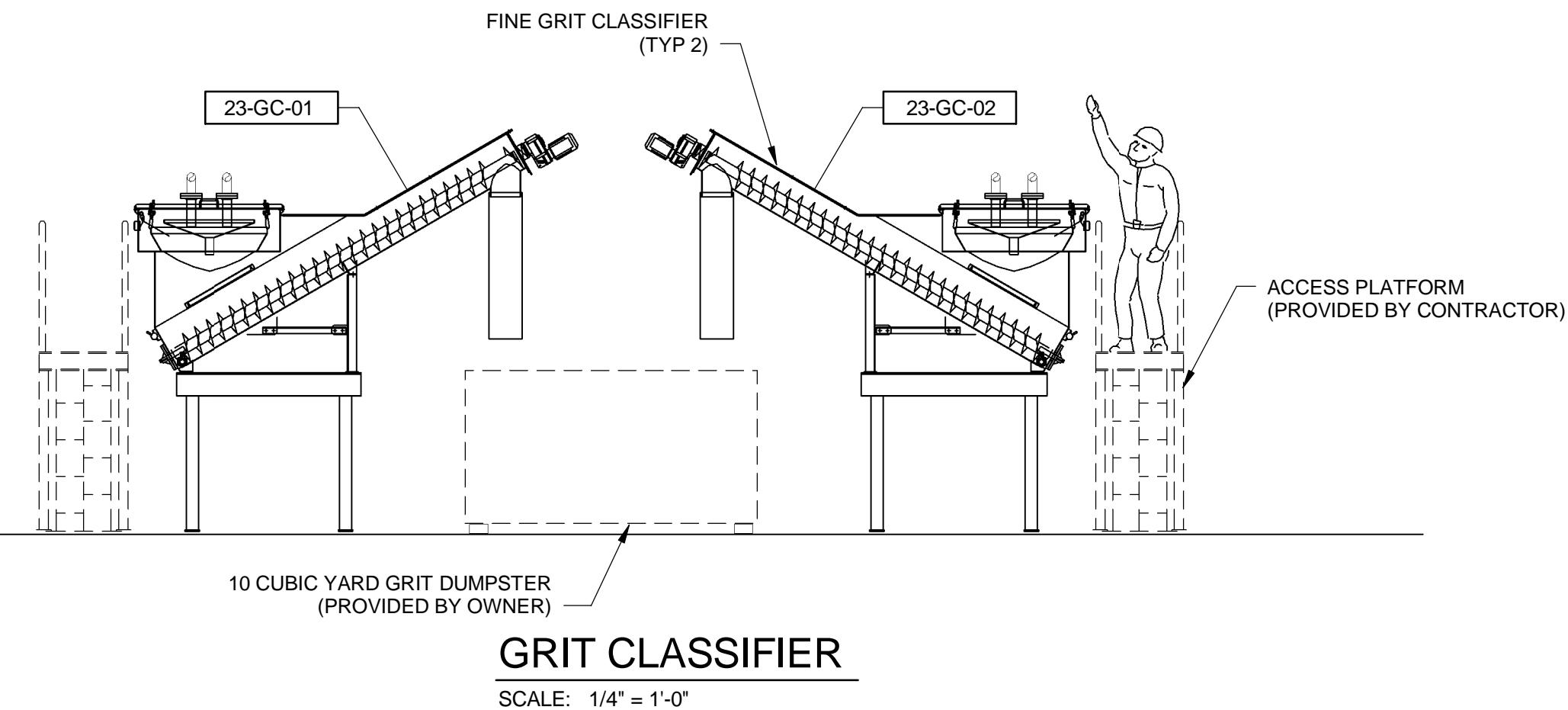




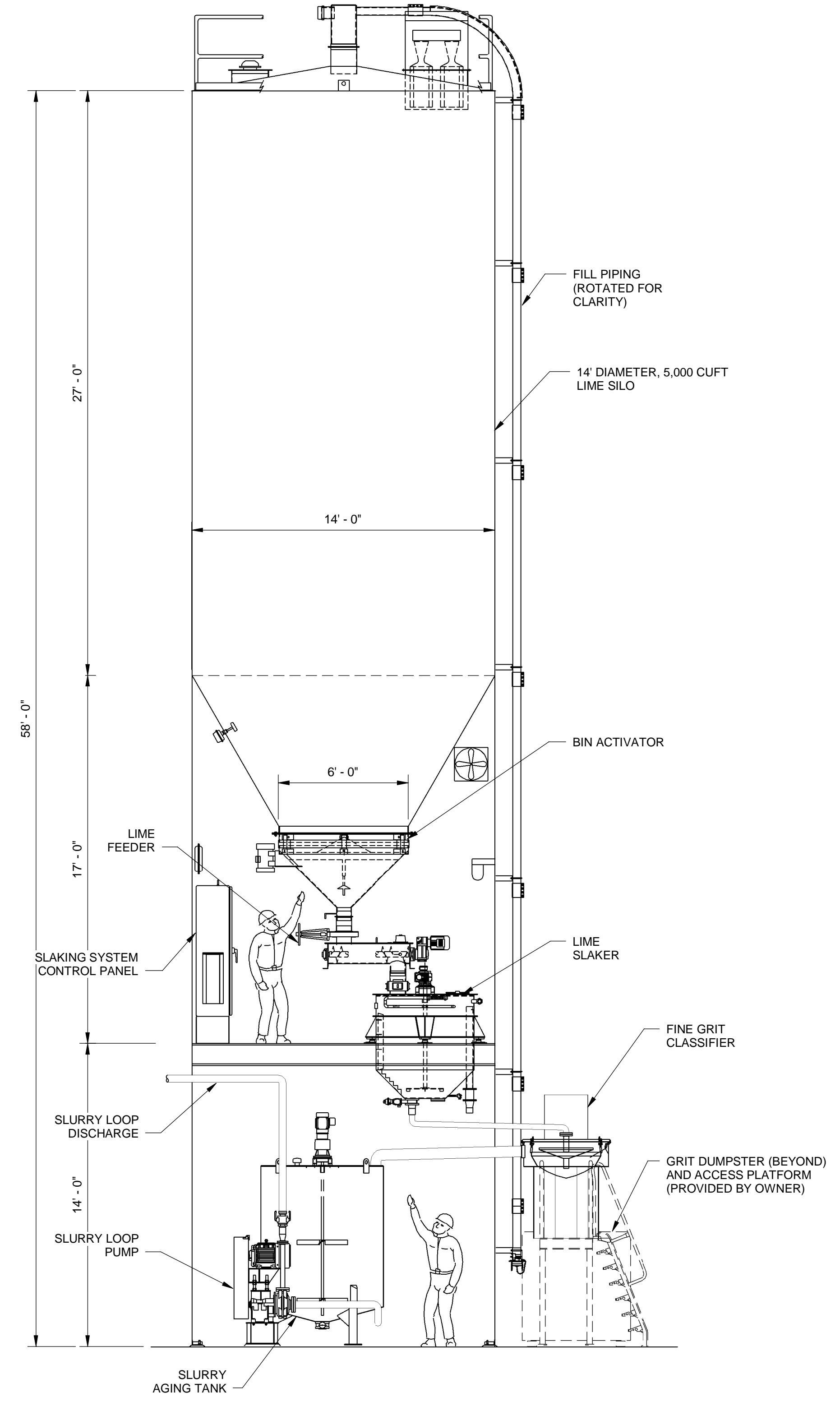
**1 SILO PLAN-FIRST FLOOR**  
D-1103 SCALE: 1/4" = 1'-0"



**1 SILO PLAN-SECOND FLOOR**  
D-1103 SCALE: 1/4" = 1'-0"



**GRIT CLASSIFIER**  
SCALE: 1/4" = 1'-0"



**SILO SECTION**  
SCALE: 1/4" = 1'-0"

NOTE:  
SOME ITEMS HAVE BEEN  
ROTATED IN VIEW FOR CLARITY.  
SEE PLANS FOR CORRECT  
ORIENTATION

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**SAN ANTONIO WATER SYSTEM**

MARK	DATE	DESCRIPTION

SAN ANTONIO WATER SYSTEM  
CENTRAL WATER INTEGRATION PIPELINE  
PROJECT TERMINUS FACILITY  
**LIME SYSTEM SILO  
INTERIOR PLANS &  
SECTION**

