Pre-Purchase of Lime Storage Silo and Feed Equipment for the Central Water Integration Pipeline Project

SAWS Job No. 18-8616
Solicitation No. 18- 18097

RELEASED FOR BID
JULY 2018

DIVISIONS 1, 11

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

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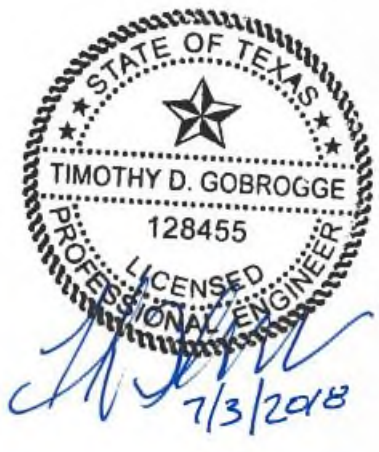
DIVISION 17



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DIVISION 11

EQUIPMENT

SECTION 11292

LIME STORAGE SILO AND FEED EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish all labor, materials, equipment, and incidentals specified, and field test complete and ready for operation, two (2) lime storage silos suitable for storage of pebble quicklime, slaking, grit removal and lime slurry feed equipment with accessories as shown on the Drawings and as specified herein.

2. Furnish the lime storage silo systems, including silo, level indicators, bin agitators, transfer screws, slakers, slurry aging tank, grit classifier, grit pumps (if applicable), slurry feed pumps/pump (as applicable), dust control systems, bulk truck unloading piping, panel and equipment, controls, valves, instrumentation, specified piping and other appurtenances necessary for a complete system.

3. The silos shall each have a total usable storage capacity of 5,000 cubic feet of dry, pebble quicklime having a bulk density of 55 pounds per cubic foot. The silos shall be designed to receive pebble quicklime from pneumatic-type delivery trucks.

4. The lime silos shall be designed with a single cone hopper. The cone hopper shall be capable of discharging pebble quicklime at a maximum rate of 5,200 pounds per hour.

5. The lime silo shall be equipped with a batch type slaking system and lime slurry aging tank. The slaking system and lime slurry aging tank will be capable of slaking and storing lime slurry such that a continuous feed of slaked lime can be fed to the saturators at a rate of 1,200 pounds per hour as dry calcium hydroxide. The lime slurry aging tank shall be sized to hold at least two complete batches of slaked lime plus sufficient excess capacity to meet the minimum suction requirements of the slurry feed pumps. The slurry feed system shall be capable of delivering 1,200 pounds per hour as dry calcium hydroxide in the form of calcium hydroxide slurry to the lime saturators at a solution strength varying between 10 and 20 percent.

B. Related Work Described Elsewhere:

1. Division 1—General Requirements

2. Section 17306 – Vendor Packaged Process Control Systems

1.02 QUALIFICATIONS

A. The equipment shall be products of Lime Silo and Feed Equipment Suppliers who are fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. The system components shall be designed, constructed, delivered and installed in accordance with the best practices and methods.

B. The Lime Silo and Feed Equipment Supplier/manufacturer of the lime silo shall have the required financial capability to produce and deliver the specified equipment.

C. The system shall be furnished by a single Lime Silo and Feed Equipment Supplier who shall be responsible for the coordination of the system design and who shall assume complete responsibilities for the proper operation of each system. The lime storage and feed system shall be as specified herein and as manufactured by RDP Technologies, or alternate system meeting the system materials and performance criteria supplied by Chemco Systems, or Merrick Industries.

D. The equipment design, layout, sizes and configuration, controls and electrical wiring shown on the Drawings are based on equipment furnished by RDP Technologies. Systems provided by alternate named Lime Silo and Feed Equipment Suppliers will be accepted provided that all of the applicable performance and materials specifications for similar functioning equipment is equal or better than those specified herein as determined by the Owner and Engineer. Lime Silo and Feed Equipment Suppliers of alternate systems will be responsible for the cost of any additional electrical, control, structural, piping or finishing work required to incorporate their equipment into the design as shown on the Drawings. All equipment, except for equipment mounted on the silo roof and the grit classifiers, are to be enclosed within the silo skirt and provided with 3 feet of clearance in front of any component requiring access for operation or maintenance. All electrical panels shall be placed so that setbacks required by Code are maintained. Any other required equipment that cannot be housed within the silo skirt while maintaining the required clearances, must be placed in an enclosure external to the silo skirt. Any external enclosures shall meet all of the requirements of the applicable building code and be equipped with lighting, ventilation, access, heating and utilities equivalent to those provided for the silo skirt. The cost of design and construction of the external enclosures, except those shown on the Drawings, shall be borne by the Lime Silo and Feed Equipment Supplier.

E. The Lime Silo and Feed Equipment Supplier/manufacturer shall have successfully provided a minimum of ten (10) installations of similar design or scope over a minimum of the last five (5) years. The Lime Silo and Feed Equipment Supplier/manufacturer shall provide a list of a minimum of five (5) references including locations, contact names, and phone numbers and cost of equipment furnished with the bid.

1.03 SUBMITTALS

A. Copies of all materials required to establish compliance with these Specifications shall be submitted in accordance with the provisions of 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 15, 2018
3.	Submittals – Level 2:	September 15, 2018

C. The Lime Silo and Feed Equipment Supplier shall submit the following with the bid:

1. Preliminary silo shop or fabrication drawings with all dimensions indicated. Include identification and catalog cuts for purchases components and details for manufactured components.

2. Pump/mixer data including:

   a. Submit catalog sheets showing pump/mixer characteristics and dimensions, including the Dimensional and Layout Data:

      1) Certified dimensional drawings of each item of equipment and auxiliary apparatus to be furnished.

   b. Submit Manufacturer's certified rating curves for each pump, showing pump characteristics for discharge head, capacity, brake horsepower, pump efficiency at the "rated" point, pump efficiency curve for pump, and guaranteed net positive suction head required (NPSHR) over the entire range of pumping requirements. This information shall be prepared specifically for each pump provided. Catalog sheets showing a family of curves will not be acceptable.

   c. Submit dry weights of pump, motor, and base plate, and weight of entire pumping unit.

   d. Submit dry weights of mixer, motor, and base plate, and weight of entire mixer unit(s).

3. Internal configuration of equipment (vibrator, feeder, slaker tank, slurry aging tank, grit classifer, and slurry pumps).

4. Valve supplier and data sheets.

5. Summary table listing the make and model of all valves, actuators, instrumentation field devices, and any other appurtenances to be furnished with the Lime Silo and Feed Equipment.

6. Performance guarantee approved by authorized signatory.

D. The Lime Silo and Feed Equipment Supplier shall submit the following with Level 1 submittals (August 15, 2018):

1. Silo shop or fabrication drawings with all dimensions indicated. Include identification and catalog cuts for purchases components and details for manufactured components. Identify materials, surface preparation, and finishes. Include ASME calculations of wall thickness for the silo.

2. Flow schematic drawing indicating line sizes of pipes connecting to and from feeder, vibrator, slaker tank, slurry aging tank, grit classifier, and slurry pumps, valving, utility (air, water, drain, electric) line sizes and connections.

3. Structural drawings and calculations for the storage silos and supports. Structural drawings and calculations for the storage silos 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. Complete pump/mixer package submittal including:

   a. Submit catalog sheets showing pump/mixer characteristics and dimensions, including the Dimensional and Layout Data:

      1) Certified baseplate (if applicable), support, and anchor bolt plans and details.

      2) Schematic electrical wiring diagram and other data as required for complete pump/mixer installation.

      3) Certified sectional drawing of pumping unit(s)/mixers with part numbers and material specifications.

   b. Cross-sectional drawings with detailed construction of each component in the pump/mixer along with the ASTM material designations.

   c. Bill of materials.

   d. Electrical and instrumentation data as detailed below.

   e. Performance curves.

   f. Data sheets applicable to proposals, purchase, and as-built drawings.

   g. Performance information.

   h. Certified drawings of auxiliary systems.

i. Forces and moments analysis, along with thrust calculations at the pump feet and at the anchor bolts. Also provide certified pump support and anchor bolt plans and details.

j. Manufacturer's installation instructions.

k. Qualifications of Service Engineer.

l. Factory test procedure and schedules for factory witness testing.

m. Materials certifications for castings, impellers, shafts, and shaft sleeves.

n. Certified motor test data.

o. Spare parts recommendations and price lists.

p. Submit mixer/pump/motor coupling manufacturer, model number, AGMA 9002-A clearances and tolerances.

q. Pumps: submit hydraulic thrust and radial load calculations along with L10 bearing life of each bearing and submit shaft design calculations including deflection at impeller and at mechanical seals.

6. Complete valve submittal according to Section 15100.

7. Affidavits of compliance with referenced standards and codes.

8. AWS certificates for welders fabricating the lime silos

9. Applicable certifications and ratings.

10. Shop inspection schedule.

11. Detailed drawings illustrating equipment arrangement, bill of materials, weights (dry and operating), size, and location of all anchor bolts and nuts, and plan view system drawing.

12. Piping arrangement drawings or plans and elevation drawings including details (i.e., flanged etc.) and location of all required connections to utilities and piping.

13. Unloading, storage and installation instructions.

14. List of any extra materials or supplies provided.

15. Proof of conformance with ANSI/NSF Standard 61 for all materials that come into contact with process water or with lime chemicals (in any form) within the system to be provided.

E. The Lime Silo and Feed Equipment Supplier shall submit the following with Level 2 submittals (September 15, 2018):

1. 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 all other Division 17 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 Silo and Feed 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) Physical point address: rack, slot and point 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, PO – Pulse Output or Ethernet (serial DI/DO/AI/AO).

g) Range

h) Engineering unit

5) Software Package Submittal:

a) Submit details of all software packages provided with the PLC. Indicate all standard and optional features provided.

b) Indicate the specific software versions that will be provided for each package.

c) Submit process control narratives prepared specifically for this project.

6) Control System Standards and Conventions Submittal:

a) Submit system configuration, including network (TCP/IP) addressing. Network addressing shall be defined to enable the plant PLC system to communicate with the Filter System control system.

b) Software tag naming conventions

c) OIT Graphic display standards, including color conventions, equipment symbols, display format, and samples of each proposed type of graphic display.

d) Alarm configuration standards, including priorities, logging, and resetting

e) Security configuration standards, including user groups and privileges

f) PLC software templates, including equipment control, sequence control and equipment runtime calculations

7) 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

8) Data Transfer Address List Submittal

a) Submit a complete Data Transfer List defining all software points for communication to/from the plant SCADA.

b) 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 Process Control Systems Integrator (PCSI).

c) The data transfer list shall be submitted in both a Microsoft Excel readable electronic file format and hard copy.

d) As a minimum, the data transfer list shall include the following information:

1. TAG NAME: The identifier assigned to the software point.

2. DESCRIPTION: A description of the function of the device

3. LOGICAL POINT ADDRESS: Software address of each point.

4. POINT TYPE:

   DO - Discrete Output is written to the Lime control system by the plant PCS.

   DI - Discrete Input is read from the Lime control system by the plant PCS.

   AO - Analog Output is written to the Lime control system by the plant PCS.

   AI - Analog Input is read from the Lime control system by the plant PCS.

5. 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.

6. 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 are "1."

7. ENGINEERING UNITS: The engineering units associated with the Analog points.

F. The Lime Silo and Feed Equipment Supplier shall submit the following with Level 3 submittals:

7. The Supplier shall submit operation and maintenance data in accordance with Section 01730.

8. Submit a Manufacturer's field report, including a report of installation, inspection, testing, and observations for each silo, slaker tank, slurry aging tank, pumping units, dosing assembly and all other miscellaneous equipment in a Letter of Certification.

1.04 OPERATING INSTRUCTIONS (COORDINATE WITH DIV 1)

A. Six (6) copies of an operating and maintenance manual shall be furnished in accordance with Section 01730. The manual shall be prepared specifically for this installation and shall include all required catalog cuts, drawings, equipment lists, PLC programming, descriptions and necessary information that are required to instruct operating and maintenance personnel unfamiliar with 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 the proper operation and maintenance shall be provided for a minimum of eight (8) hours 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 time. 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 instructions shall be provided at a time that is approved by the Owner and be in accordance with Section 01730.

1.05 TOOLS AND SPARE PARTS

A. Special tools required for normal operation and maintenance shall be supplied for each piece of equipment furnished.

B. Each piece of equipment shall be furnished with the manufacturer's recommended spare parts to include the following:

1. 1 Set - Dust filters/cartridges.

2. 1 Box - Indicator lamps and fuses of each size and type used for the control panel.

3. 2 sets - All gaskets, seals and packing used for specified equipment.

4. One year supply of each type of lubricant required.

5. 1 set - Fittings for the silo fill piping.

C. All tools and spare parts shall be furnished in containers clearly identified with indelible markings as to their contents. Each container shall be packed with its contents protected for storage.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Product delivery, storage and handling of all equipment shall be in accordance with Section 01600. All equipment and parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the equipment is ready for operation.

B. All equipment and parts must be properly protected against any damage during a prolonged period at the site.

C. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

D. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

E. Each box, crate or package shall be properly marked to show its net weight in addition to its contents.

F. Handle during delivery, storage and installation in a manner to prevent damage of any nature in accordance with the manufacturer's approved instructions.

1.07 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 Silo and Feed Equipment Supplier shall be responsible for all patents or licenses that exist because of the equipment that may be provided.

2. The Lime Silo and Feed Equipment Supplier shall assume all costs of patent fees or licenses for the equipment or process, and shall safeguard and save harmless the Owner 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.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT - GENERAL

A. These Specifications are intended to give a general description of what is required but do not cover details of construction which may vary in accordance with the exact requirements of the equipment as offered.

B. All necessary accessory equipment and auxiliaries required for the proper functioning of the lime storage and feed system installation incorporating the highest degree of standards for the specified type of service shall be furnished by the Lime Silo and Feed Equipment Supplier whether or not specifically mentioned in these Specifications or shown on the Drawings.

C. The materials covered by these specifications are intended to be standard equipment of proven ability and as manufactured by reputable concerns, having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily.

D. All equipment shall be designed and fabricated to have liberal strength, stability, and stiffness and to be especially adapted for the intended service.

E. All bolts, nuts, washers, plates, clamps and other mounting hardware shall be Type 316 stainless steel. All equipment and piping shall be rigidly and accurately anchored into position and all necessary mounting hardware shall be furnished and installed.

F. All motor couplings, V-belt drives and similar exposed rotating equipment shall be provided with removable, all metal guards in conformance with OSHA requirements. Guards shall be fabricated of steel and shall be hot-dip galvanized, after fabrication.