PROJ:	200-09308-18001
DESN:	JEC
DRWN:	JTE
CHKD:	JKK

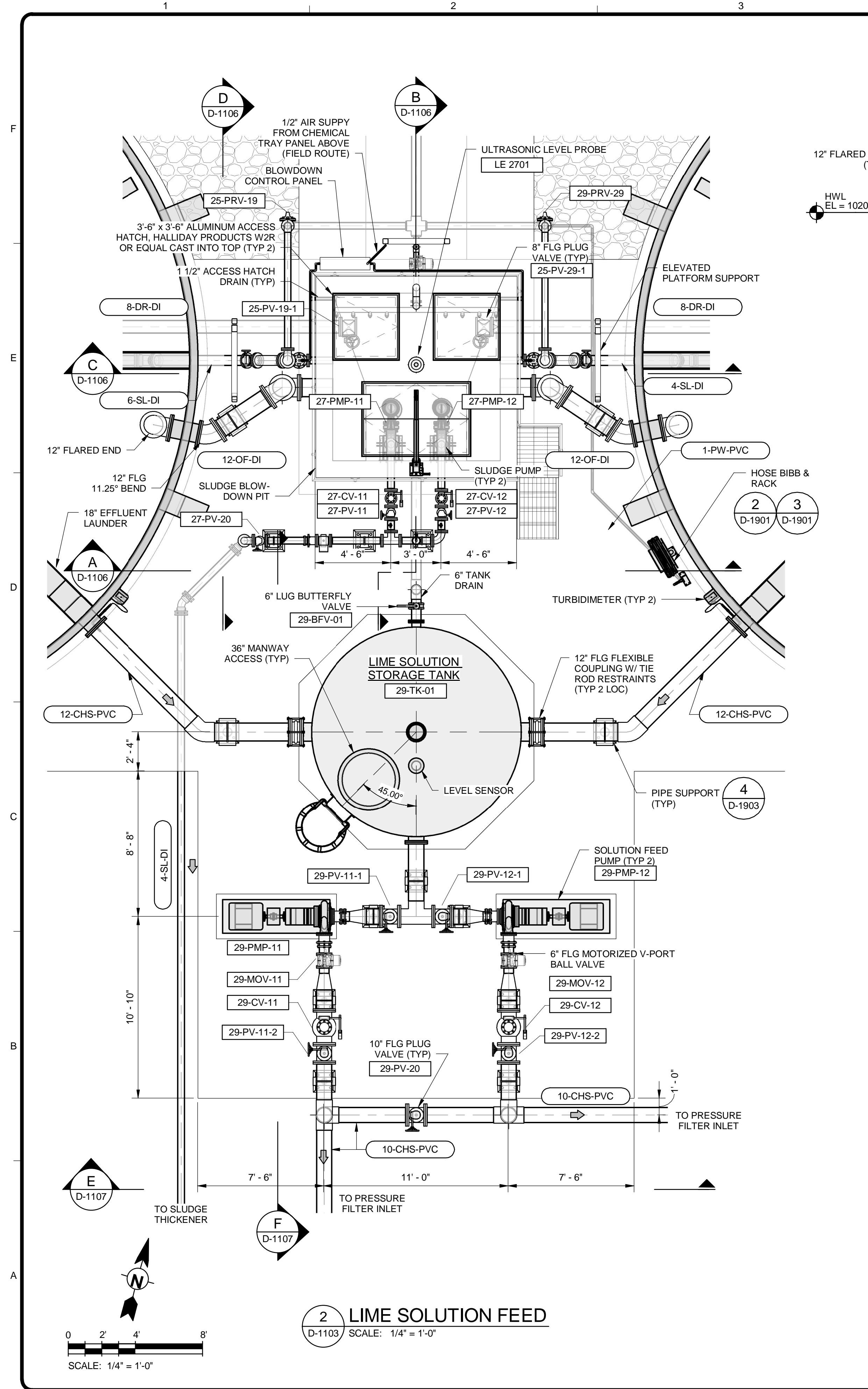
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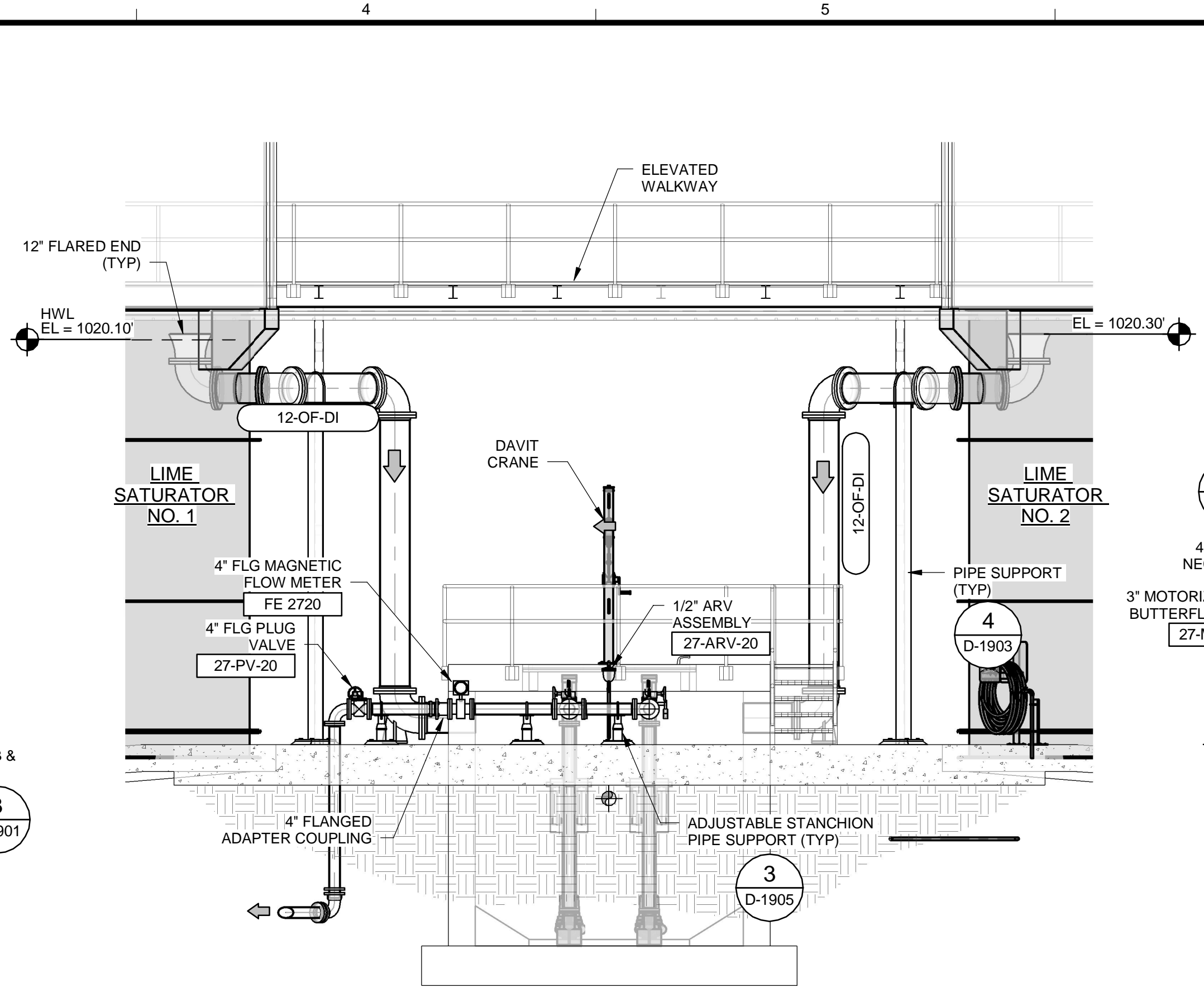
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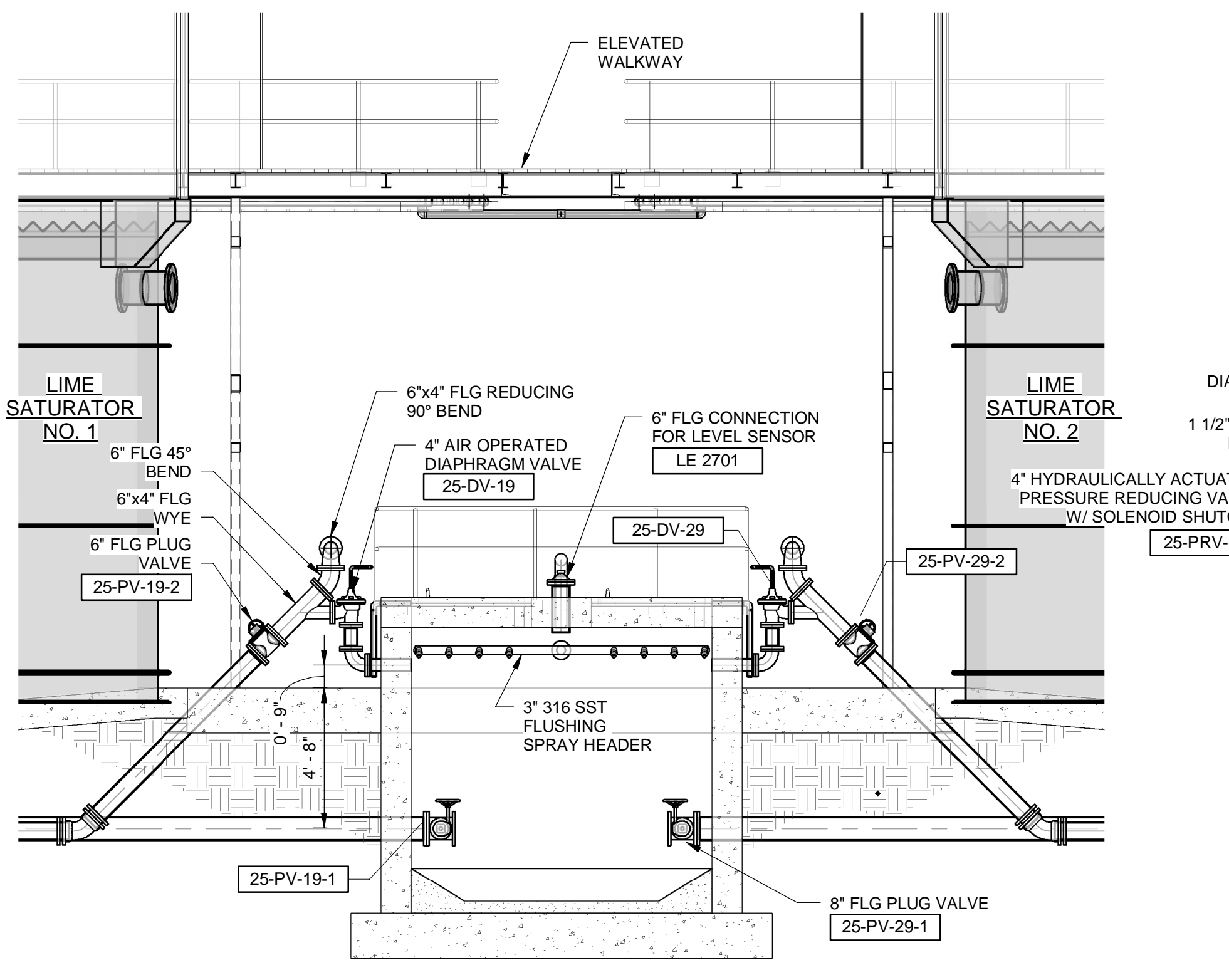
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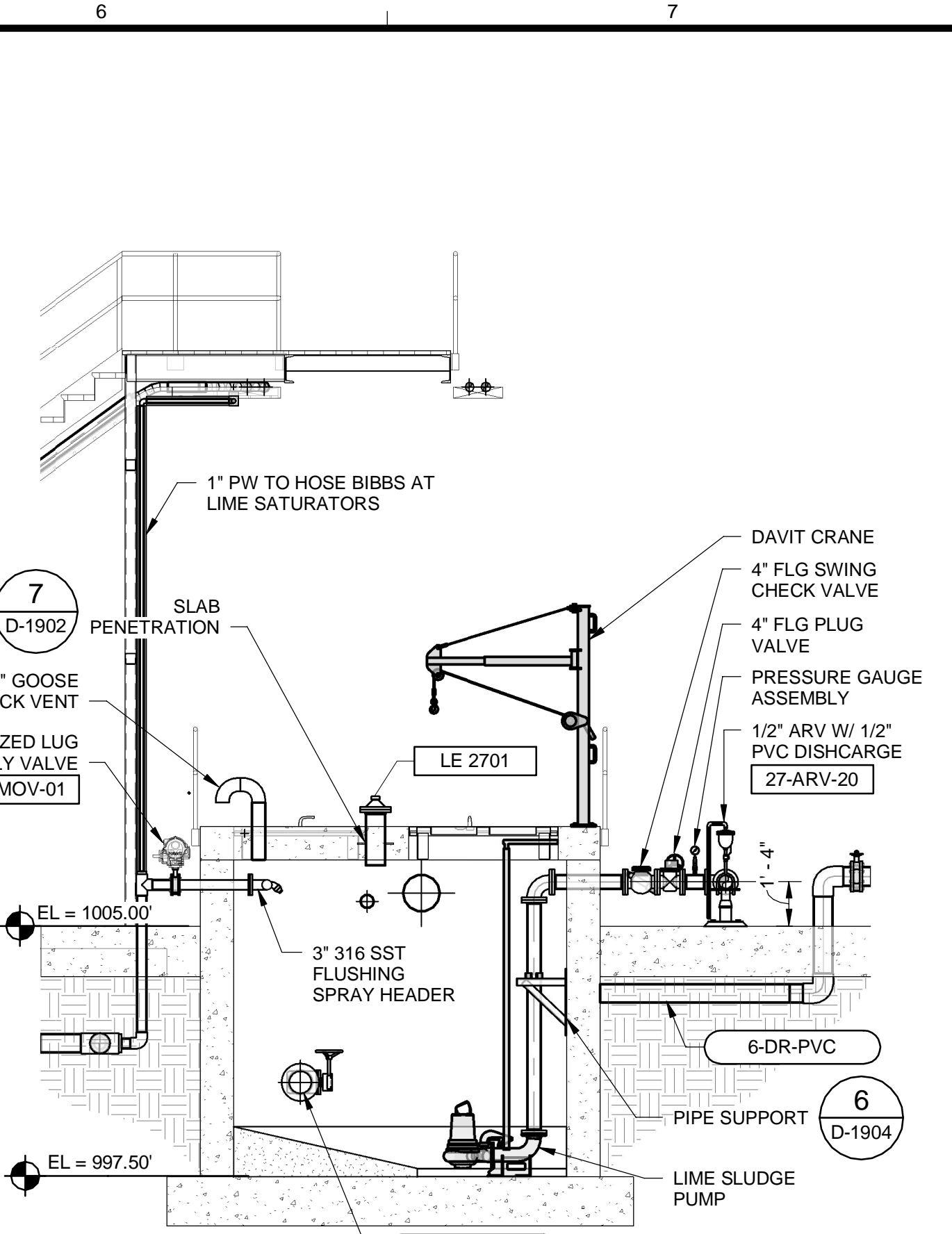
**2 LIME SOLUTION FEED**  
D-1103 SCALE: 1/4" = 1'-0"



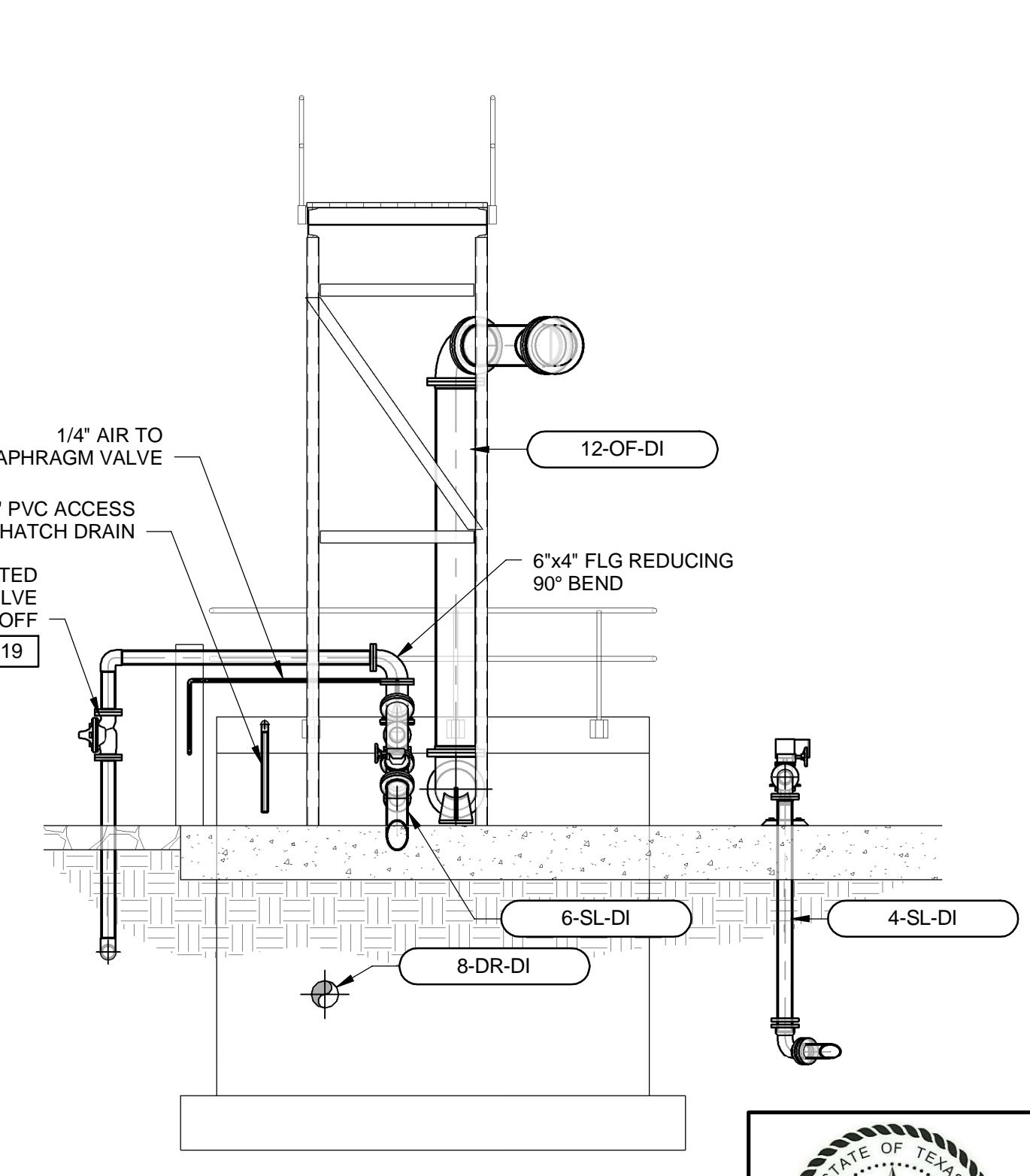
**A SECTION**  
D-1106 SCALE: 1/4" = 1'-0"