G. When completed, the lime storage silo systems shall be completely dust-tight. Equipment shall be weathertight and suitable for outdoor operation.

1. All motors furnished under this Section shall be in accordance with the following requirements:

a. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable: General Electric and U.S. Motors. The listing of specific manufacturers does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed are not relieved from meeting these specifications in their entirety.

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

c. The motor manufacturer’s nameplates shall be engraved or embossed on stainless steel and fastened to the motor frame with stainless steel screws

or drive pins. Nameplates shall indicate clearly all of the items of information enumerated in NEMA Standard MGI, as applicable, including but not limited to the following information: Horsepower (output), RPM at full load, frequency, number of phases, model number, rated voltage, service factor, full load amps, insulation class, NEMA design letter, NEMA code letter, temperature rise at 1.15 SF, NEMA frame size, motor weight, date of manufacture, thermal protection (if supplied), ambient temperature rating, max KVAR allowed, and power factor.

d. Where frequent starting occurs, the design for frequent starting duty shall be equal to the duty service required by the driven equipment.

e. Motors shall have sufficient horsepower and torque capacity to drive the equipment without overloading under all conditions, without exceeding the nameplate rating of the motor and without use of the service factor.

f. Motors shall have a breather drain in each end bracket of the TEFC motor enclosure. Stainless steel automatic breather drains shall be provided in the lowest part of both end brackets to allow drainage of condensation.

g. Motors shall be slide rail mounted for all belt or chain-driven applications.

h. Air inlets and outlets shall be protected by vermin-proof, corrosion resistant louvers. The air inlets shall be located on end or side as required by the application.

i. Motors shall have an oversized, gasketed, cast iron conduit box, field adjustable in 90- degree increments unless the box contains equipment, diagonally split with tapped NPT threaded conduit entrance hole, and shall exceed the minimum volumes defined in IEEE 841-2001. Neoprene conduit box cover gasket and neoprene lead seal gasket with flexible nipples to ensure the seal is maintained as the leads are moved shall be furnished. Provision for grounding shall be provided in the conduit box utilizing a mounted clamp- type lug.

j. Provide separate accessory lead conduit boxes. Minimum size entrance hub shall be ¾”C. Resistance temperature detector leads shall not occupy the same box with any other type of power or monitoring leads.

k. Motor frames, end brackets, and conduit box shall be of cast-iron.

l. Provide lifting lugs on the motor frame.

m. Motors shall be NEMA Design B standard, unless otherwise specified in these Specifications.

n. Service factor shall be 1.15 for all motors. In sizing motors, no portion of a motor’s service factor above 1.0 shall be used in normal continuous

operation of the motor.

o. Motors shall be totally enclosed fan cooled (TEFC). All TEFC Motors shall have corrosion resistant enclosures, fan, cover, epoxy paint, corrosion resistant fittings and stainless steel nameplates.

2. Guards:

a. Exposed moving parts shall be provided with guards in accordance with the requirements of OSHA. Guards shall be fabricated of flattened expanded metal screen, 3/4-inch No. 10, to provide visual inspection of moving parts without removal of the guard.

b. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Windows shall be provided in the guard for access to the lubricating fittings.

3. Motors ½ HP and larger:

a. Motor voltage shall be 3-phase, single voltage, as shown on the Drawings, and in compliance with IEEE 841.

b. Motors shall have NEMA standard Class "F" insulation with a maximum temperature rise of 90 Deg C above a 40 Deg C ambient, on a continuous operation or intermittent duty, at nameplate horsepower.

c. Motors shall have non-hygroscopic encapsulated windings. Motor leads shall be Class F rated, with permanent identification.

d. Motor rotors and assembly, shall be dynamically balanced.

e. Motors less than 15 HP shall have a locked rotor inrush not exceeding MG 1. Motors 15HP and larger shall have a locked rotor inrush kVA` not exceeding Code G (6.29 KVA/HP).

f. The motor insulation system for motors controlled with AFD's shall be inverter duty rated and have full capability to handle the common mode voltage conditions imposed by the AFD. Motor insulation system shall conform to all of the requirements of the latest version of NEMA MG1, Part 31 for peak voltage withstand capability. All motors controlled with AFD's shall have minimum 1600 Volt insulation system.

g. The critical speed of the shaft and rotor assembly shall exceed the operating speed by a minimum of 10 percent.

h. The no-load sound pressure level, based on the A-weighted scale at 3 feet, when measured in accordance with IEEE Std. 85 shall not exceed 85 dBA.

i. Vibration limits shall not exceed 0.2-in/sec at any frequency.

j. Motors shall have a minimum of one grounding pad on each motor frame.

k. Bearings:

1. Motors 1/2 through 5 HP shall have permanently lubricated sealed antifriction ball-bearings and motors larger than 5 HP shall have oil or grease-lubricated antifriction ball- bearings. All bearing shall have a L10 lifetime of 60,000 HRS.

2. Vertical motor thrust and guide bearings shall conform to AFBMA standards and shall have L10 lifetime ratings as specified for ball-bearings of the same horsepower range. Down thrust information shall be provided to the motor manufacturer by the equipment supplier.

3. Anti-friction motor bearings shall be designed to be regreasable and initially shall be filled with grease suitable for the motor ambient temperature specified.

4. Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic type as manufactured by the Alemite Division of the Stewart Warner Corporation.

5. Sealed bearings shall be contact seal (lip) or non-contact labyrinth type.

6. Motors controlled by AFD's shall have the opposite drive and bearing insulated and a shaft grounding brush installed on the drive end bearing.

l. Space heaters shall be supplied with all outdoor, 3-phase motors, 10 hp and above. Heaters shall be of the cartridge or flexible wrap around type installed within the motor enclosure adjacent to core iron. Heaters shall be rated for 120 V, single phase with wattage as required. The heater wattage and voltage shall be embossed on the motor nameplate. Power leads for heaters shall be brought out at the motor accessory lead junction box

4. Motors shall have a maximum speed of 1,800 rpm, unless noted otherwise herein.

5. Motor horsepower required shall be as determined by the Lime Silo and Feed Equipment Supplier and as approved by the Engineer. Motors shall be designed for operation on a power supply as specified below in this Section.

2.02 DESIGN REQUIREMENTS

A. The lime slaking and feed system shall be designed and sized to allow pebble lime (93% calcium oxide) to be slaked to produce a calcium hydroxide solution. The batch slaking system will be designed and sized to achieve the maximum slaking temperature to ensure that the slaking reaction is complete before diluting the slurry or transferring it to the slurry holding tank. The system shall be able to control the quantity of lime and water added to the slaker to be able to control the slaking temperature within 5 degree of a predetermined set point to within a range of 170 to 195 degrees Fahrenheit without additional operator input or adjustment. After the slaking reaction is complete the lime slurry will be diluted to an operator input concentration set point between 10 and 20% as calcium hydroxide. The concentration will be controlled by the direct measurement of lime and water. The slurry concentration shall be able to be controlled within +/- 0.5% of the set point.

B. The system shall be proportioned and designed to resist all loads and stresses caused by the material stored, especially during lime loading operations, as well as local wind and seismic conditions. The lime silo shall be designed for a super imposed roof live load of 50 PSF, a wind load of 130 MPH and 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

C. 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 storage silo 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.

D. All welds to construct the silo 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.

E. All components that come into contact with the lime chemical (in any form) and with process water used in the system shall conform to ANSI/NSF Standard 61 for suitability with use in potable water systems.

F. All electrical equipment and wiring shall conform to the applicable NEMA and NEC Standards, and the Standard Building Code.

2.03 LIME STORAGE AND FEED SYSTEM

A. The lime storage and feed system shall consist of, but not be limited to, the following components:

1. Storage Silo
2. Silo Level Indicator Switches
3. Silo Bin Activator
4. Silo Dust Filter
5. Knife Gate Valves
6. Lime Feeder
7. Slaker Dust Collector.
8. Slaker Tank
9. Slaker Mixer and Slurry Tank Mixer
10. Grit Classifier
11. Slurry Aging Tank
12. Slurry Recirculation Pumps
13. Double Doors and Frame
14. Ventilation Fan and Damper
15. Fixed Aluminum Stormproof Louver
16. Access Ladder/Platforms
17. Aluminum Handrailing
18. Silo Roof Access Manhole
19. Fill Pipe
20. Lime System and Truck Fill Panel
21. Lime Slaking and Feed System Control Panel
22. Electrical Distribution Panel
23. Interior Electrical and Lighting

2.04 LIME STORAGE SILO

A. Each storage silo shall be not exceed the dimensions as indicated the Drawings and shall include a single compartment bin, with conical hopper bottom, and structural skirt. Structural steel plates shall be minimum 1/4-inch thick and in accordance with ASTM A36. The silo shall incorporate a 60° cone bottom terminating with 1/2-inch thick, minimum, flanged bottom opening/connections. The flanged bottom opening/connection shall be sized and drilled to connect to an inlet knife gate valve. Mounting pads shall be provided for the silo vibrators. Connection and interior paddle guards shall be provided, near the roof access ladder, for intermediate and low silo level indicator switches.

B. The elevation of the bottom of the hopper discharge shall be as indicated on the Drawings. Each lime storage silo shall be designed with a usable storage volume of 5,000 cubic feet. The lime storage silo shall be designed to accommodate all dead and live loads anticipated, including vibrations from silo vibrating devices and a total full live load of pebble quicklime with a bulk density of 55 pounds per cubic foot. The interior of the silo storage compartment shall be smooth with no inward projecting members, except protection plates for silo level indicators. The lime storage silo shall be completely dust-tight and weatherproof. All connections to the storage compartment shall be by flanged and gasketed connections. Gaskets for flanged connections shall be neoprene, full faced type. All nuts, bolts, washers and other hardware for bolted, ANSI 125/150 pound flanged connections shall be Type 316 stainless steel. (Intermediate platform and bottom angle)

C. The silo manufacturer shall supply the silo skirt with an upper level floor to support the lime feed and slaking equipment. An aluminum tread plate floor shall be provided. The Lime Silo and Feed Equipment Supplier will be responsible for the structural design of the floor plate and support structure to support all equipment, live and dead loads.

D. The silo manufacturer shall provide the silo with shear tabs for the attachment of the platforms between the silos as shown on the Drawings. The silo shell shall be designed to support the loads imposed by the landings and stairs; 1,500 lbs Dead Load and 12,500 Live Load.

E. The silo manufacturer shall install rolled angle stiffening rings on each silo assembly, to provide structural integrity. A silo roof angle stiffening ring shall be a minimum 2 1/2-inch x 2 1/2-inch x 1/4-inch angle, continuously welded outside the silo shell and to the roof plates. Where the silo straight wall intersects the silo cone, a minimum 4-inch x 4-inch x 1/4-inch angle stiffening ring shall be continuously welded to the silo wall to prevent cone separation from the silo straight wall. Top surface of angle leg shall be welded to the silo storage compartment wall, the bottom of the angle shall be welded to the silo skirt, and the cone section shall be welded to the inner portion of the ring.

F. The silo roof shall be constructed of minimum 1/4-inch structural steel plate and shall be have a slope of 10°. The silo roof shall be reinforced such that the deflection will be less than 1/240. The roof shall be designed to support a live load of 20 psf. Where applicable, all flanges shall be a minimum of 125 lb connections unless noted otherwise within these specifications. The roof shall be designed to support all roof appurtenances and shall have the following appurtenances and connections:

1. Flanged connection for a 24-inch square or round combination manhole with-pressure/vacuum relief valve.

2. Flanged nozzle type connection of 1/4-inch steel plate suitable to support the silo dust collector/filter.

3. Flanged nozzle connection no smaller than 14 inches O.D. for a material inlet turbulence (target) box with screw cap clean out.

4. Flanged nozzle connection for high silo level indicator switch.

5. Two (2) flanged nozzle connections for radar bin level sensors.

G. The storage silo and skirt shall be of all welded construction. All welding for the silo shall be continuous, seal welded throughout shop fabrication. All welded joints for the silo shall be full penetration butt welds, both on the interior and exterior. Single pass welding on the exterior only shall be rejected. The lime silo shall be shipped in the minimum number of pieces required for final field assembly and welding at the Project site.

H. The storage silo fill pipe shall be 4-inches, schedule 40 steel, equipped with long radius elbows and dresser couplings. Fill pipe will be located at the target box and within 4-feet of the unloading control panel. The fill line shall be provided with a dust cap and NEMA 4 limit switch to control the operation of the dust collector.

I. The silo will be equipped with continuous level monitoring equipment to measure the level of the product within the storage portion of the silo. A continuous level monitoring device will be mounted on the silo roof adjacent to the target box. The device shall be a guided radar bin level sensor with 4-20 ma output corresponding to 0 to 100% level in the bin provided in a NEMA 4X enclosure. Silo will be equipped with a 6-inch diameter 150 pound flange bolts and gaskets for mounting of the sensor. Silo shall also be equipped with a high level sensor mounted on the roof of the silo near the target box and a reorder level sensor mounted on the side of the tank. Silo shall be provided with 6-inch diameter 150 pound flange connections for mounting of the level sensors. Sensor switches shall be rotating paddle type with stainless steel paddle, NEMA 4 polyester-coated aluminum housing, 120 volt, single pole, double throw switch or equal.

J. The skirted portion of each storage silo shall have the following:

1. Two (2) 5 kW unit heaters rated at 400 CFM and 17,100 BTU per hour with one (1) SPST built-in thermostat for a temperature range of 45° to 90°. The heater shall be horizontally mounted with mounting hardware and shall be 480 volt, 3 phase, 60 Hz.

2. Two dampers and exhaust fans as specified in Section 2.16

3. Two (1) double door openings one on the ground level and one on the upper level. Each type door being a minimum of 3’-0” wide by 6’-8” high. The doors will be aluminum with an anodized or Kynar coating to match the color of the exterior of the lime silo. The door size listed here is the minimum. The doors shall be sized to provide at least 6 inches of clearance (height and width) around the largest item of equipment installed within the silo skirt to provide access for installing and removing the equipment. The doors will be supplied with stainless steel hinges and lockset. The door hardware and keying shall conform to the project hardware requirements and be provided by the same manufacturer.

4. Six (6) minimum 1600 lumen LED light fixtures, wall mounted, vapor tight.

2.05 SILO VIBRATOR/BIN ACTIVATOR

A. A 115 volt, 60 hertz, 1 phase electric impact vibrator shall be provided for the silo cone section for each silo. The vibrators shall be capable of 3,600 vibrations per minute, adjustable impact. Controllers to be housed in a NEMA 4X stainless steel enclosure. The unit to be field mounted and wired. Silo vibrator shall have adjustable vibrating frequency and timer controls. The vibrator controls shall be furnished in a NEMA 4X Type 316 stainless steel control panel, mounted as shown on the Drawings. The silo vibrator controls shall be interconnected with the lime feeder/slaker controls such that the appropriate vibrator shall operate only when the corresponding lime feeder/slaker is in operation.

B. The bin activator shall include independent primary and secondary cone shaped baffles attached to the silo vibrator to provide a positive flow of lime. The system is constructed so vibration is transmitted to both the inner cone and the outside shell. Vibration shall be generated by a motor-driven eccentric type oil lubricated gyrator. Motor enclosures shall be TENV. Electric controls for this unit shall be provided in the control panel for the feeder and slaker systems

C. The bin activator shall have a gyrated type hopper with eccentric weights mounted such that vibration is applied perpendicular to the flow. The vibrating bottom shall be hung from the bud with rubber-bushed steel hangers and connected to the bins with reinforced butyl sleeves such that no vibrations are transmitted to the bin. The discharge spout shall be fitted with a flex connection suitable for connection to the screw feeder. The activator shall be coated with the manufacturers standard shop finish.

2.06 SILO DUST FILTER

A. A complete pulse-jet bin vent filter shall be furnished on each silo as specified herein and shown on the drawings. The system shall contain product within the bin or silo while discharging air displaced by product filing the storage device. An alternate dust filter system providing equivalent dust control using the baghouse shaker type design will also be acceptable.

B. The filter system shall operate at an air-to-media ratio of 3:1. The model number shall indicate the quantity of filter cartridges. The filter shall be provided either as an insertable model for minimum headroom applications or as a plenum model. The bin vent shall be furnished complete with filter cartridges, cleaning system hardware, installation and maintenance manual and replacement parts list.

C. The bin vent shall be of bolted and welded construction using 12 gauge HRS complete with pulse jet pipework, 3/4" diaphragm valves and blowpipes, pilot solenoid valves, 4" square x 3/16" wall tubing compressed air manifold, venturis to enhance cleaning, and a top service door with prop brackets and safety latch. Filter replacement shall be performed without tools. The compressed air connection shall be 1" NPT for attachment of clean and dry compressed air at 90100 PSIG and at a temperature not exceeding 150□F.

D. Filter cartridges shall be supplied preassembled in a vertical configuration, serviced from outside on the top of the unit and on the clean side of the filter. Product entrained in the storage container while filling shall enter at the bottom of the filter and collect on the outside surface of the filter cartridge. Clean air shall pass through the filter media and escape through the back of the filter or through an optional exhaust fan.

E. The collector cleaning system shall be controlled by a solid state printed circuit cleaning control. The cleaning control shall progressively energize pilot solenoid valves, which cause the corresponding diaphragm valve to send a pulse of 90-100 PSIG supply compressed air into the blowpipe. The pulse shall be discharged from the air manifold through the diaphragm valves, through the blowpipe, into the filter venturis, and into the filter cartridge, discharging product from the media surface. Product shall fall into the storage container.

F. The collector shall be a Torit Model TBV pulse-jet bin vent filter as manufactured by Donaldson Company, Inc. The dust collector and gaskets will be shipped loose. Installation and air supply shall be provided by the Contractor. The silo manufacturer shall provide a method of supporting and securing the air piping to the exterior of the silo with a support spacing not less than every ten feet.

2.07 INLET KNIFE GATE VALVE WITH ADAPTER AND FLEXIBLE CONNECTION

A. The connection between the feeders and the associated lime silo shall be made using an inlet knife gate valve with adapter and a flexible connection, all supplied by the manufacturer of the lime feeder and slaker.

B. The inlet knife gate valve, Dezurik or approved equal, shall be 10" minimum diameter between the cone and flexible connection. A larger size will be supplied if determined to be required by the Supplier to provide an even flow of lime at the maximum feed rate without clogging. The valve will be manually operated, dust tight, arranged for easy access by plant operators. The knife gate valve shall be stainless steel body with metallic seats. The entire valve will be constructed from Type 316 stainless steel.

C. The flexible connection shall be located between the inlet knife gate valve and the feeder. The flexible connection shall consist of a nylon reinforced, neoprene sleeve clamped to metal sleeves. The metal sleeves shall be at least 1/8-inch thick Type 316 stainless steel with flanged end connections, suitable for mating to the inlet knife gate valve and the feeder. Clamps shall be made of Type 316 stainless steel. Flexible connectors shall have suitable provisions to insure that the neoprene sleeve will not slip off the metal sleeves. The flexible connection shall provide a dust tight connection, withstand operating temperatures up to 250°F and have sufficient strength to withstand the maximum pressure exerted by the full contents of the silo, without bursting or deforming.

2.08 LIME FEEDER AND ACCESSORIES

A. Feeder: One (1) screw-type feeder in each silo shall be supplied to feed quicklime from the silo to the slaker at up to 5,000 pounds per hour. The feeders shall be capable of confining all dust and provide accurate feeding to an accuracy of +/- 2 percent of set point. Alternately, the quantity of lime delivered to the slaker can be measured by load cells on the slaker. The feeders shall be designed to insure a constant feed of quicklime when called to run. The feeders shall be of the non-flood type. The feeder drives shall be located to provide easy access for maintenance and will consist of a motor and drive mechanism. The controls will be interlocked with the level sensors in the slurry tank and with the lime slaker.

B. Feeder Drive: Feeder shall be supplied with a 2 horsepower constant speed drive motor and speed reducer tied directly to the screw.

C. The lime feeder shall be supplied as factory primed, carbon steel. Primer to be applied over SSPC-SP5 prepared surface and primed with 3.0 to 5.0 mils DFT of Tnemec 66-1211 epoxy or equivalent compatible with finished coats applied in the field to provide a finished system in compliance with NSF 61.

2.09 LIME SLAKER DUST COLLECTOR INDUCER-TYPE VENT FAN

A. The slaker shall be supplied with dust control system as described below or alternate system which will prevent the release of moisture and dust from the slaker into the silo skirt.

B. The lime slaker shall be provide a draft inducer-type vent fan for each lime slaker dust collector discharge vent or alternate slaker dust control system that does not allow dust from the slaker to escape into the air within the silo skirt. The vent fan shall be attached to a vitreous enamel eductor tube so that all moving parts are external to the air flow stream in the duct. The vent fan shall be capable of maintaining a negative pressure on the lime slaker dust collector system. The draft inducer-type, duct vent fan shall be a Quickdraft, Model Q4CA - 1/2 as manufactured by Quickdraft, Canton, Ohio or an approved equal. The fan shall be capable of venting a minimum of 100 cfm. The fan blower motor shall be a 1/2 hp, 230/460 volt, 3-phase, 3,600 rpm with a TEFC enclosure. The vent fan shall be mounted in the field as shown on the Drawings. All mounting hardware for the vent fan shall be type 316 stainless steel.

C. Power to each vent fan shall be controlled by the lime feeder/slaker control panel. Whenever the feeder/slaker is operating, the vent fan for the slaker dust collector shall also operate until the feeder/slaker is de-energized, and then shall continue to operate until a run timer times out upon slaker shut down.

2.10 LIME SLAKERS

A. Lime Slakers: Two (2) batch lime slaker systems shall be furnished and installed with accessories as per the specifications listed below. Alternative systems which employ a volumetric or gravimetric feeder that can accurately measure the quantity of lime delivered to the batch slaker to produce a lime slurry concentration within the limits stated in the performance requirements will be considered.

B. Operating Requirements: The slaker reactor installation shall be suitable for continuous or intermittent operation without manual cleaning or servicing when the unit is shut down overnight or over a weekend. It shall be capable of slaking commercial pebble quicklime, manufactured and supplied in accordance with AWWA Specification No. B-202-65, 100% passing the 1/4 inch sieve size and fines included. The unit shall be capable of slaking at temperatures between 180 and 200 degrees F., when lime is being slaked in the batch reactor prior to dilution to the final slurry concentration.

C. Slaker Reactor Tank: The slaker tank shall be constructed of 304 stainless steel with a 2-B finish. The tank will be self-supporting on the load cell assembly will be shipped loose, complete with all necessary components for installation by the Contractor. The slaker reaction tank will be sized to provide a capacity to slake 1,000 pounds per hour of pebble lime to a produce a 10% hydrated lime solution up to a maximum capacity of 2,000 pounds per hour of pebble lime to produce a 20% hydrated lime solution. The slaking tank shall be provided with an access opening located on top of the unit. The access opening will be complete with a cover which will fit securely over the opening and the cover will be gasketed to prevent the escape of steam and dust into the equipment area.

The slaking tanks shall each be provided with a mixer assembly, which will be mounted on the slaking tank and tested by the Lime Silo and Feed Equipment Supplier prior to shipment. The mixer assembly shall be a SEW Eurodrive's standard SA series and consist of a motor directly connected to a right angle speed reducer. The speed reducer will be oil lubricated with food grade oil or oil that is NSF 60 certified and directly connected to the mixer shaft assembly. The mixer shaft and blades shall be constructed of 316 stainless steel. Mixer design will be the responsibility of the Lime Silo and Feed Equipment Supplier to provide the required mixing to full slake the lime and produce a lime slurry of uniform consistency.

D. The slaker tanks will be mounted on a special Kistler Morse LD# series load cell assembly to weigh the contents of the tank to control the operation of the slaking and dilution process. The assembly will consist of three loads cells which will form part of the support structure for the slaking tank. The Lime Silo and Feed Equipment Supplier will be responsible for making all final adjustments to the weighing assembly so that it accurately measures the contents of the slaking tank prior to the system being placed into operation.

E. Consistency Controls: During normal operation, the slaker motor shall be continuously monitored by a motor load control cell mounted in the control panel. Unit shall have suitable adjustable load contacts to increase the water to lime ratio if the consistency of the slurry in the slaking compartment exceeds a set value. If the slaker motor overload is sufficient to trip the magnetic starter, the feeder system shall automatically stop and must be restarted by the operator. The electrical system of the entire feeder and slaker unit shall be sequence wired to prevent the operation of the lime feeder and water system, unless the slaker motor and grit remover motor are operating.

F. Temperature Controls: Suitable equipment and temperature controls shall be provided such that the slaker may be operated at an adjustable temperature between 120 and 195 degrees F., regardless of the lime quality and at operating rates between minimum and maximum specified operating rates.

G. Water Feed Controls: Controls and valves shall be provided to automatically control slaking water to achieve the slaking temperature setpoint. The slaking water shall be initiated by the slaker batch controller and shall shut down when the correct volume of water has been added as determined by level, weight or temperature. Following the time required to slake the lime, the water system shall fill the slaker tank to achieve the slurry concentration set point based upon tank level or weight. Water supply to the lime slaker shall be potable water, supplied to the unit through a water supply line. Supply header shall be 2-inch pipe with regulated water supply of approximately 85 gallons per minute at 90 psi for each slaker.

I. Safety Controls: A separate over-temperature safety switch shall be provided on the slaker body and wired to a timer in the control panel to stop the feeder and energize the alarm circuit in the event the slaker temperature exceeds safe operating limits for an adjustable period of 1 to 5 minutes due to a failure of the water supply. An audible and visual alarm with silence push-button shall be provided in the control panel to de-energize alarm circuit.

J. The slaker tanks shall include a Bray Series 30. Dezurik, or approved equal, cast iron, air operated inlet and discharge damper butterfly valve. The inlet damper butterfly valve shall automatically open and close upon the start and completion of the lime addition cycle. The

inlet damper shall be controlled by an air operated control valve. The inlet damper will be installed and tested by the Lime Silo and Feed Equipment Supplier prior to shipment. The discharge butterfly valve shall automatically control the draining of the tank. A separate drain opening shall be provided for maintenance and cleaning of the slaker tank.

K. The slaker tank shall include a dust arrestor to be located externally on the tank wall or internally beneath the access opening. The dust arrestor shall have a minimum 3-inch opening to remove the dust from the tank. The dust arrestor shall include two separate spray nozzles to quench the stream and to remove the dust from the tank. The dust arrestor shall be provided with a solenoid valve and shall automatically control the operation of the unit.

L. The slaker system shall be provided with a wash down pump. The wash down pump shall be used for periodic maintenance cleaning of the slaker tank, slurry aging tank, and fine grit classifier. Maintenance is a manual process requiring the operator to add required chemicals to the tanks and initiate the acid cleaning process via the lime system control panel. The pump shall be ½ HP and provide 8 GPM at 20 psi. The pump shall be provided with a 120 volt plug and caddy to move the pump from each piece of equipment.

M. The tank shall include a temperature sensor consisting of a type K thermocouple assembly installed in a stainless steel thermowell located at the bottom of the tank. The temperature sensor shall provide a continuous indication of the slaker temperature, and shall be used to automatically adjust the slaker operation in order to maintain a constant slaking temperature.

N. Air operated solenoid valves for actuated valves shall be shipped loose for installation by the Contractor. The Lime Silo and Feed Equipment Supplier will provide a mounting frame for mounting of the valves so that they are located above the slaker and the electrical components are isolated from the slaking process. All interconnecting stainless steel air and water supply piping shall be furnished and installed by the Contractor.

2.11 LIME SLAKER AND SLURRY MIXER

A. Agitator: Drive unit shall consist of a parallel shaft, double reduction gear reducer with a cast aluminum or cast-iron housing. The speed reducer shall be directly connected through a pinion connection to a C-face type electric motor driver. The speed reducer shall be specifically designed for mixing service, and shall be capable of 24 hour/day continuous operation in a damp and lime dust laden environment, with moderate shock loading. The basic rating of the speed reducer shall adhere to appropriate AGMA standards, and the speed reducer shall bear an AGMA nameplate, or the manufacturer shall certify, in writing, that the speed reducer is designed to the applicable AGMA standards. The minimum AGMA service factor for the gear reducer, based upon motor nameplate horsepower, shall be 2.0. The gear motor/reducer shall be heavy-duty type, high torque rated for a slow speed turbine type mixer. Unit shall not exceed 100 RPM. Motor shall be a “C” flange motor, 2 HP, 60 Hz, 1725 RPM, 230/460 volts, TEFC. No bearings shall be permitted to be in contact with the lime slurry. The mixer shall be a vertical shaft turbine type with four bolt-on replaceable stainless-steel paddles, arranged for turbulent mixing action in the bottom of the slaking chamber. Mixer impeller shall be of the axial type as indicated in the mixer schedule and shall include blades which are bolted to the central hub. The hub shall be attached to the shaft by means of a set screw arrangement. The design of the impeller hub and shaft shall be adequately and safely designed and constructed to withstand all loads to

which they may be subjected. A keyway shall provide a vertical adjustment. The impellers shall be constructed of Type 316 stainless steel. The maximum stress on any impeller component shall not exceed 11,000 psi under maximum operating loads. The mixer shall be as manufactured by Chemineer; Lightnin Mixer; or approved equal.