**C SECTION**  
D-1106 SCALE: 1/4" = 1'-0"



**B SECTION**  
D-1106 SCALE: 1/4" = 1'-0"



**D SECTION**  
D-1106 SCALE: 1/4" = 1'-0"

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**SAN ANTONIO WATER SYSTEM**

MARK	DATE	DESCRIPTION

SAN ANTONIO WATER SYSTEM  
CENTRAL WATER INTEGRATION PIPELINE  
PROJECT TERMINUS FACILITY  
**LIME SYSTEM SLUDGE & SOLUTION FEED PLAN & SECTIONS**

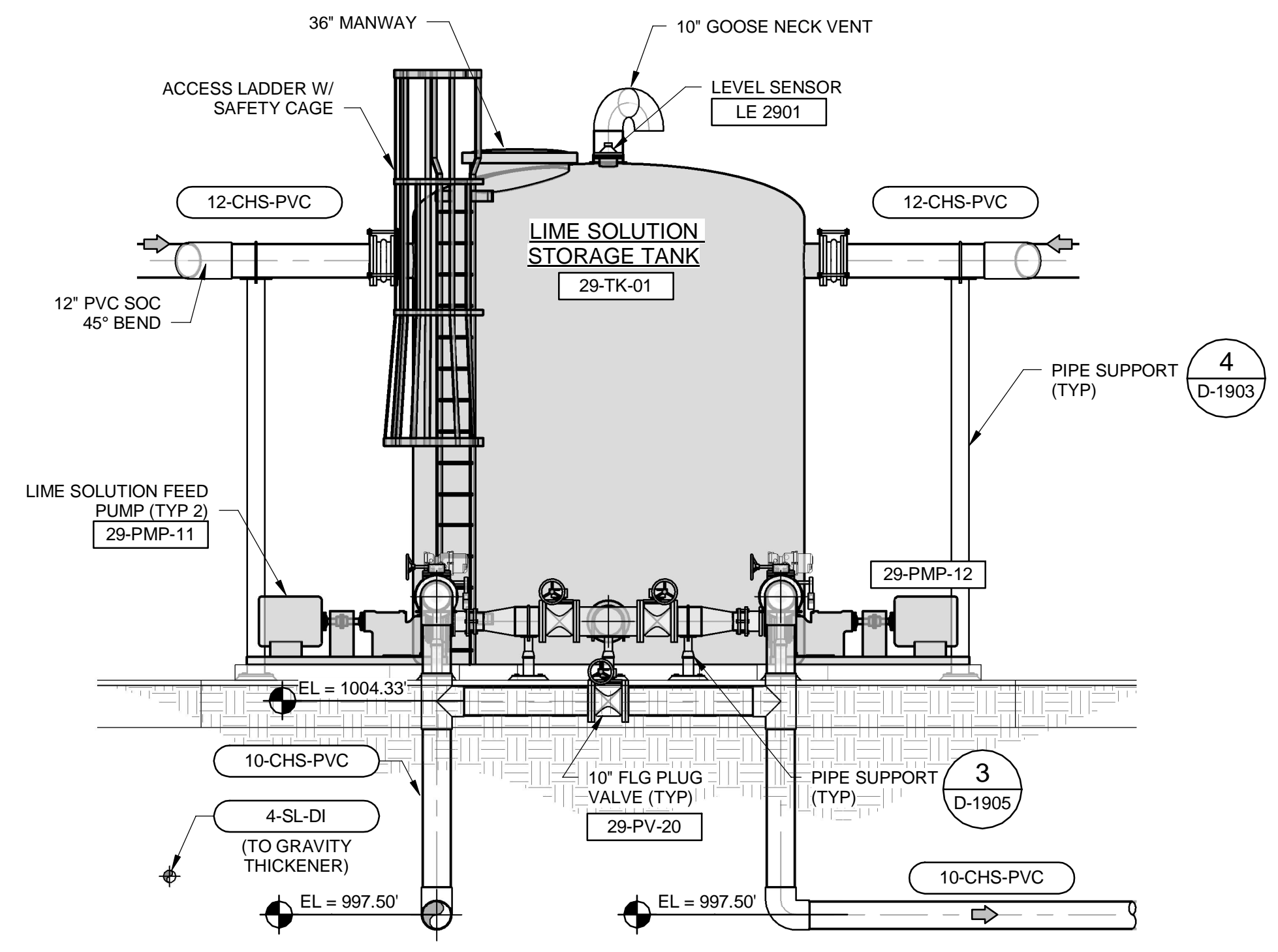
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DESN:	JEC
DRWN:	JTE
CHKD:	JJK