B. The agitator drive shall be a double reduction-type, utilizing helical gearing. Helical gears are to be through hardened or, if case hardened, the gears are to be either ground or 100 percent analytically checked to AGMA quality 8 levels, per AGMA Std. 2000-A88. The efficiency of the reducer shall be a minimum 96 percent. Full load operating noise levels of the reducer shall not exceed 83 dBA at 3 feet from the drive assembly.

C. General maintenance, including motor changes, shall not require removal of the speed reducer housing from its mounting.

D. Agitator drives having an oversized output shaft with a diameter which is larger than the diameter of the impeller shaft shall be provided with a minimum overall AGMA service factor for the speed reducer of 2.0. Support the output shaft by two heavy-duty tapered roller bearings having a minimum B-10 life of 100,000 hours under actual full load conditions.

E. All drive bearings shall be anti-friction type, roller bearings, oil-or grease-lubricated. All shall have a minimum B-10 life of 100,000 hours under actual load conditions. The agitator gearbox shall be permanently lubricated at the factory and shall require no lubrication for the life of the unit.

F. All gears and bearings shall be protected from rusting while being stored by the application of a shop-applied protective coating as specified in this Section.

G. The thermal rating of the speed reducer shall exceed the design mechanical rating to eliminate the need for external coolers. External cooling devices are not acceptable.

H. Guards: All rotating shafts above the tank top level shall be supplied with guards in accordance with OSHA Standards.

I. Coupling: The lower mixer shaft shall be connected to the upper, or drive output shaft, by means of a rigid flanged coupling, of either the welded or interference fit hub type. Mating coupling faces shall have a rabbeted male and female piloted connection for accurate concentricity, and shall not require match marks for alignment. Coupling shall be made of the same material as the mixer shaft. The coupling shall be designed to transmit 200 percent of the full torque and 150 percent of the axial load on the mixer.

J. Shaft:

1. Shaft shall be manufactured of ground and polished or smooth-turned, fully annealed bar which is straightened to 0.003-inch maximum runout per foot of length. The shaft shall be constructed of Type 316 stainless steel and shall be a minimum of 1.25-inch diameter or larger.

2. The shaft shall be designed such that the maximum stress shall not exceed 8,000 psi under maximum operating loads. It shall be of the overhung design. The use

of underwater steady bearings is not permitted. Lower shaft straightness, rigid coupling squareness, and output shaft accuracy shall be such that the maximum total indicated runout at the lower end of the shaft does not exceed 1/8-inch for every 10 feet of overhang, as measured when turning over by hand.

3. The shaft-impeller system design shall be such that its operating speed shall not exceed 65 percent of its first lateral critical speed. The use of stabilizing rings or fins shall not influence this limitation. Calculations supporting all shaft and impeller design criteria (stresses and critical speed) shall, upon request, be supplied with approval drawings.

K. Motor:

The motor shall be squirrel cage induction type for operation on 460-volt, 3-phase, 60 Hertz power supply with a speed of 1800 rpm or less and a maximum HP of 7.5. The motor shall be NEMA Design B and shall be designed, constructed and tested in accordance with applicable IEEE, NEMA and ANSI standards. Motor shall be of all cast iron construction. Motor shall be furnished with the following:

Enclosure:	TEFC with fan, corrosive duty
Efficiency:	Premium
Insulation:	Class F
Temperature Rise:	Class B based upon 40 degrees C ambient
Service Factor:	1.15, non-overloading
Noise Requirement:	Full load noise level of less than 83 dBA at 3 feet from the motor.
Wire Material:	Copper windings and wire leads
Bearings:	Minimum B-10 bearing life of 100,000 hours

L. All exposed carbon steel and aluminum surfaces of the mixer and motor shall be properly surface prepared by abrasive blasting or solvent cleaning as appropriate and coated with one (1) coat, 2 to 3 mils dry film thickness, of a VOC compliant catalyzed epoxy primer and one (1) finish coat, 2 to 3 mils total dry film thickness, of Polane HS Plus Polyurethane Enamel.

2.12 MISCELLANEOUS SLAKER EQUIPMENT

A. In addition to the equipment described above, the feeder/slaker shall be supplied with the following miscellaneous equipment:

1. Two (2) (1 for each slaker), discharge chutes to connect the feeder to the slaker. Discharge chutes shall be fabricated of heavy gauge Type 316 stainless steel and shall be mounted by the feeder/slaker manufacturer.

2. Transition sections as required for each feeder/slaker provided. Transition sections shall be accurately fabricated for proper fit of heavy gauge Type 316 stainless steel.

3. Bolting materials and hardware supplied for the lime feeder, lime slaker and transitions between the inlet knife gate valve and the feeder and between the feeder and the slaker shall be Type 316 stainless steel.

4. Piping to convey the slaked lime solution to the lime slurry tank.

2.13 GRIT CLASSIFIER

A. Grit Remover: One (1) grit remover shall be provided for each lime silo. The grit remover will contain an automatic grit separator, complete with a grit washing chamber, slurry dilution fan spray, grit washing jets and screw type grit conveyor, driven by a minimum 1/2 HP, 480 volt, 3-phase, TEFC gear motor to convey grit out of the separator. The hopper, conveyor, flights, trough and cover will be constructed of 304 stainless steel. The grit separator will remove approximately 90 percent of all the grit larger than that remaining on a 40-mesh screen while operating at a maximum rated capacity. The grit remover will be capable of removing up to 30 percent by weight of grit if quicklime quality should be temporarily as low as 70 percent available CaO at the maximum specified lime feed rate.

B. The grit classifier shall be located on the exterior of the silo such that the conveyor and discharge chute are positioned to allow the grit removed to fall directly into a dumpster located on the exterior of the silo.

2.14 LIME SLURRY TANK

A. Slurry aging tanks shall be provided to store and age the lime slurry as required. The tanks shall have a minimum capacity of 1,000 gallons and be of sufficient capacity so that when delivering lime slurry to the process at the maximum rate the slaking system will have sufficient time to slake additional batches to maintain a sufficient level in the slurry tank for continuous delivery of the lime slurry. The tanks shall be furnished with an access cover located on the top of the unit. The cover shall be gasketed to contain steam and dust. The tank shall be constructed of 304 stainless steel and have a 2-B finish. The slurry tank shall be furnished complete with all necessary inlet, drain, outlet, vent and overflow connections and shall have a mechanical mixer to maintain a uniform strength slurry. No bearings shall be permitted to be in contact with the lime slurry. The mixer shall be vertical shaft turbine type, with four bolt-on replaceable stainless-steel paddles and stainless-steel shaft.

B. Level Controls: The slurry tank will be provided with an automatic ultrasonic level or load cell level monitoring system to provide a continuous level signal in order to maintain a continuous supply of lime slurry to the slurry delivery system. Low and high-level alarms will also be provided at the control panel.

C. Slurry Piping: Lime slurry from the slaker reactor shall discharge via flexible reinforced hose to the grit classifier and slurry aging tank. Lime Silo and Feed Equipment Supplier

shall coordinate the design and sizing of slurry piping system to move lime slurry from the slaker to the grit classifier and slurry aging tank.

2.15 SLURRY PUMP AND SLURRY DELIVERY SYSTEM

A. One (1) lime slurry delivery system shall be provided for each silo to deliver up to 1,200 pounds of calcium hydroxide to the lime saturators per day. The system shall operate as a continuous 3-inch feed loop being pumped at a rate of 100 GPM. Each system shall include the following:

1. One (1) slurry pump taking suction from each of the slurry aging tanks and a third uninstalled spare pump. The slurry pumps shall be of the horizontal centrifugal type, ductile iron casing, cartridge-style bearing housing, short overhang and rubber lined. Pumps shall be Warman Type AH or approved equal. Each pump shall be capable of pumping 100 GPM at 50 TDH. The liners shall be bolted in place and easily replaceable. Materials in contact with the slurry shall be suitable for potable water service, meeting the requirements of NSF 61. The pumps shall be powered by a 7.5 HP, 480 V, 3 phase motor through a V-belt drive with metal belt guard. The pump shall be provided with a double mechanical seal and have a flushing connection for seal water. The seal water flow shall be controlled by the lime system control panel to run whenever the pump is in operation.

2. Each loop shall be provided with two (2) dosing assemblies consisting of one (1) Badger Meter, M series non-contacting flow meter, and one (1) electrically actuated pinch valve. The flow meter shall be wafer type and shall provide a 4-20 mA signal back to the slaker control panel. The pinch valve shall infinitely adjust or shut off the flow of lime to the lime saturators. The valve shall receive a 4-20 mA signal from the slaker control panel. The valve shall have an integral base and shall be anchored directly to the lime saturator wall or platform.

3. Contractor shall be responsible for providing and installing 3-inch CPVC slurry loop piping and XLPE hose transitions.

B. Alternate designs that do not incorporate a loop delivery system will be required to provide two (2) feed pumps for each slurry aging tank equipped with a flow meter and controls on each feed pump discharge to ensure accurate dosing of lime to the process.

2.16 SILO VENTILATION FAN AND DAMPER

A. A silo exhaust ventilator shall be provided for each level and shall be a direct driven, propeller type exhaust fan. Exhaust fan shall be a Model "F" as manufactured by New York Blower Company or an approved equal. Wall panel and venturi for the fan shall be fabricated of heavy duty steel with a gray acrylic-epoxy finish. The fan blades shall be fabricated of aluminum. The exhaust fan shall be non-overloading type, shall have a minimum diameter of 19-inches and shall be capable of exhausting 1,625 cfm with a static pressure of 1/4-inch w.c. The fan motor shall be 1/3 hp, 230/460 volt, 3 phase, 1,760 rpm with a TEFC enclosure. The motor bearings shall be permanently lubricated. The motor shall be supported by a vibration isolator-type mounting on a rigid frame. The fan shall be provided with a galvanized wire guard. All nuts, bolts, washers and other fasteners, used

to mount the fan housing to a steel mounting flange on the interior of the silo skirt, shall be Type 316 stainless steel.

B. The exhaust fan shall be controlled by a thermostat with a scale range of 35ºF to 100ºF, visible on the front cover. The exhaust fan shall operate whenever the temperature in the silo reaches the predetermined set point. The thermostat shall have a 2ºF switch differential utilizing sealed switches and shall operate on 120 volt, 1 phase, 60 Hz power. The thermostat shall have an integral wall mounting base and an on-off-auto control switch. The thermostat shall be as manufactured by Honeywell or an approved equal.

C. A backdraft damper shall be provided for each level for exterior mounting to a steel mounting flange on the silo skirt. Backdraft damper shall have a frame fabricated of extruded aluminum sections. Blades shall be fabricated from 0.025 inch thick aluminum with felt on the closing edge. Each blade shall be hinged with continuous 3/16 inch stainless steel rod which pivots on nylon bushings. Damper shall be color anodized or Kynar finished with a color finish to be selected by the Owner. Backdraft damper shall be manufactured by Swartwout, Penn Ventilator Company, Greenheck Fan Corporation or an approved equal. Each damper shall be provided with a stainless steel bird screen. All nuts, bolts, washers and other fasteners used to mount the backdraft damper to the silo shall be Type 316 stainless steel.

2.17 ACCESS STAIRS, PLATFORMS AND HANDRAILING

A. Silo roof access shall be by means of spiral stairs with necessary intermediate transfer platforms as required to comply with OSHA safety requirements and the Standard Building Code. The intermediate and top platforms between the silos will be provided by the Contractor. The Lime Silo and Feed Equipment Supplier shall provide structural steel clips as shown on the Drawings for connection of the silos to the platforms. The Lime Silo and Feed Equipment Supplier shall coordinate the structural design of the silo with the structural design of the access stairs and platforms performed by others to insure that all structural design criteria, standards and code requirements are met by the completed installation. The structural supports on the silo shall provide full support of the dead and live loads from the spanning access platforms by others, while allowing for independent movement of the silos.

B. A three-rail type roof handrail with 4-inch aluminum toe plate shall also be provided. Handrailing shall be constructed of 1 1/2-inch (1.9" O.D.), Schedule 40, aluminum pipe, Alloy 6063-T6. The handrails shall be fabricated in major sections for installation in the field. Structural steel supports shall be provided by the silo manufacturer for bolting of the fabricated sections to the silo exterior wall and roof. All items to be shipped loose for field assembly and installation. All hardware, nuts, bolts, and the like, for mounting the aluminum handrails shall be Type 316 stainless steel.

2.18 SILO ROOF ACCESS MANHOLE HATCH

A. The silo shall be provided a 24-inch square or round opening providing equivalent access, combination manhole hatch-pressure/vacuum relief valve to be mounted on the silo roof. The hatch shall be of all aluminum construction and flanged for bolted installation. The pressure relief shall be set for 2.0 ounces per square inch and the vacuum setting shall be

set for 0.5 ounces per square inch. The hatch shall be a Model HH as manufactured by the Knappco Corporation, or an approved equal.

B. The flanged connection on the tank shall be gasketed. All nuts, bolts, washers and other hardware for bolted, flanged connections shall be Type 316 stainless steel.

2.19 FILL PIPE

A. Provide one (1) complete fill pipe arrangement for each lime storage silo. The fill pipe arrangement for the truck unloading station shall include one (1) set of 4-inch dia., Schedule 40, ASTM A53, steel pipe with one (1), hardened steel 45° short radius elbow, one (1) hardened steel 90° long radius elbow, turbulence box, Type 316 stainless steel camlock-type adapter coupling with chained Type 316 stainless steel dust cap, and limit switch on end of pipe. The pipe arrangement and location shall be as shown on the Drawings. Provide eleven (11) equally spaced structural steel fill pipe supports welded to the silo shell. All hardware for anchoring pipe to the supports including U-bolts, nuts, washers and the like shall be Type 316 stainless steel. The pipe shall terminate approximately 3 1/2 ft. above the finished grade. The pipe, fittings and turbulence box to be shipped loose for field installation.

B. The fill pipe shall be fabricated and trial fit at the shop to ensure proper fit and then disassembled for shipment to the job site. The fill pipe will be joined with Morris compression couplings for pneumatic conveying systems or approved equal. The long radius 90° bend for the fill pipe shall have minimum radius' of 4 feet. The 45° and 90° bends shall be fabricated of a hardened steel material and shall have grooved-type pipe connections.

C. A heavy duty inlet target box shall be mounted on the storage silo roof flanged connection. This target box shall be complete with a grooved-type pipe connection for adapting to the 90° long radius elbow. The target box shall be designed to reduce the velocity of the pebble quicklime being conveyed, and allow it to drop into the storage silo in an even pattern. The target box shall be provided with a removable end cap to facilitate cleaning of the silo fill system.

C. The limit switch shall be mounted on the adapter coupling to provide automatic operation of the silo dust filter during and after the truck unloading cycle. The limit switch assembly shall be NEMA 4X, adjustable and secured with a heavy duty, Type 316 stainless steel mounting bracket for dependable operation. The limit switch shall include two sets of normally open (N.O.) and normally closed (N.C.) contacts wired to the truck fill control panel. The dust cap for the adapter coupling shall be provided with a milled slot opening to prevent actuation of the limit switch, while the truck fill system is not in use.

2.20 ANCHOR BOLTS

A. Bolts and nuts to anchor bolt the lime silo skirt anchoring flange to the concrete foundation shall be furnished by the lime silo Lime Silo and Feed Equipment Supplier. The quantity of bolts required and the bolt diameters shall be as required by the lime silo Lime Silo and Feed Equipment Supplier for the anticipated loads based upon the structural design provided for the silo. Concrete wedge-type or adhesive-type anchor bolts shall be used to anchor the lime silo skirt anchoring flange to the concrete curb foundation. The wedge-

type or adhesive-type anchor bolts shall also be furnished by the lime silo Lime Silo and Feed Equipment Supplier.

B. All threads for nuts and bolts shall be in accordance with ANSI B1.1, Class 2A fit, 8 pitch thread series. Wedge-type or adhesive-type anchor bolts to anchor the lime silo skirt shall be manufactured of Type 316 stainless steel, Alloy Group 2, Condition "A" in accordance with ASTM F 593 for bolts and studs and ASTM F 594 for nuts.

C. The nuts for all anchor bolts shall have a hardness that is lower than that of the anchor bolts by at least a difference of 50 Brinnell hardness to prevent galling during installation. Washers shall be the same material as the anchor bolts and nuts.

2.21 SHOP COATINGS

A. Surface Preparation: After fabrication all surfaces of the lime silo and all accessories shall be prepared for shop coating as follows:

1. Remove all weld spatter and slag by grinding smooth. 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. Interior Surface Coatings: All interior storage surfaces of the lime silo and accessories shall be factory primed and surfaces of equipment not requiring field welding shall be coated with an NSF approved epoxy coating system.

1. Primer - Self Priming
When self-priming on steel, a minimum angular anchor profile of 3.0 mils is required.

2. Finish Coats - 1 coat, 16.0 to 20.0 mils DFT
Finish coating shall be Tnemec Series FC22, Epoxoline, Color: White, or equal.

C. Exterior Primer: All exterior surfaces of the lime silo, cones, skirt and accessories shall be coated with a rust-inhibitive, polyamide epoxy primer. Shop primer shall be applied in one or more coats to achieve a minimum dry film thickness of 4 mils, DFT. Shop primer shall be equal to Tnemec Series 65, Poxiprime; Color: gray. Shop primer used shall be compatible with the intended finish coats to be applied in the field.

2.22 TRUCK FILL CONTROL PANEL

A. General:

1. Provide a truck fill control panel for the lime storage silo in materials and rating noted below. Panel shall be sized to adequately dissipate heat generated by equipment mounted inside or on the panel face with minimum dimensions as shown on the Drawings.

Panel Name	Rating	Qty	Material	Power Feed
Truck Fill Control Panel	NEMA 4X	1	316 SST	480 V

2. All electrical equipment and materials required to control the dust control system for the product storage portion of the lime silo shall be installed in a single control panel.

3. Panel control layout and wiring interface shall be shown on the electrical shop drawings for the control panel. Exceptions to these specifications and wiring requirements shall be submitted with Supplier's Bid. 4.

B. Finish:

1. Smoothly finish panel face openings for panel-mounted equipment. Cut with counter boring, and provide with trim strips as required to give a neat finished appearance.

2. Stainless steel surfaces shall not be painted. Finish interior steel back plate with two coats of baked enamel, white, ANSI No. 51.

C. 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 three point, quick-release 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, engraved 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.

D. Corrosion Control: Protect all panels from internal corrosion by the use of corrosion - inhibiting vapor capsules, Hoffman, Model A-HCI, or approved equal. Provide panels with combination drain/breathers, Crouse-Hinds model ECD18; or approved equal.

E. Temperature Control: Provide panels with thermostatically controlled space heaters to maintain internal temperatures above dew point.

F. Construction: All panels shall be manufactured items, Hoffman Engineering, or approved equal. Panel shall be constructed of Type 316 stainless steel sheet metal 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.

G. 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, filter exhaust fan power feed, filter shaker power feed, and controls shall be on separate branch circuits. The panel shall include motor starters for the filter exhaust fan and filter shaker motors.

2. Design, furnish and install all interior wiring within the control panel 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, heat-shrink type numbered tags to each panel wire for identification. Inside each panel, provide a copy of the panel wiring diagram. No power shall be applied until the Lime Silo and Feed Equipment Supplier has approved the installation.

3. Wiring within panels shall meet the following requirements:

   a) Discrete wiring shall be 600-volt, type TFF/MTW stranded copper, sized for the current carried, but not smaller than No. 16 AWG.

   b) Power wiring shall be 600-volt, type TFF/MTW stranded copper, No. 12 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 an integral adjustment knob or dip switches and rangeability of at least 10:1. All relays shall have permanent, legible identification.

5. Terminal blocks shall meet the following requirements:

   a) Provide unused spare terminals as indicated on the Drawings.

   b) Provide terminal blocks for dc and analog signals separate from ac circuit terminal blocks.

c) Screw-type terminal connections shall have locking, fork-tongue or ring-tongue lugs crimped with proper sized anvil. Terminate no more the 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 or grounding terminals to ground all signal and shield connections. Ground analog signal shielding. Properly ground all surge and transient protection devices. Coordinate grounding system with Division 16, Electrical.

H. Front-Face Panel Instrument Components

1. Indicating Lights, Watertight: Units shall be heavy duty, watertight, push-to-test industrial-type with integral transformer for 120V AC application. The lights shall be rated for NEMA 4X service. Units shall have screwed-on flat-faced lenses in colors shown and factory-engraved legend plates as noted. Units shall be single hole mounted in panel thicknesses of 1/16- to 1/4-inch. Units shall be Square D Type SK, Allen Bradley Type 800H, Cutler Hammer Type E34, or approved equal.

2. Switches, Maintained Contact, Watertight: Units shall be heavy duty, watertight, industrial type selector switches with contacts rated for 120-volt AC service at 10 amperes continuous. The switches shall be rated for NEMA 4X service. Units shall have factory-engraved legend plates indicating position definition. Operators shall be black knob type. Units shall have the number of positions and contact arrangements as required. Units shall be single hole mounting in panel thicknesses of 1/16- to 1/4-inch. Units shall be Square D Class 9001, Type SK; Allen Bradley Type 800H, Cutler Hammer Type E34, or approved equal.

3. Switches, Momentary Contact, Watertight: Units shall be heavy duty, watertight, industrial type pushbuttons with momentary contact rated for 120 volt AC service at 10 amperes continuous. The pushbuttons shall be rated for NEMA 4X service. Units shall have factory-engraved legend plates indicating service definition. Units shall have contact arrangements as required in colors as shown. Units shall be single hole mounted in panel thicknesses of 1/16- to 1/4-inch. Units shall be Square D Type SK, Allen Bradley Type 800H, Cutler Hammer Type E34, or approved equal.

4. Alarm, Audible Horn: Provide audible horn that generates a loud audible alarm when activated by 115V AC power. The horn shall surface mount remotely as noted, suitable for outdoor use. Outdoor units with sealed conduit entry, shall be Ronan Model 350W, or approved equal.

5. Alarm, Visual Strobe Beacon: Alarm lights shall be strobe type units that produce 360-degree beams of colored light. Flashing rate shall be 60 to 80 flashes per minute. Unit shall use a solid state strobe source. Light color shall be red and unit shall have simple technique for relamping. Unit shall be suitable for panel

mounting and shall operate on 120V AC power, unless otherwise noted or shown. Housing shall be weatherproof, suitable for use in outdoor environments without other protection. General purpose units shall be Benjamin Electric Manufacturing, Series KL-4000; or approved equal.

I. Indicating lights shall be provided for the silo level indicator switches on the silo fill control panel. The high and low level indicator switch lights shall be red in color. The intermediate level indicator switch shall have an amber indicating light on the panel. The panel audible and visual alarms shall be activated when either the high or low level silo indicator switches are tripped. The high and low level indicator switches shall include an extra set of contacts that will be wired to the silo fill control panel terminal strip for use as remote alarms to the Plant computer control system.

J. Automatic Operation:

1. Move the dust filter shaker selector to the "auto" position. When the truck hose is connected, a limit switch on the end of the fill pipe shall be actuated. When the limit switch is actuated, the silo exhaust fan shall be energized. The exhaust fan shall continue to run as long as the truck fill hose is connected. When the truck hose is disconnected, the limit switch deactivates, the exhaust fan is de-energized and the dust filter shaker is started. The shaker running time shall be controlled by an adjustable timer (0-15 minutes). The system shall be sequence wired to prevent operation of the exhaust fan and the bag shaker at the same time.

2. If material in the silo reaches the high level indicator, the "high level" indicating light will come on, the alarm horn will sound, the alarm strobe beacon will be activated, and the remote alarm contact will be actuated.

3. If material in the silo reaches the low level indicator, the "low level" indicating light will come on, the alarm horn will sound, the alarm strobe beacon will be activated, and the remote alarm contact will be actuated.

4. The panel shall be field mounted and wired. Field connection to panel, level indicators, dust filter shaker and fill pipe limit switch is required.

5. The auxiliary contacts on the limit switch, mounted to the truck fill pipe, shall be wired to a terminal strip in the truck fill control panel. These auxiliary contacts shall be dedicated to remote monitoring of the truck filling operation.

2.23 ELECTRICAL WORK

A. Interior conduit shall be Schedule 80 PVC and exterior conduit shall be aluminum. Lime Silo and Feed Equipment Supplier shall provide attachments for conduit supports required for running conduits between panels and between panels and equipment. Conduit supports shall be Type 316 stainless steel with stainless steel hardware.

B. The lime silo Lime Silo and Feed Equipment Supplier shall provide two (2) prewired wall receptacles and two (2) wall switches for lighting, one on each floor. Wall receptacle and switch boxes shall be corrosion resistant plastic. The switch boxes shall have PVC dust tight cover plates. The duplex receptacles shall be GFI type, rated at 20 amperes and

comply with UL 943, Class A. Receptacles shall be provided with plastic, spring tensioned, weatherproof covers.

C. The lime silo Lime Silo and Feed Equipment Supplier shall provide three (3) prewired, lighting fixtures on each silo floor. The fixtures shall be surface mounted on the interior of the silo wall at 120º points within the silo skirt. Three (3) fixtures shall be installed at a convenient height above the floor to provide complete lighting of all equipment mounted within the silo skirt area. Mounting hardware shall be Type 316 stainless steel. Fixtures shall be LED providing 1600 lumens with a glass refractor. Fixtures shall be wired for 120 volt electric service.

D. All of the above equipment will be furnished by the Lime Silo and Feed Equipment Supplier loose for installation and wiring shall by the Electrical Contractor.

2.24 SLAKING AND FEED SYSTEM CONTROL PANELS

A. Slaking and Feed System Control Panel: One power and one control panel shall be supplied with each lime storage and feed system to control the operation of the slaking and slurry feed system. All 480 volt equipment including motor starters, variable frequency drives and power feeders to equipment supplied with the system shall be enclosed in a separate NEMA 4X stainless steel power panel. All system controls, 120 V and control voltage equipment and PLC's shall be supplied in a separate slaking system control panel. The electrical and control panels shall be completely prewired ready to accept field connections to equipment, devices and power supplies and shipped loose for installation by the contractor. Electrical and control panels shall be provided to control all motors, valves, switches and monitoring equipment and perform all control functions for the automatic operation of the Lime Slaking and Feed System and provide proper interlocking of the equipment. Panel dimensions and general instrument arrangement will be as indicated on the drawings.

B. The construction of the control panels shall follow all applicable requirements and use materials and equipment as specified under 2.22 and 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.

C. A programmable logic controller, PLC, and a Human-Machine Interface, HMI will be provided for each lime slaking and feed system and housed in the system control panel. The HMI will be mounted on the control panel to allow access by the operators to control the system. The panel shall be provided with a dead front or the face of the HMI will be completely covered to protect it from dust in the silo skirt. The control system will allow the system to be controlled in manual or automatic mode. In manual mode each piece of

equipment can be manually controlled from the HMI and equipment interlocks to other equipment, except for operator and equipment safety, will be disabled. In automatic mode each piece of equipment will be interlocked for completely automated slaking routines. In the automatic mode the system will be programmed to place the system in local or remote operation. In the local operation the system will operate automatically once a manual start command is input from the control panel and all equipment and system set points will be adjusted on the HMI. In remote operation the system will start once a manual start command is input from the control panel and equipment and system set points can be changed remotely from the plant control system.