**D-1106**

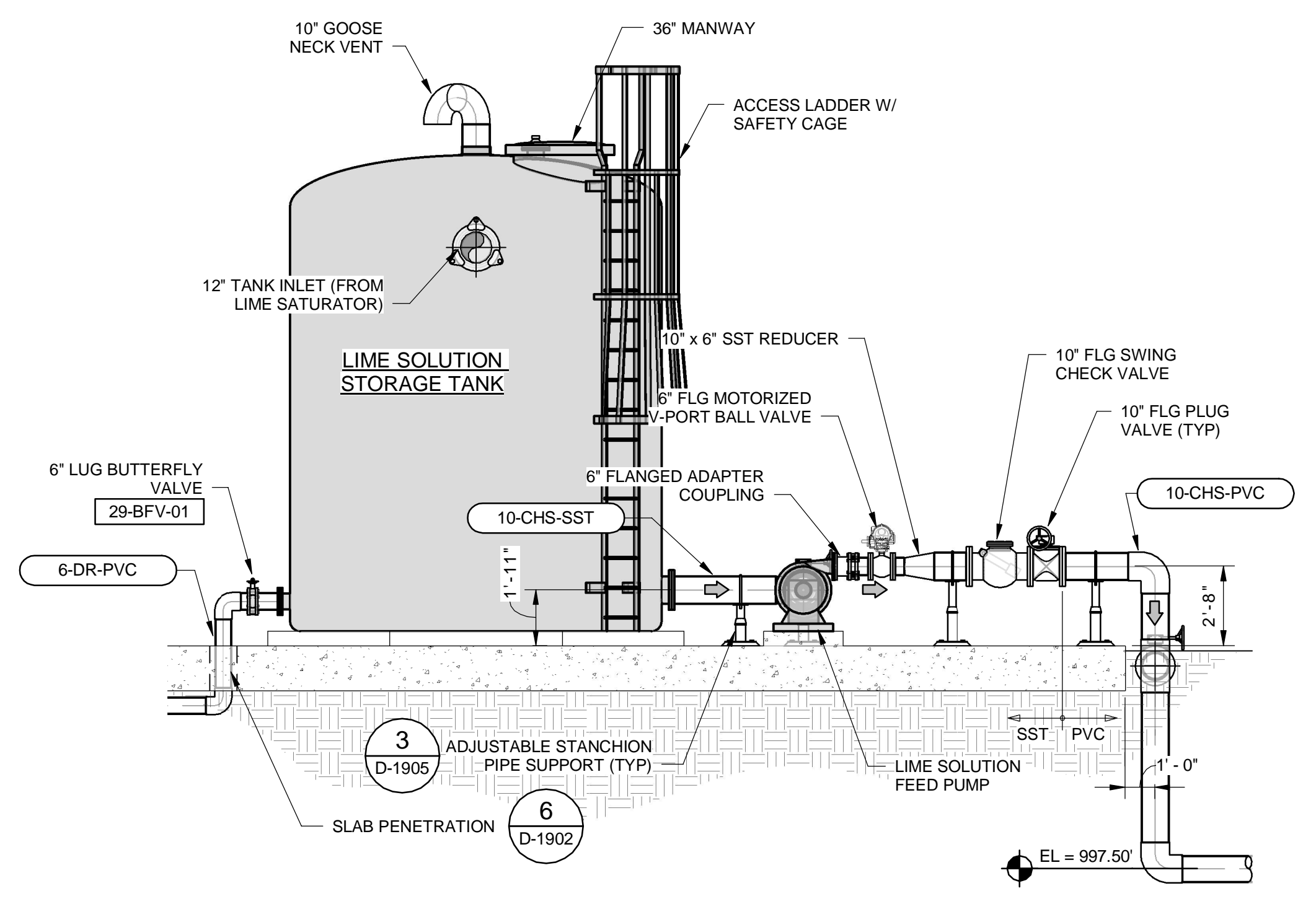


Bar measures 1 inch, otherwise drawing is not to scale





**E SECTION**  
D-1106 SCALE: 1/4" = 1'-0"



**F SECTION**  
D-1106 SCALE: 1/4" = 1'-0"

7/12/2018 1:42:00 PM BIM: 360/200-09308-18001 CMIP/09308-01-01-USAT-D-2017.rvt

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**SAN ANTONIO WATER SYSTEM**

MARK	DATE	DESCRIPTION	BY

SAN ANTONIO WATER SYSTEM  
CENTRAL WATER INTEGRATION PIPELINE  
PROJECT TERMINUS FACILITY  
LIME SOLUTION  
FEED SECTIONS

PROJ: 200-09308-18001  
DESN: JEC  
DRWN: JTE  
CHKD: JKK

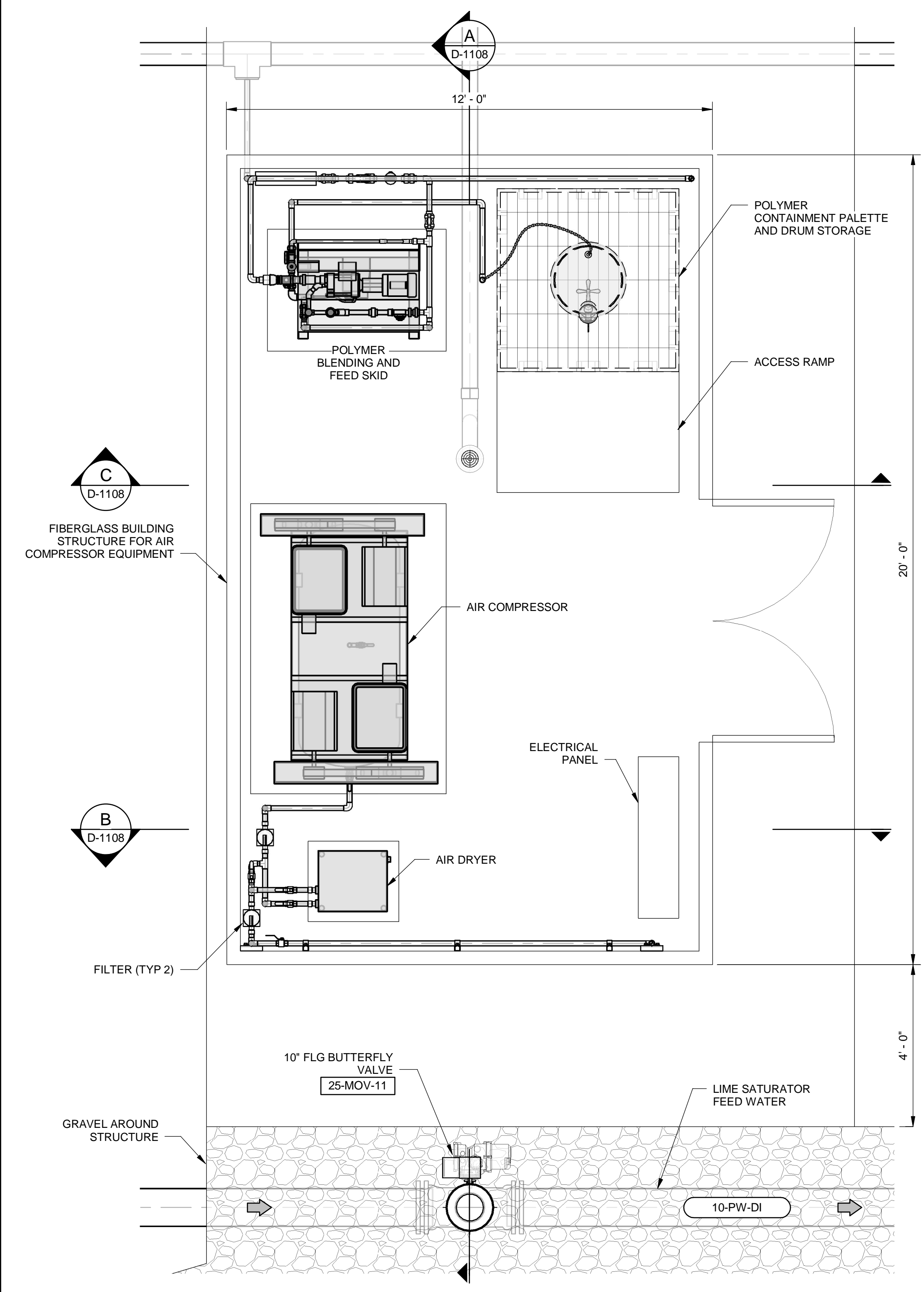
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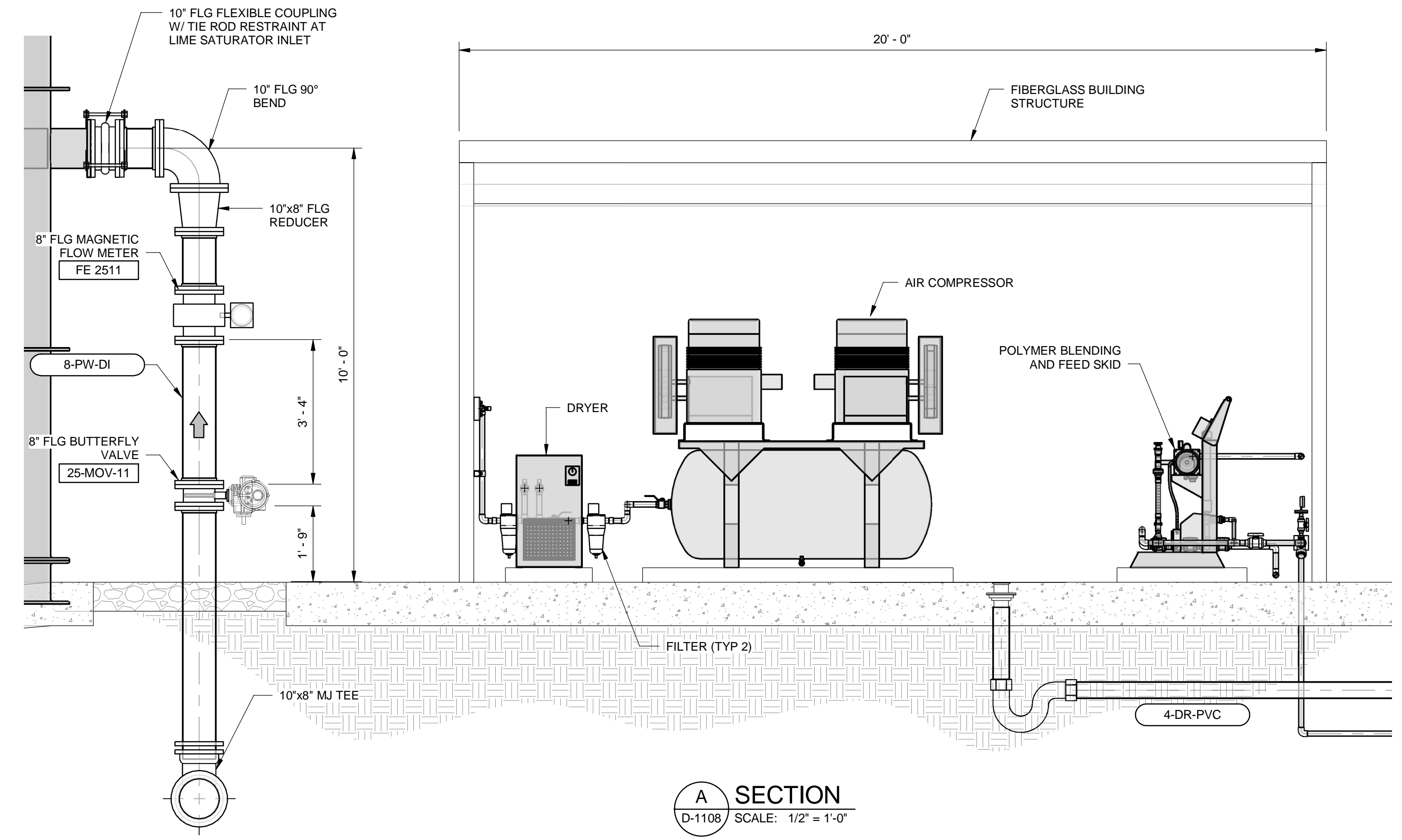
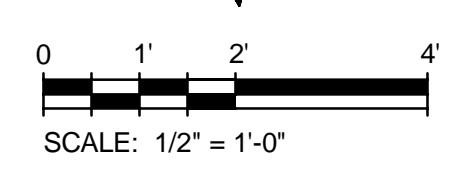
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1 2 3 4 5 6 7