D. The system Lime Silo and Feed Equipment Supplier will provide a fully functional and tested PLC program, to automatically monitor and control the Lime Silo, Slaking and Feed System. The Lime Silo and Feed Equipment Supplier shall program their system to provide the following inputs and outputs to facilitate communication with the plant control system:

1. Local Controls

    a. System Start Push Button
    b. System Stop Push Button
    c. System Emergency Stop

2. Digital Inputs from the Plant Control System to each System

    a. Slaker System Stop
    b. Emergency System Stop

3. Digital Outputs to the Plant Control System from each System

    a. Lime System Start/Stop
    b. Lime Slaker System in Auto
    c. Bin Activator Run Status
    d. Lime Feeder Run Status
    e. Lime Slaker Inlet Valve Open/Closed
    f. Slaker Feed Water Valve Open/Close
    g. Slaker Mixer Run Status
    h. Slaker Temperature Fault
    i. Slaker Weight Fault
    j. Slaker Level Fault
    k. Slaker Discharge Valve Open/Close
    l. Grit Classifer Run Status
    m. Slurry Aging Tank Mixer Run Status
    n. Slurry Aging Tank Fault
    o. Slurry Loop Pump Run Status
    p. Slurry Pump High Pressure
    q. Silo High Level
    r. Silo Fill Level

4. Analog Inputs from the Plant Control System

    a. Slurry Solution Strength System #1 and #2

b. Slaker Temperature Set Point System #1 and #2
c. Lime Slurry Dosing Assembly #1 Dose Rate
d. Lime Slurry Dosing Assembly #2 Dose Rate
e. Lime Slurry Dosing Assembly #3 Dose Rate
f. Lime Slurry Dosing Assembly #4 Dose Rate

5. Analog Outputs to the Plant Control System

a. Slaker Temperature Slaker #1 and #2
b. Lime Silo Level #1 and #2
c. Slaker Tank Weight/Level #1 and #2
d. Slurry Aging Tank Weight/Level #1 and #2
e. Lime Slurry Dosing Assembly #1 Flow
f. Lime Slurry Dosing Assembly #2 Flow
g. Lime Slurry Dosing Assembly #3 Flow
h. Lime Slurry Dosing Assembly #4 Flow

E. Panel Wiring: All internal instrument and component device wiring inside panels supplied by the Lime Silo and Feed Equipment Supplier will be performed by the Lime Silo and Feed Equipment Supplier. All wiring to connect the panels to external sources of power, external equipment, controls and instruments and connections to the plant control system will be provided by the Electrical Contractor.

F. Terminal blocks for external connections will be fabricated complete with marking strip, covers and pressure connectors. A terminal will be provided for each conductor of external circuits plus one ground for each shielded cable. All wiring will be grouped or cabled and firmly supported to the panel. Not less than 8 inches clearance will be provided between the terminal strips and the base for conduit and wiring space. All electronic control type circuits will be shielded. Each control loop or system will be individually fused, and all fuses or circuit breakers will be located for easy maintenance. Fuses and/or circuit breaker panel may be located in the main motor control center for easy access.

G. Device Identification: All devices within the panel will be permanently identified. The device and terminal identification will agree with those shown on the equipment drawings.

H. Panel Arrangements: Panel instruments and control devices will be arranged in a logical configuration from an operator's standpoint. Preliminary arrangement layouts of the front of panels will be submitted for review before panel designs are completed. Control switches will be within 6'0" and 2'0" above floor.

I. Nameplates: Nameplates for panels will be approximately one inch by three inch constructed of black and white laminated phenolic material having engraved letters approximately 3/16 in. high extending through the black face into the white layer. Nameplates for field mounted equipment will be provided with engraving similar to their related panel mounted controls.

J. Panel Factory Test: Panel will be factory tested electrically by the panel fabricator before shipment.

PART 3 - EXECUTION

3.01 GENERAL (RESERVED)

3.02 INSTALLATION (RESERVED)

3.03 FIELD PAINTING (RESERVED)

3.04 FACTORY SERVICES AND START-UP

A. During the course of the project, the Contractor will verify that the project is ready for manufacturer's field services. The Lime Silo and Feed Equipment Supplier shall prepare system test procedures for each phase of the work, approved by the Owner and the Engineer, which will demonstrate conformance of the system to the Specifications and project requirements.

B. The Lime Silo and Feed Equipment Supplier shall provide the services of a factory representative during start-up of the equipment. At a minimum, the Lime Silo and Feed Equipment Supplier's technician shall perform the following start-up functions:

1. Inspect the final installation to assure proper installation, connection and wiring of all equipment of the Lime Silo and Feed Equipment Supplier's scope of supply.

2. Start-up of the equipment in the presence of the Contractor and Owner's operating personnel.

3. Training of Owner's operating personnel in proper operation and maintenance procedures, start-up/shutdown procedures, response to emergency conditions, and troubleshooting. The responsibility of the Contractor and the factory service representative with regard to startup shall be fulfilled when the start-up is complete, the equipment is functioning properly, operating personnel have been trained and the equipment has been accepted by the Owner.

3.05 SUPPLIER'S FIELD SERVICES

A. Provide under provisions of Section 01640.

B. Services of Manufacturer's Representative:

1. Provide services of Lime Silo and Feed Equipment Supplier factory service Engineer specifically trained in the installation, operation, and maintenance of pumping units as specified herein. The services of the Lime Silo and Feed Equipment Supplier's Representative shall be made available during the installation period for assistance to the Contractor for adjusting and checking equipment.

2. Man-hour requirements tabulated below are exclusive of travel time and do not relieve the Lime Silo and Feed Equipment Supplier of obligation to provide sufficient service to place equipment in satisfactory operation.

3. At a minimum, factory representatives(s) shall be provided for trips and durations as shown below.

	Services to be Provided by Factory Representative	Minimum Number of Trips[(a)]	Minimum Time on Site Per Trip (hours)
1	Supervise Unloading and Setting of Silos[(b)]	1	4
2	Supervise Installation of Slaker Tank, Aging Tank, and Slurry Feed Pumps, Check Leveling and Pre-Alignment[(c)]	1	8
3	Inspect Final Pump Alignments[(d)]	1	2
4	Supervise Installation of Miscellaneous Equipment	1	4
5	Supervise Lime Loading Operations for Silos	1	4
6	Checkout equipment and perform initial startup, troubleshooting and testing of the equipment	1	16
7	Perform Startup and Demonstration Tests to Demonstrate Successful Operation[(e)(f)] • Perform 72-hour Slaking Performance Testing. Verify Proper Installation and Operation of all Feed Equipment.	1	24
8	Instruct Engineer and Owner's Reps in Proper Operation and Maintenance of Lime Silo and Feed Equipment.[(g)]	1	8
9	Additional Trips for Troubleshooting Following Installation.[(h)]	-	8

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

(b) This assumes both silos are shipped together. An additional trip shall be included if two shipments.

(c) Before grouting and piping connection.

(d) After grouting and piping connection.

(e) The Manufacturer's representative shall provide to the Engineer a written certification that each component of the silo and feed equipment has been installed in accordance with the Manufacturer's recommendations.

(f) In the event the services of the Manufacturer's Representative are needed and requested by the Contractor for periods longer than indicated in these Contract Documents, payment for such services shall be made by the Contractor. No payment from the Owner shall be due for time spent by the Representative due to faulty design, fabrication or installation of the equipment.

(g) Instruction may be given upon completion of Item 6, provided that the field testing by the Owner's independent testing laboratory is successful and the OM Manuals have been submitted to and accepted by the Engineer.

(h) Representative(s) shall be present as necessary to operate successfully following start-up, at no additional cost to the Owner.

C. Materials and equipment shall be tested or inspected as required by the Engineer, and the cost of such work shall be included in the cost of the equipment.

D. Field tests shall not be conducted until the entire installation is complete and ready for testing.

E. Demonstration Testing:

1. Upon completion of all the mechanical and electrical work, the Lime Silo and Feed Supplier shall make adjustments to the equipment and conduct testing, as specified herein, to demonstrate that the equipment performs in accordance with all specifications.

2. The Lime Silo and Feed Supplier shall perform initial testing of the equipment to insure himself that the tests listed in the Demonstration Test paragraph below can be completed.

3. The Demonstration Test shall demonstrate that all items of these Specifications have been met by the equipment, as installed, and shall include the following tests:

a) That the equipment can deliver the specified lime feed rates to the lime feeders and slakers.

b) That the equipment controls perform satisfactorily.

c) That the equipment performs satisfactorily in each manual, automatic and shutdown mode specified.

d) That the equipment can function over the full range of feed rates, from the minimum to the maximum equipment design rates.

e) That the silo level indicators have been calibrated and operate properly.

f) That the silo vibrators operate properly and have been interfaced with the lime feeders and slakers.

g) That the Truck Fill Control Panel and the silo dust filter operate properly when lime is loaded into the silo.

h) Performance test:

The Lime Slaking System shall be capable of running, fully automatic,

demonstrating the ability of the Slaker to allow the solid-liquid phased slaking reaction to run until completion, at a predetermined temperature, and then dilute to a predetermined slurry concentration. Both Slaking Systems shall be tested over a three (3) day period, running 72 continuous hours without any adjustments made by operating personnel, demonstrating the ability to meet the requirements of these specifications. During the 72 hour performance test the Slaking Temperature Set Point and the Slurry Concentration Set shall be varied each day to demonstrate the System's ability to adjust to input variable changes.

Number of Batches	Slaking Temp Set Point	Slurry Concentration Set Point
2	185-F	20%
2	190-F	15%
2	195-F	10%

4. In the event that the equipment does not meet the Demonstration Test, the Lime Silo and Feed Equipment Supplier shall, at his own expense, make such changes and adjustments in the equipment which he deems necessary and shall conduct further tests until written certification is received from the Engineer.

5. Following successful completion of the initial start-up and demonstration testing, each unit shall be placed into continuous service for a period of 48 hours under normal operating conditions and shall perform satisfactorily prior to acceptance by the Owner. Any deficiencies noted shall be corrected by repairing or replacing the defective component and retesting for successive 48 hour periods, until the equipment meets these specifications and the satisfaction of the Engineer. Lime for all required testing will be supplied by the Owner.

F. The Contractor shall submit to the Engineer six (6) copies of a certified report from the factory service representative of the results of the representative's inspections, adjustments, testing and start-up. The report shall include descriptions of the inspection, adjustments made, and the start-up. The report shall also include a statement that the equipment is ready for permanent operation and that nothing in the installation will render the Lime Silo and Feed Equipment Supplier's warranty null and void. Final payment shall not be made to the Contractor until this report has been submitted to and approved by the Engineer.

G. The Contractor's attention is directed to the fact that the services specified represent an absolute minimum acceptable level of service, and are not intended to limit the responsibilities of the Contractor to comply with all requirements of the Contract Documents. The Contractor shall procure, at no additional cost to the Owner, all services required, including additional or extended trips to the jobsite by Lime Silo and Feed Equipment Supplier's representatives, to comply with said requirements.

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 Silo and Feed 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

PANEL ID	ENCLOSURE MATERIAL	ENCLOSURE RATING	PANEL LOCATION	MINIMUM ENCLOSURE SIZE*
20-CP-01 LIME SLAKER AND FEED CONTROL PANEL	STAINLESS STEEL	NEMA 4X	LIME FACILITY	
20-CP-02 SLAKER AND FEED CONTROL PANEL	STAINLESS STEEL	NEMA 4X	LIME FACILITY	
20-LCP-01 TRUCK FILL CONTROL PANEL	STAINLESS STEEL	NEMA 4X	LIME FACILITY	
20-LCP-02 TRUCK FILL CONTROL PANEL	STAINLESS STEEL	NEMA 4X	LIME FACILITY	
20-LCP-03 LIME SILO NO. 1 POWER PANEL	STAINLESS STEEL	NEMA 4X	LIME FACILITY	
20-LCP-04 LIME SILO NO. 2 POWER PANEL	STAINLESS STEEL	NEMA 4X	LIME FACILITY	

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 11292 Lime Storage Silo And Feed Equipment.

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 Insruments 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 ½", 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: +/- ¼ 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: ±0.25 percent full scale.

(ii) Zero Offset: ±0.50 percent full scale.

(iii) Span: ±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 (½) 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: ½-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): ±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 ½". 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. Entrelec

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): ±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 Ul 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 µs, 10 kA-8/20 µs).

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 ½". 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 PROGRAMMBLE LOGIC CONTORLLER (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:

   Availability = (Total Testing Time-Down Time) / 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.

CALIBRATION CERTIFICATE						
Tag Number/Loop Number:						
Loop Description						
Instrument Location						
Manufacturer						
Model Number						
Adjustable Range						
Calibrated Range						
Remarks						
Installation Per Manufacturer's Requirements?			**Yes**		**No**	
Installation Per Contract Documents?			**Yes**		**No**	
If "No", explain						
Calibration Test:						
	Input (Units)		Output (Units)		Accuracy	
0%						
25%						
50%						
75%						
100%						
Switch Test	Switch Point Upscale		Switch Point Downscale		Setting Deadband	
Setpoint 1						
Setpoint 2						
Setpoint 3						
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. Receipt of this Calibration Certification shall in no way imply acceptance of any work or instrument						
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

APPENDIX A

DIVISION 1

GENERAL REQUIREMENTS

SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. This section describes the requirements for preparing and presenting submittals that are necessary for the execution of this contract. Requirements within the following subject areas are included:

1. Definitions.
2. Procedures.
3. Product Data.
4. Shop drawings.
5. Samples.
6. Manufacturer's certificates.
7. Miscellaneous submittals.
8. Schedule of Values.
9. Quality Control Documentation (Blank Copies of Report).

1.02 DEFINITIONS

A. Product Data and Shop Drawing - General Definition

1. Drawings, diagrams, illustrations, brochures, schedules, bills of materials and other data prepared by the EARLY PROCUREMENT EQUIPMENT SUPPLIER (SUPPLIER), his subcontractors, suppliers or distributors, or equipment manufacturers and fabricators; illustrating the manufacture, fabrication, construction, or installation of the Work or a portion thereof.

B. Shop Drawings

1. Assembly and fabrication drawings, bills of materials for items shop fabricated exclusively for this project. In addition, shop drawings should show fabrication details of each part, the assembly of each part and how each part and/or assembly is integrated into the project including existing parts or assemblies.

C. Manufacturer’s Representative

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

D. Working Drawings

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

E. Design Calculations

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

1.03 PROCEDURES

A. Electronic Submittal Procedures

1. All electronic submittals shall be transmitted in Portable Document Format (PDF) as generated by the Adobe Acrobat Professional Version 7.0 or higher.

2. It will be the SUPPLIER’s responsibility to scan all necessary documents or convert previously received electronic files from vendors into pdf format before uploading the files to the specific designated project site. Scanned images must be at a readable resolution. For most documents, they should be scanned at 300 dots per inch (dpi). Optical character Recognition (OCR) capture must be performed on these images so that text can be searched and copied from the generated PDF file.

3. When it is not possible to make submittals electronically, SUPPLIER may deliver submittals to OWNER using conventional mail only after securing OWNER's written approval. When electronic submittals are not possible, hard copy submissions will be made as required in this section. Submittal of a transmittal page into the contract-specific Prolog site of Portal by SUPPLIER shall still be required for recordkeeping.

4. When electronic submittal is not possible and upon securing OWNER's written approval, SUPPLIER may submit hard copies of product data and shop drawings according to the following distribution list:

   a. OWNER's designated Agent (if applicable): Three (3) copies.

   b. OWNER (if a designated Agent reviews the submittals): One (1) copy.

   c. ENGINEER: One (1) copy.

5. If regular mail delivery is approved by OWNER, the submittal transmittal form shall still be logged into the contract specific Contract and Project Management System (CPMS) by SUPPLIER for record keeping purposes.

6. All responses to a submittal by ENGINEER will be made electronically and no hard copies of the response will be sent to SUPPLIER.

B. Supplier's Responsibilities

1. Submit a list of specified submittals and identify the long lead items to the OWNER within five (5) calendar days of receipt of the Notice to Proceed (NTP).

2. Within 30 days after the pre-construction conference and at the same time that the initial critical path schedule is submitted, a schedule shall be submitted of the items of materials and equipment for which shop drawings are required by the specifications. For each required shop drawing, the date shall be given for intended submission of the drawing to ENGINEER for review and the date required for its return to avoid delay in any activity beyond the scheduled start date. Sufficient time shall be allowed for initial review, correction and resubmission, and final review of all shop drawings. In no case shall a schedule be acceptable which allows less than 21 days for each review by ENGINEER.

3. SUPPLIER to approve all submittals prior to submission.

4. SUPPLIER shall submit dimensional and layout drawings and product data, certified correct for construction, for review by the ENGINEER.

5. Submit shop drawings and product data in accordance with the approved submittal schedule. Also, submit shop drawings to the ENGINEER for review prior to their need in the Work, allowing sufficient time for the ENGINEER's review and the SUPPLIER response.

6. SUPPLIER shall make specific mention of those items that vary from the requirements of the Contract Documents in the letter of transmittal. The letter transmittal shall include the specification number, detail name/number, or plan sheet of the item being submitted.

7. Submit shop drawings and product data covering related items of equipment or material or integrated systems of equipment or material at the same time. Partial submissions will not be accepted.

8. All submittals, regardless of origin, shall be stamped with the approval of SUPPLIER and identified with the name and number of this contract, SUPPLIER name, and references to applicable specification paragraphs and Contract Drawings. Each submittal shall indicate the intended use of the item in the Work. When catalog pages are submitted, applicable items shall be clearly identified and inapplicable data crossed out. The current revision, issue number, and date shall be indicated on all drawings and other descriptive data.

9. SUPPLIER shall be solely responsible for the completeness of each submission. SUPPLIER stamp of approval is a representation to OWNER that SUPPLIER accepts sole responsibility for determining and verifying all quantities, dimensions, field construction criteria,

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

10. SUPPLIER shall coordinate shop drawings and product data with drawings previously submitted, with drawings being prepared, and with drawings and data previously approved. All such coordination shall be indicated by reference.

11. SUPPLIER shall assign a sequential number to each submittal.

    a. Assignment of numbers shall be by means of a letter prefix, a sequence number, a letter suffix to indicate resubmittals and a specification number. For example, submittal SD-012C-01300 is the third re-submittal of the twelfth Shop Drawing for the Project.

    b. The sequence number shall be issued in chronological order. Resubmittals shall be followed by a letter of the alphabet to indicate the number of times a submittal has been resubmitted to the ENGINEER for processing. As an example, a shop drawing with the number SD-001 indicates that the submittal is the first shop drawing submitted for the project. Shop Drawing Number SD-002A indicates that the submittal is the second shop drawing submitted for and is being submitted for the second time. Acceptable prefixes for submittals are as follows:

        i. SD -Shop Drawing
        ii. PS – Project Schedule
        iii. RD – Record Data
        iv. OM – Operation and Maintenance Manual

    c. Correct assignment of numbers is essential as different submittal types are processed in different ways. Some submittals received do not require that any response be given for the material. SUPPLIER and ENGINEER shall both maintain a log of submissions to allow the processing of SUPPLIER's submittals to be monitored. Logs will be reviewed periodically to determine that all submittals are received and processed.

    d. Submittals shall be marked to show clearly the applicable sections of the specification and sheet number of drawings.

    e. Submittals shall be accompanied by a Submittal Transmittal Form to be provided by the OWNER. A separate form shall be used for each specific item, class of material, equipment, and items specified in separate discrete sections, etc. for which a submittal is required. Submittals for various items shall be made with a single form when the items taken together constitute a manufacturer's package or are so functionally related that they should be.

12. SUPPLIER shall not deliver to the site, storage, or incorporate into the Work, any materials or equipment for which approved submittals have not been obtained.

13. If a submittal is returned to the SUPPLIER marked “NO EXCEPTIONS NOTED”, formal revision and resubmission shall not be required. SUPPLIER may proceed to perform submittal related Work.

14. If a submittal is returned marked "EXCEPTIONS NOTED", SUPPLIER shall make the corrections on the submittal, but formal revision and resubmission shall not be required and the SUPPLIER shall proceed with the Work.

15. If a submittal is returned marked "RETURNED FOR CORRECTION," the SUPPLIER shall revise it and resubmit to the OWNER for review. Resubmittal and a grade of "NO EXCEPTIONS NOTED" or "EXCEPTIONS NOTED" is required before the SUPPLIER may proceed with the Work, unless approved in writing by the OWNER. Resubmittal of portions of multi-page or multi-drawing submittals shall not be allowed. For example, if a Shop Drawing submittal consisting of 10 drawings contains one drawing noted as "RETURNED FOR CORRECTION", the submittal as a whole is deemed "RETURNED FOR CORRECTION", and all 10 drawings are required to be resubmitted.

16. If a submittal is returned marked "NOT ACCEPTABLE," it shall mean either that the submitted material or product does not satisfy the Specification, the submittal is so incomplete that it cannot be reviewed, or it is a substitution request not in accordance with the General Conditions of the Contract. SUPPLIER shall prepare and deliver a new submittal to the ENGINEER for review.

17. Resubmittal of rejected portions of a previous submittal shall not be allowed. When resubmittals are needed, every change from a submittal to a resubmittal or from a resubmittal to a subsequent resubmittal shall be clearly identified and flagged on the resubmittal by SUPPLIER.

18. When resubmittals are needed, resubmittals shall be made within 30 days of the date on which documents to be modified or corrected were posted on CPMS by ENGINEER or its designated reviewer (electronic submittals) or of the postmark date of the letter returning the material (if a hard copy-type submittal was approved by OWNER), whichever is later. A time extension shall be considered by ENGINEER only if within the required number of days SUPPLIER submits an acceptable request for an extension of time, listing the reasons why the resubmittal cannot be completed within the stipulated time.

19. The need for more than one resubmittal, or any other delay in obtaining ENGINEER's review of submittals, shall not entitle SUPPLIER to extension of the Contract Times unless delay of the Work is the direct result of a change in the Work authorized by a Change Order or failure of OWNER to review and return any submittal to SUPPLIER within the specified review period.

20. SUPPLIER shall not deliver to the site, store, or incorporate into the Work, any materials or equipment for which approved submittals have not been obtained.

21. When electronic submittals are not possible, hard copy submissions shall be made as required in this Section. Submittal of a transmittal form into the contract-specific web-based project management system by SUPPLIER shall still be required for record keeping.

22. SUPPLIER is responsible for frequent monitoring of the web-based documents and the submittal process status.

C. ENGINEER Responsibility

1. ENGINEER will conduct a thorough review within 21 calendar days after its receipt in CPMS so as not to create delay. This review will be for general conformance, subject to the requirements of the Contract Documents, and will be an effort to assist the SUPPLIER to discover errors and omissions in submittals. ENGINEER review, approval, or other appropriate action regarding SUPPLIER submissions will be only to check conformity with the design concept of the Project and for compliance with the information contained in the Contract Documents and shall not extend to means, methods, techniques, sequences or procedures of construction (except where a specific means, method, technique, sequence or procedure of construction is indicated in or required by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate component item will not indicate approval of the assembly into which the item is functionally integrated. SUPPLIER shall make corrections required by ENGINEER, and shall return the required number of corrected copies of Shop Drawings to the OWNER. SUPPLIER may be required to resubmit, as required, revised Shop Drawings or Samples for further review and approval. SUPPLIER shall direct specific attention in writing to any new revisions not specified by SUPPLIER on previous SUPPLIER submissions.

2. ENGINEER review does not relieve the SUPPLIER of the obligation and responsibility to coordinate the Work and plan the details of the Work.

3. The OWNER reserves the right to require written confirmation from the SUPPLIER that the comments placed on submittals stamped "Exceptions Noted" will actually be followed.

4. Review by the ENGINEER will not be construed as relieving the SUPPLIER of the responsibility for the accuracy, proper fit, functioning, or performance of the Work.

1.04 PRODUCT DATA

A. Product data, including materials reproduced from manufacturer’s product catalogs will not be larger than 8 ½" by 11" in size.

B. Catalog data will be explicit with regards to the name of the manufacturer and to the details of the products being furnished. It will also be complete enough to enable the OWNER to determine that the products being submitted conform to the requirements of the Specifications.

C. For submittals with more than one style or size of a product on a sheet, the SUPPLIER will clearly indicate which product is being submitted for review.

D. SUPPLIER will provide electronic submittals in .pdf format of all product data to the OWNER. Files shall be readable using Adobe Acrobat Reader Version 7.0.

1.05 SHOP DRAWINGS

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

B. Substitute and “Or Approved Equal” Items: Meet requirements of Paragraph 5.12 of the General Conditions.

C. SUPPLIER will submit detailed drawings and descriptions of proposed deviations from details or component arrangement indicated on the Plans.

D. Single line drawings will not be acceptable. Copies of the Plans will not be accepted for submission as drawings, nor will catalog numbers alone of materials or equipment.

E. SUPPLIER will submit electronic copies in .pdf format of each shop drawing to the OWNER for review. Files shall be readable using Adobe Acrobat Reader 7.0.

1.06 SAMPLES

A. SUPPLIER will furnish samples of items and materials as required. Samples shall be submitted to the OWNER in duplicate. Each sample will be properly labeled and identified by providing the following:

1. Date.

2. Job name for which it is offered.

3. Specification section and paragraph.

4. SUPPLIER’s name.

5. Supplier and trade name.

6. Other data indicating conformance to the Specifications.

7. Color charts or samples with manufacturer’s number.

1.07 MANUFACTURER’S CERTIFICATES AND AFFIDAVITS

A. Where specified in the Contract Documents that a certificate and affidavit shall be submitted to the OWNER for review of a particular product, or component of a product, such submittals shall be made in accordance with the following:

1. A certificate submitted for a product, or component of a product, indicates test results proving that product, or component of a product, meets the requirements of the standard specified in the Contract Documents.

2. An affidavit consisting of a sworn statement by an official of the company manufacturing the product indicating that the information on the certificate is true and accurate shall accompany the certificate.

3. A statement from the SUPPLIER, or his subcontractors, suppliers, or other agent which indicates that a particular item of equipment, product, or component of a product, meets the

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

1.08 MANUFACTURER'S REPRESENTATIVE

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

1.09 MISCELLANEOUS SUBMISSIONS

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

1. Work plans.

2. Quality Control (QC) Plan.

    (i) QC Plan must be submitted and approved prior to commencing Work.

3. Accident reports.

4. Inspection and test reports.

5. Guarantees and warranties.

6. Operation and Maintenance Manuals.

7. Course of Action Plan (Fuel Spill or Other Substances).

    (i) SUPPLIER must submit the Course of Action Plan (Fuel Spill or Other Substances) to the OWNER prior to start of construction.

    (ii) With regard to the accidental spill of fuel, the Plan must address the procedures required by applicable regulations and laws.

8. SUPPLIER's Safety and Health Plan.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

SECTION 01600

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. This Section describes the requirements for material and equipment that are necessary for the execution of this contract. Requirements within the following subject areas are included:

1. Products.
2. Preparation for shipment.
3. Packaging and delivery of spare parts and tools.
4. Shipment and handling.
5. Inspection
6. Storage and protection
7. Inventory control.
8. Product options.
9. Substitutions.
10. Systems demonstration.
11. Warranties.

1.02 PRODUCTS

A. The term "products" means new material, machinery, components, equipment, fixtures, and systems forming the Work. It does not include machinery and equipment used for preparation, fabrication, conveying, and erection of the Work. Products may also include existing materials or components required for reuse.

B. Do not use materials and equipment salvaged from this project, except as specifically permitted by the Plans.

C. Materials and equipment to be provided under this contract shall be standard catalogue products of manufacturers regularly engaged in the manufacture of the products and shall duplicate material and equipment in satisfactory service for at least two (2) years.

D. Material and equipment shall meet the requirements of the Contract and shall be suitable for the installation for which they are planned. Where two (2) or more of the same equipment class are furnished, the equipment shall be from the same manufacturer and shall be interchangeable. Materials and equipment shall be new and free from defects.

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

1.03 PREPARATION FOR SHIPMENT

A. When practical, equipment shall be factory assembled. The equipment parts and assemblies that are shipped unassembled shall be furnished with an assembly plan and instructions. The separate parts and assemblies will be match-marked or tagged in a manner to facilitate field assembly.

B. Generally, machined and unpainted parts subject to damage by the elements shall be protected with an application of a strippable protective coating.

C. Equipment shall be packaged or crated in a manner that will provide protection from damage during shipping, handling, and storage.

D. The outside of the package or crate shall be adequately marked or tagged to indicate its contents by name and equipment number, if applicable, approximate weight, special handling precautions, and recommended storage procedures.

1.04 PACKAGING AND DELIVERY OF SPARE PARTS AND SPECIAL TOOLS

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

1.05 SHIPMENT AND HANDLING

A. Shipments shall be addressed to the CONTRACTOR who will be responsible for their receipt, unloading, handling, and storage at the site. The OWNER will not accept deliveries on behalf of the CONTRACTOR or his subcontractors nor assume responsibility for the security of the materials, equipment, or supplies delivered to the site.

B. CONTRACTOR will transport and handle products in accordance with manufacturer’s instructions.

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.06 INSPECTION

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

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

1.07 STORAGE AND PROTECTION

A. CONTRACTOR will store products in accordance with the manufacturer's instructions, with seals and labels intact and legible. Sensitive items will be stored in weather-tight enclosures; with the humidity and temperature maintained within the ranges recommended by the manufacturer.

B. For exterior storage of fabricated products, the CONTRACTOR will place on sloped supports above ground. Products that are subject to deterioration will be covered with an impervious sheet and will be supplied with adequate ventilation to avoid condensation.

C. CONTRACTOR will store loose granular materials on solid surfaces in a well-drained area in such a manner as to prevent mixing.

D. CONTRACTOR shall arrange to provide access for inspection. He will also periodically inspect to ensure products are undamaged and are maintained under required conditions.

1.08 INVENTORY CONTROL

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

1.09 PRODUCT OPTIONS

A. CONTRACTOR has the following options in providing products specified for the Work:

1. Products specified by reference standards or by description only: CONTRACTOR may provide any product meeting the standard.
2. Products specified by naming one or more manufacturers: CONTRACTOR may provide the product from the named manufacturer or he may submit a request for substitution for any manufacturer not specifically named.