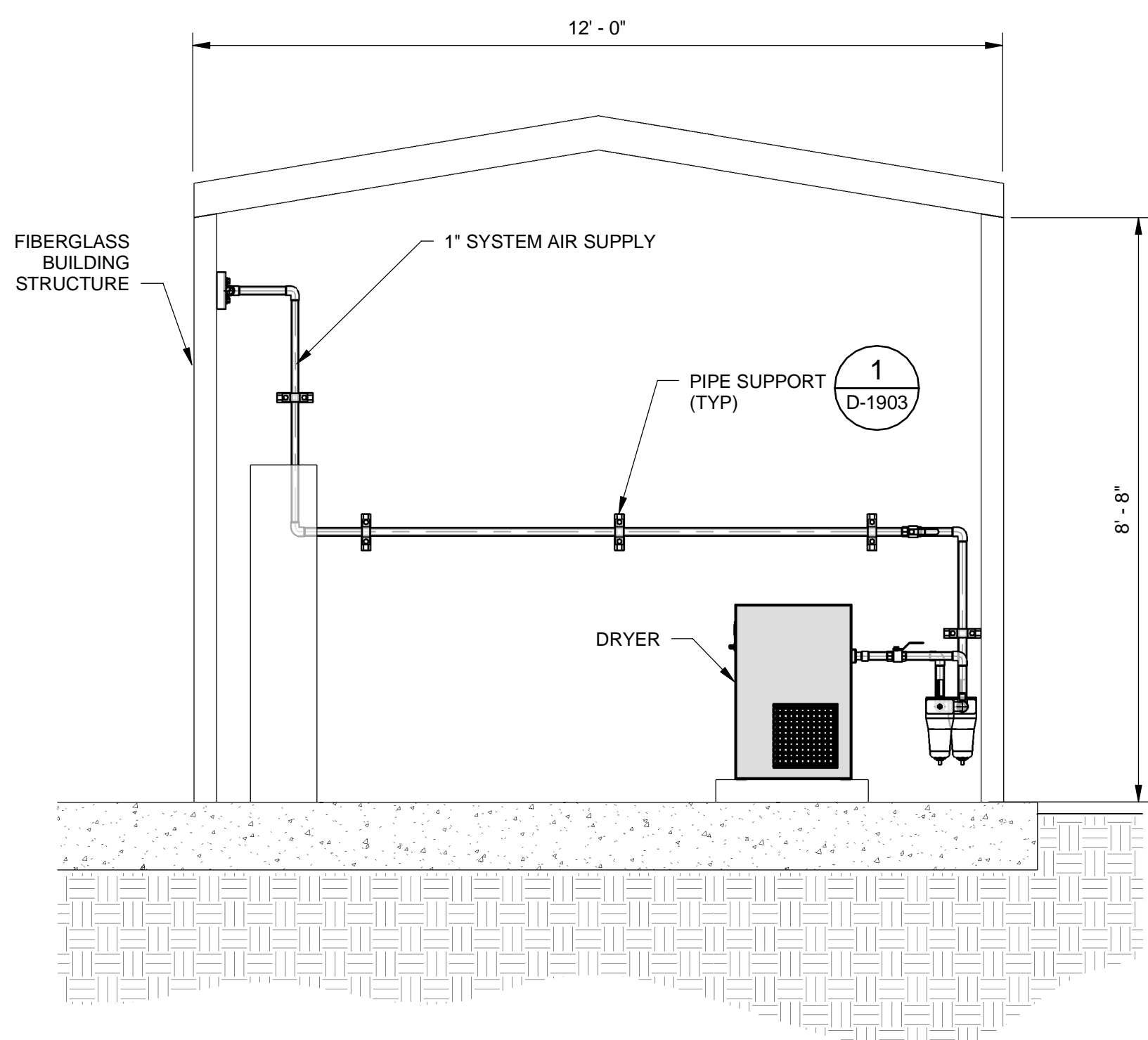
F  
E  
D  
C  
B  
A



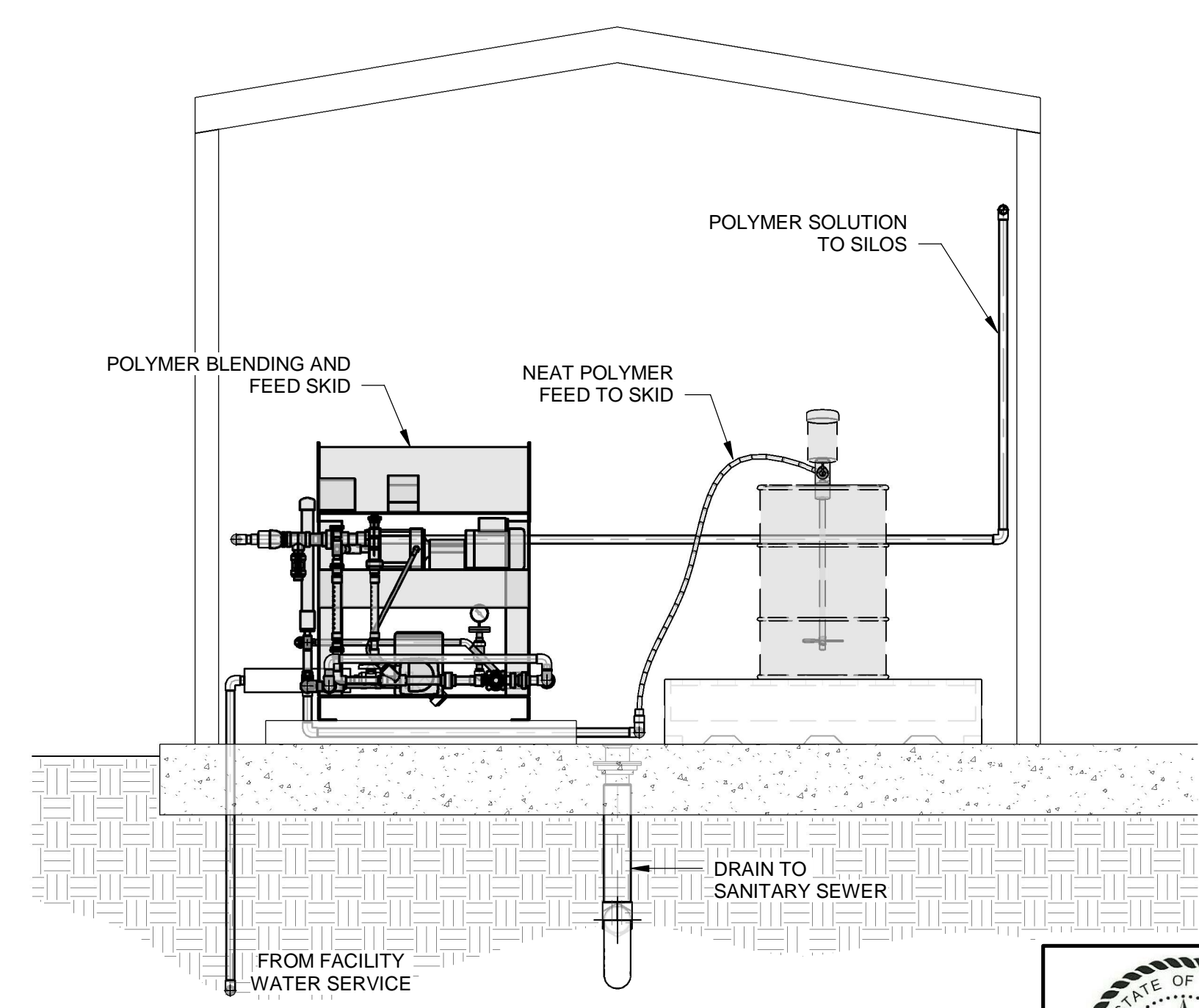
**3 AIR COMPRESSOR BUILDING**  
D-1103 SCALE: 1/2" = 1'-0"



**A SECTION**  
D-1108 SCALE: 1/2" = 1'-0"



**B SECTION**  
D-1108 SCALE: 1/2" = 1'-0"



**C SECTION**  
D-1108 SCALE: 1/2" = 1'-0"

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MARK	DATE	DESCRIPTION

SAN ANTONIO WATER SYSTEM  
CENTRAL WATER INTEGRATION PIPELINE  
PROJECT TERMINUS FACILITY  
**LIME SYSTEM AIR COMPRESSOR BLDG PLAN & SECTIONS**

PROJ: 200-09308-18001  
DESN: JEC  
DRWN: JTE  
CHKD: JKK

**D-1108**

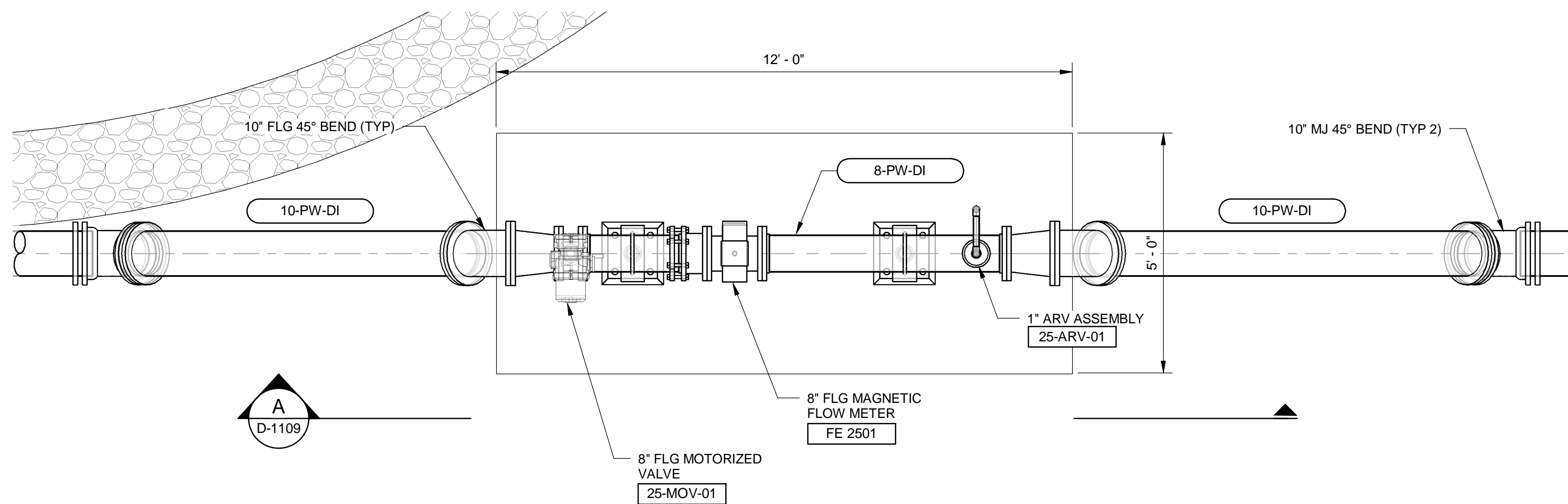
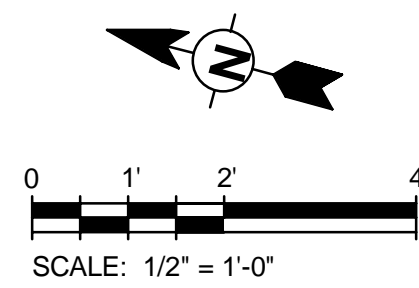


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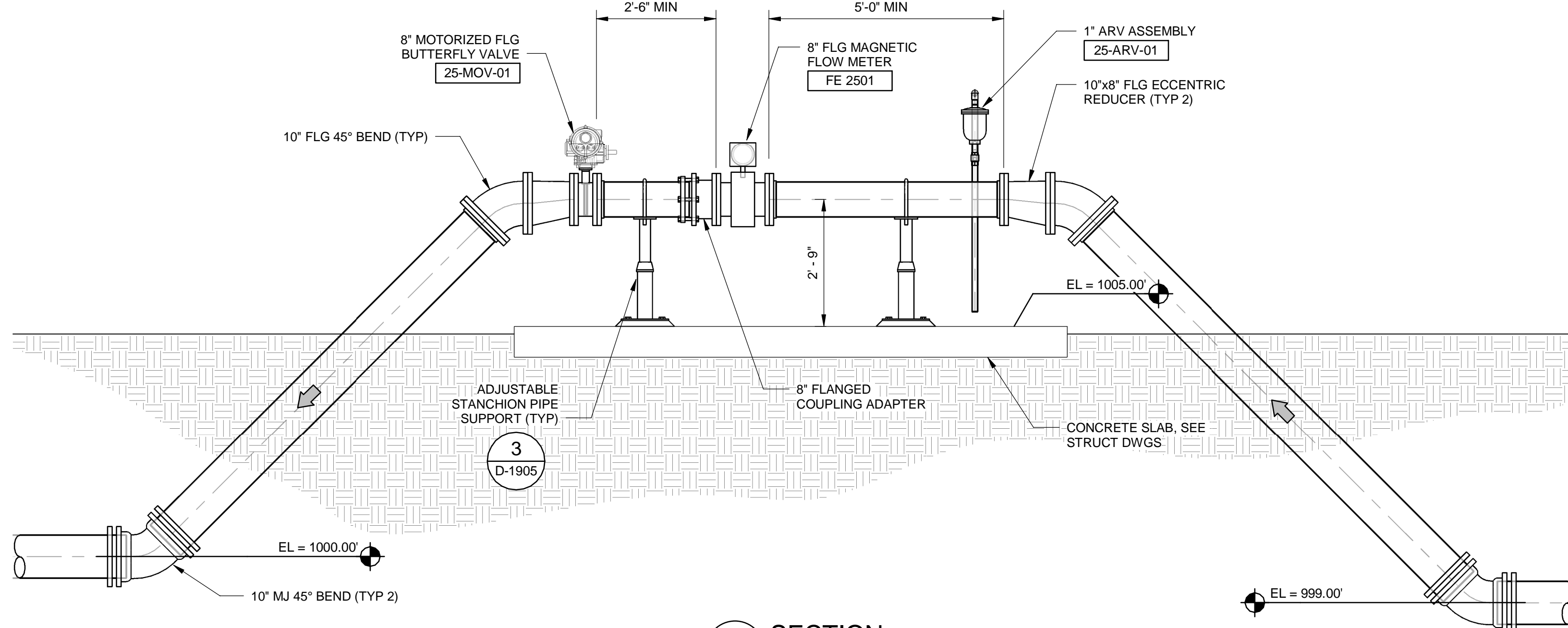
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7/12/2018 1:42:05 PM BIM 360://200-09308-18001 C:\WIP\09308-01-01-USAT-D-2017.rvt



**4 FLOW METER PLAN**  
D-1103 SCALE: 1/2" = 1'-0"



**A SECTION**  
D-1109 SCALE: 1/2" = 1'-0"

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MARK	DATE	DESCRIPTION	BY

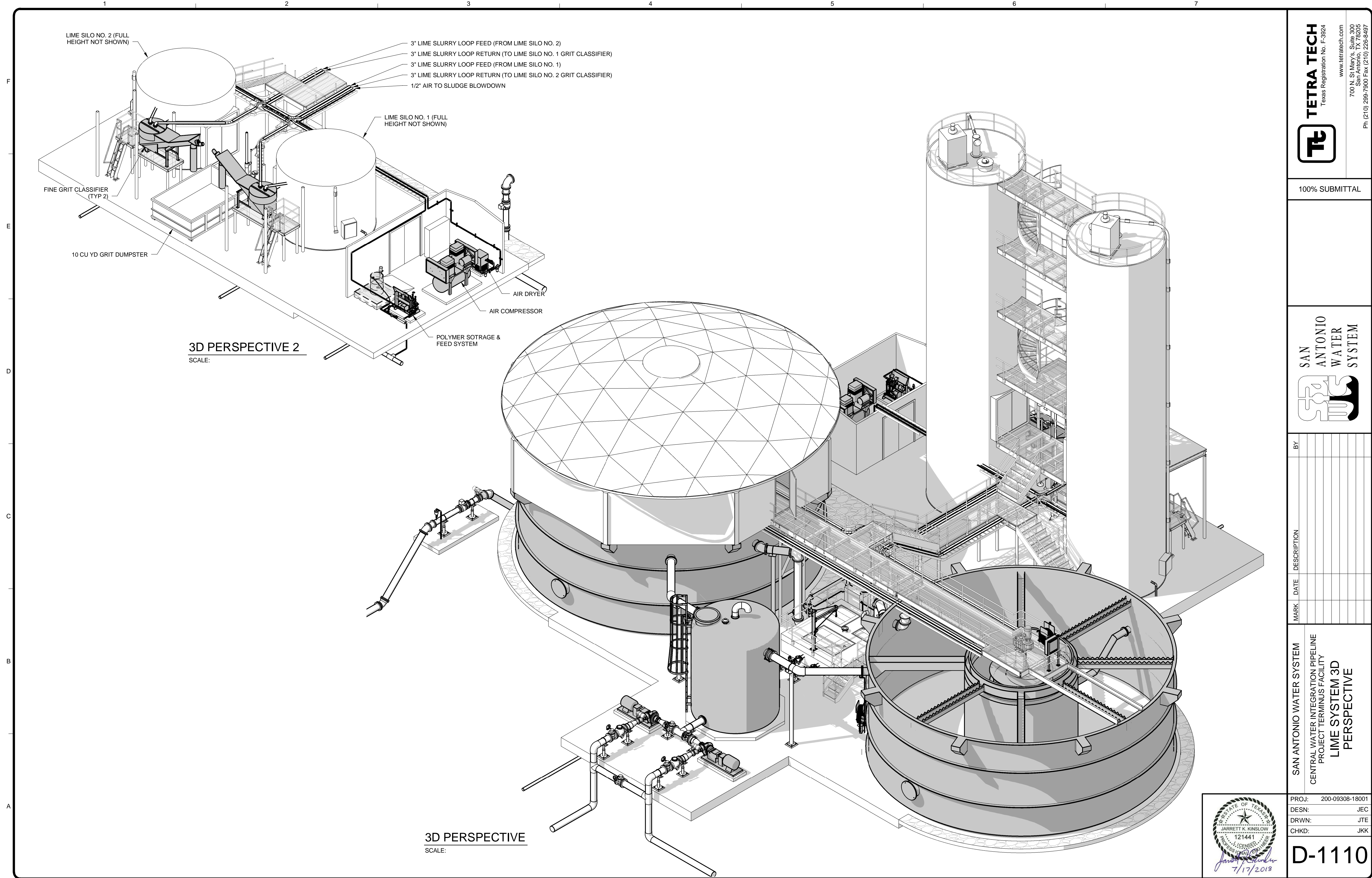
SAN ANTONIO WATER SYSTEM  
CENTRAL WATER INTEGRATION PIPELINE  
PROJECT TERMINUS FACILITY  
**LIME SYSTEM INFLUENT FLOW METER PLAN & SECTION**

PROJ: 200-09308-18001  
DESN: JEC  
DRWN: JTE  
CHKD: JKK

**D-1109**

Bar measures 1 inch, otherwise drawing is not to scale





**3D PERSPECTIVE 2**  
SCALE:

**3D PERSPECTIVE**  
SCALE:

7/12/2018 1:42:13 PM BIM\_360/200-09308-18001 CWIP/09308-01-01-LISAT-D-2017.rvt

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**SAN ANTONIO WATER SYSTEM**

MARK	DATE	DESCRIPTION	BY

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CENTRAL WATER INTEGRATION PIPELINE  
PROJECT TERMINUS FACILITY  
**LIME SYSTEM 3D PERSPECTIVE**

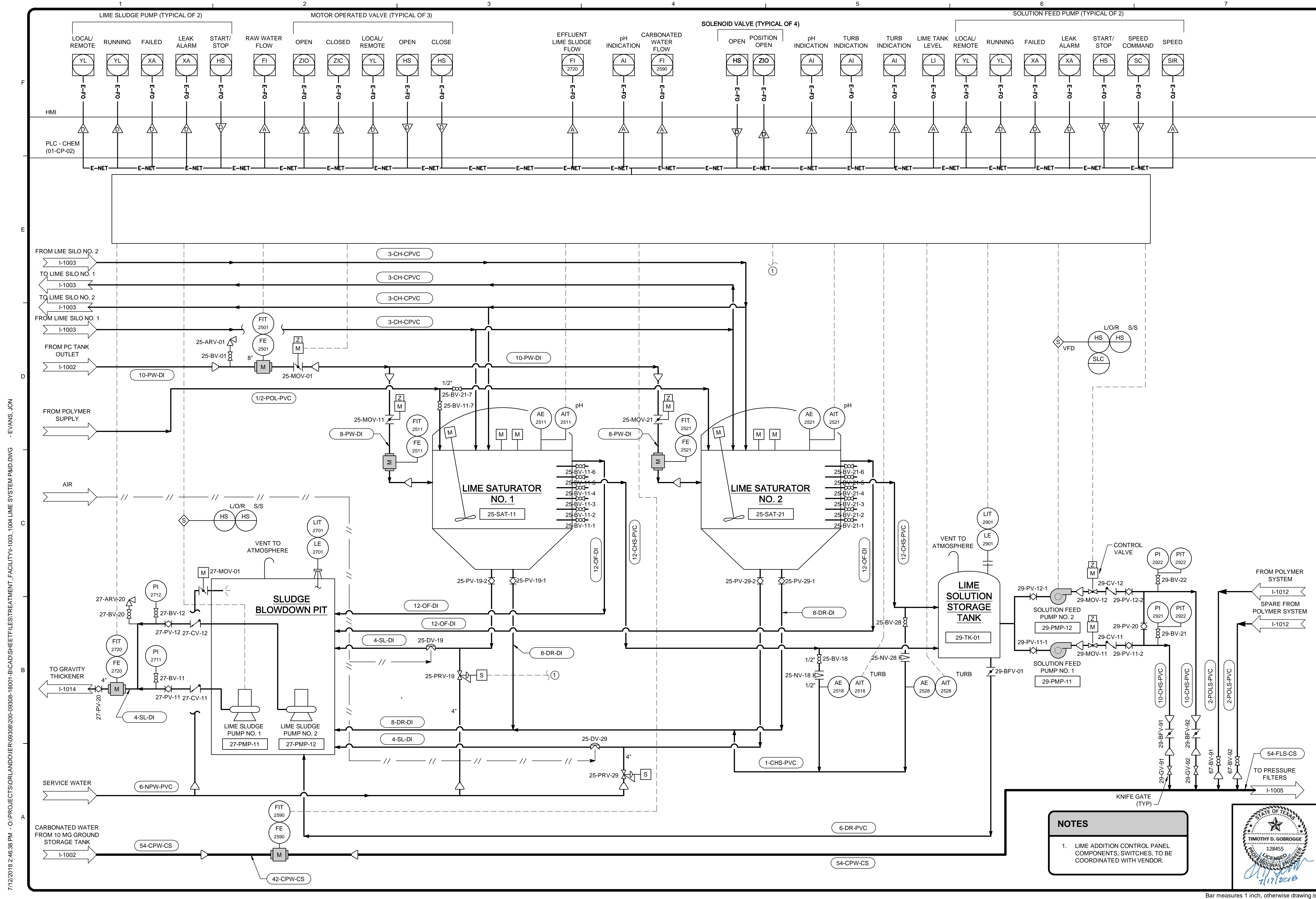
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DESN: JEC  
DRWN: JTE  
CHKD: JKK

**D-1110**



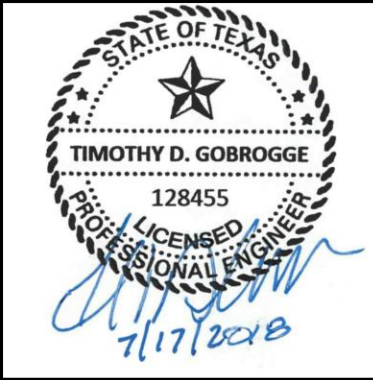
Bar measures 1 inch, otherwise drawing is not to scale





**NOTES**

1. LIME ADDITION CONTROL PANEL COMPONENTS, SWITCHES, TO BE COORDINATED WITH VENDOR.



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**SAN ANTONIO WATER SYSTEM**

BY	DATE	DESCRIPTION

SAN ANTONIO WATER SYSTEM  
 CENTRAL WATER INTEGRATION PIPELINE  
 PROJECT TERMINUS FACILITY  
**LIME SYSTEM P&ID - II**

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

**I-1004**

7/12/2018 2:46:38 PM - O:\PROJECTS\ORLANDO\09308\200-09308-18001-B\CAD\SHEET\ESTREATMENT\_FACILITY\I-1003-1004.LIME SYSTEM P&ID.DWG - EVANS, JON

Bar measures 1 inch, otherwise drawing is not to scale