1.10 SUBSTITUTIONS

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

B. CONTRACTOR will document each request with complete data substantiating compliance of proposed substitution with the Contract Documents. Each request constitutes a declaration from the CONTRACTOR that:

1. CONTRACTOR has investigated the proposed product and determined that it meets or exceeds, in all respects, the specified product.
2. CONTRACTOR will provide the same warranty for substitution as for the specified product.
3. CONTRACTOR will coordinate installation and make all other changes, which may be required for the Work to be complete in all respects.
4. CONTRACTOR waives claims for additional costs and/or time, which may subsequently become apparent.

C. Substitutions will not be considered when they are indicated or implied on shop drawings or product data submittals without a separate written request, or when acceptance will require substantial revision of the Contract Documents.

D. OWNER will determine acceptability of proposed substitution, and will notify CONTRACTOR of acceptance or rejection in writing within a reasonable period of time.

E. Only one request for substitution will be considered for each product. When substitution is not accepted, the CONTRACTOR will provide the specified product.

1.11 SYSTEMS DEMONSTRATION

A. Prior to final inspection, demonstrate operation of each system to the OWNER.

B. CONTRACTOR will instruct the OWNER's personnel in operation, adjustment, and maintenance of equipment and systems, using the operation and maintenance data as the basis of instruction.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

SECTION 01640

MANUFACTURER'S FIELD SERVICES

PART 1 GENERAL

1.01 SCOPE

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

1.02 RELATED WORK

A. Section 01300 – Submittals

B. Section 01600 – Material and Equipment

C. Section 01752 – Facility Start Up/Commissioning Requirements

1.03 DESCRIPTION OF WORK

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

1.04 SUBMITTALS

A. Training Plan (Pre Start Up and Post Start Up):

1. Submit not less than 21 calendar days prior to start of equipment testing and revise as necessary for OWNER's acceptance.

2. Submit MANUFACTURER'S tentative training schedule, training plan, and contact person not less than 60 calendar days prior to commencement of any training.

a. MANUFACTURER'S proposed Training Plan shall include the elements presented in the Outline of Instruction Training Plan specified herein. Specific components and procedures shall be identified in the proposed Training Plan. Hands-on demonstrations planned for the instruction shall be described in the Training Plan. The MANUFACTURER shall indicate the estimated duration of each segment of the Training Plan.

b. Outline of Instruction Training Plan:

i. Equipment Description and Purpose
ii. Equipment operation
iii. Detailed component description
iv. Equipment preventative maintenance (PM)
v. Equipment troubleshooting
vi. Equipment corrective maintenance

3. Provide complete training materials, to include operation and maintenance data as required in this section to be retained by each trainee.

B. Quality Control Submittals:

1. MANUFACTURER'S Certificate of Proper Installation:

a. When specified in the individual equipment specification sections or Equipment Schedule, submit certificate certifying:

i. The product or system has been installed in accordance with the MANUFACTURER'S recommendations, inspected by a MANUFACTURER'S authorized representative, and serviced with the proper lubricants.
ii. Necessary safety equipment has been properly installed.
iii. Electrical and mechanical connections have been made meeting quality and safety standards as required.
iv. Free from undue stress imposed by exterior connections or loads.
v. Proper adjustments have been made and the product or system is ready for testing, facilities startup, operational test, and operation.

b. Submit MANUFACTURER'S Certificated of Proper Installation Form at end of this Specification.

4. Certificate of Successful Equipment Testing: Prepare and submit where specified in individual equipment specification sections or Equipment Schedule, and upon completion of successful testing of respective equipment by the CONTRACTOR. See Certificate of Successful Equipment Testing Form at end of this Specification.

5. Certificate of Successful Equipment System, Subsystem or Component, Start Up Testing including Functional and Performance Tests: Prepare and submit where specified in individual equipment specification sections or Equipment Schedule, and upon completion of successful Start Up testing of respective equipment system, subsystem or component by the CONTRACTOR. See Certificate of Successful Equipment System, subsystem or component Start Up Testing Form at end of this Specification.

6. Certificate of qualification of MANUFACTURER'S representative.

1.05 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

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

1.06 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

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

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

B. Coordinate and Schedule MANUFACTURER'S field services to avoid conflicting with other field testing or other MANUFACTURER'S field services. Determine that all conditions necessary to allow successful testing have been met before scheduling field services.

C. Only those days of service approved by OWNER will be credited to fulfill the specified minimum services.

D. If specified, MANUFACTURER'S field services shall include as a minimum:

1. Assistance during installation to include observation, guidance, instruction of CONTRACTOR's assembly, erection, installation or application procedures.

2. Inspection, checking, and adjustment as required for equipment to function as warranted by MANUFACTURER and necessary to provide written approval of installation.

3. Revisiting the site as required to correct problems and until installation and operation are acceptable to OWNER.

4. Resolution of assembly or installation problems attributable to, or associated with, respective MANUFACTURER'S products, equipment, system, subsystem and components.

5. Assistance during testing and Start Up demonstration, and until product acceptance by the OWNER.

6. Training of OWNER's personnel in the operation and maintenance of respective products as required herein.

7. Completion of MANUFACTURER'S Certificate of Proper Installation and applicable certificates of Successful Equipment Testing and Successful Equipment System, Subsystem or Component Start Up Testing, as required, including functional and performance tests service. (Forms at the end of this Specification)

1.07 TRAINING SCHEDULE

A. List specified equipment, system, subsystem, and component with respective MANUFACTURERs that require training services of MANUFACTURER'S representatives and show:

1. Estimated dates for installation completion.

2. Estimate training dates to allow for multiple sessions when several shifts are involved.

3. Use Equipment Schedule as guidance and revise as needed to meet individual equipment specifications or MANUFACTURER'S requirements for the preparation of estimated dates. Dates must be included as milestones on general project schedule, and must be coordinated as to allow completion of the project including Start Up Phase by Substantial Completion Date.

B. Adjust training schedule to ensure training of appropriate personnel as deemed necessary by OWNER and to allow full participation by MANUFACTURER'S representatives. Adjust schedule for interruptions in operability of equipment.

C. Training shall not proceed until all individual equipment, systems, subsystems or components have been installed and approved by the MANUFACTURER and completed the testing requirements indicated in specification 01650.

D. Pre Start Up Training:

1. Coordinate and furnish classroom training sessions with the OWNER's operating personnel and MANUFACTURER'S representatives.

2. Conduct training prior to as defined in Specification Section 01752 – Facility Start-up/Commissioning Requirements.

3. Provide Draft O&M Manuals.

E. Post Start Up Training:

1. Coordinate and furnish on-site training sessions with the OWNER's operating personnel and MANUFACTURER'S representatives.

2. Conduct after Facility Start Up, but prior to Operational Testing of the equipment as defined in Specification Section 01752.

3. Provide Final O&M Manuals.

1.08 TRAINING OWNER'S PERSONNEL

A. Provide trained, articulate personnel acceptable to the OWNER to coordinate and expedite training, to be present during training coordination meetings with OWNER and familiar with operation and maintenance manual information.

B. MANUFACTURER'S Representative shall provide the number of days of training for equipment as indicated in the Equipment Schedule section. Operator training days shall be in addition to MANUFACTURER'S field services required as indicated in the Equipment Schedule and submittals sections.

1. All training will be performed during the operating staff's normal business hours and at other times requested and approved by the OWNER.

C. MANUFACTURER'S representatives to provide detailed training to OWNER's personnel on operation and maintenance of specified product (equipment, system, subsystem, and

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

1. Training services include Pre Start Up classroom instruction and Post Start Up onsite hands-on instruction.

2. MANUFACTURER'S Representative shall be familiar with system operation and maintenance requirements for specified equipment, system, subsystem, or component.

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

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

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

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

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

(Check Applicable)

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

Comments:_____
_____
_____
_____
_____
_____

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

Date: _____

Manufacturer:_____

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

CERTIFICATE OF SUCCESSFUL EQUIPMENT TESTING

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

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

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

(Check Applicable)

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

☐ Tested at every level of control.

Comments:_____
_____
_____
_____
_____
_____

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

Date: _____

Contractor:_____

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

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

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

SAN ANTONIO WATER SYSTEM
EQPT TAG NO.:_____
PROJECT NO.:_____
EQPT SERIAL NO.:_____
EQPT/SYSTEM:_____
SPEC. SECTION:_____

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

(Check Applicable)

☐ Demonstrate all operational features, instrumentation, and control functions while in automatic mode.

☐ Checked for proper installation, started and successfully tested.

☐ System has been functionally tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer.)

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer.)

.

☐ Facility is ready for intended operation.

Comments:_____
_____
_____
_____
_____
_____

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

Date: _____

Contractor:_____

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

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

END OF SECTION

SECTION 01730

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 DEFINITIONS

A. Maintenance Operation: As used in the Maintenance Summary Form, attached to this specification, maintenance operation is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.

B. System and Subsystem: Refer to Section 01652 – System Operation and Section 01752 – Facility Startup and Commissioning Requirements.

1.02 QUALITY ASSURANCE

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

1.03 SEQUENCING AND SCHEDULING

A. Manual Outline: Submit detailed outline of each manual prior to preparation of Preliminary Manuals.

B. Manuals for Equipment and Systems:

1. Preliminary Manuals: Submit prior to shipment date for equipment, system, subsystem, or component. Include copy of warranties, bonds, and service agreements if specified.

2. Final Manuals: Submit not less than 30 days prior to equipment or system field testing or startup.

C. Manuals for Materials and Finishes:

1. Preliminary Manuals: Submit at least 30 days prior to request for final inspection.

2. Final Manuals: Submit within 10 days after final inspection.

1.04 GENERAL

A. Furnish for each item of equipment or system as specified in the individual Specification sections.

B. Prepare data for use by OWNER's personnel in the form of an instructional manual in both paper format and on electronic media. Data for electronic media shall be provided to OWNER on optical compact disc.

C. Manual Format:

1. Size: 8-1/2 inches x 11 inches.

2. Paper: 20-pound minimum, white for typed pages.

3. Text: Manufacturer's printed data, or neatly typewritten.

4. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.

5. Provide flyleaf for each separate product or each piece of operating equipment, with typed description of product and major component parts of equipment and provide with heavy section dividers with numbered plastic index tabs.

6. Provide each manual with title page, and typed table of contents with consecutive page numbers. Place contents of entire set, identified by volume number, in each binder.

7. Cover: Identify each volume with typed or printed title "OPERATION AND MAINTENANCE MANUAL, VOLUME NO. – OF – ", if applicable, and list:

   a. Project title.

   b. Designate the system or equipment for which it is intended.

   c. Identity of separate structure as applicable.

   d. Identity of equipment number and Specification section.

8. Assemble and bind material in same order as specified, as much as possible.

9. Final copy shall not have fax copies or photocopies of manufacturer information. Each manual shall have original materials.

10. Binders:

    a. Preliminary Manuals: Heavy paper covers.

    b. Final Manuals: Commercial quality, substantial, permanent, three-ring binders with durable, cleanable, plastic binders.

11. Table of contents neatly typewritten, arranged in a systematic order:

    a. CONTRACTOR, name of responsible principal, address, and telephone number.

    b. List of each product required to be included, indexed to content of each volume.

c. List with Each Product: Name, address, and telephone number of Subcontractor, Supplier, installer, and maintenance contractor, as appropriate.

i. Identify area of responsibility of each.

ii. Provide local source of supply for parts and replacement.

d. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.

12. Product Data:

a. Include only those sheets that are pertinent to specific product.

b. Clearly annotate each sheet to:

i. Identify specific product or part installed.

ii. Identify data applicable to installation.

iii. Delete references to inapplicable information.

13. Drawings: Supplement product data with Drawings as necessary to clearly illustrate:

a. Relations of component parts of equipment and systems.

b. Control and flow diagrams.

c. Coordinate drawings with Project record documents to assure correct illustration of completed installation.

d. Do not use Project record documents as maintenance manual drawings.

e. Provide reinforced punched binder tab, bind in with text.

f. Reduced to 8-1/2 inches x 11 inches, or 11 inches x 17 inches folded to 8-1/2 inches x 11 inches.

g. Where reduction is impractical, fold and place in 8-1/2-inch x 11-inch envelopes bound in text.

h. Identify Specification section and product on Drawings and envelopes.

14. Instructions and Procedures: Within text, as required to supplement product data.

a. Handling, storage, maintenance during storage, assembly, erection, installation, adjusting, testing, operating, shutdown in emergency, troubleshooting, maintenance, interface, and as may otherwise be required.

b. Organize in a consistent format under separate heading for each different procedure.

c. Provide a logical sequence of instructions for each procedure.

d. Provide information sheet for OWNER's personnel, including:

i. Proper procedures in the event of failure.

ii. Instances that might affect the validity of warranties or Bonds.

15. Warranties, Bonds, and Service Agreements.

D. Electronic Format: All electronic submittals shall be transmitted in Portable Document Format (PDF) as generated by the Adobe Acrobat Professional Version 7.0 or higher. The PDF file(s) shall be fully indexed using the Table of Contents, searchable with thumbnails generated.

1. File names shall use the “eight dot three” convention (XXXXX_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

GRIT DUMPSTER

B D-1104

14' DIAMETER, 5,000 CUFT LIME SILO (TYP 2) (SEE ENLARGED PLANS ON DWG D-1105 FOR INTERNAL EQUIPMENT ORIENTATION)

FINE GRIT CLASSIFIER (TYP)

FRP ENCLOSURE FOR AIR COMPRESSOR EQUIPMENT

4" FILL LINE (TYP)

LIME TRUCK UNLOADING PANEL (TYP)

LIME SILO NO. 1

LIME SILO NO. 2

1 D-1105

24" MANWAY ACCESS (TYP)

DUST COLLECTOR (TYP)

3 D-1107

0 2'-8" 5'-4" 10'-8"

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

25-MOV-11

25-MOV-21

10-PW-DI

21' - 0"

28' - 0"

21' - 0"

40' - 0"

8 D-1901

18"x3" ELEVATED CABLE TRAY FOR AIR, WATER & LIME SLURRY PIPING (TYP EA SIDE OF WALKWAY)

7 D-1901

PROVIDE FLG STEEL SLEEVE FOR FUTURE POLYMER ADDITION (TYP)

PROVIDE FLG STEEL SLEEVE FOR 3" LIME SLURRY ADDITION (TYP)

43' DIAMETER LIME SATURATOR (SOLIDS CONTACTING UNIT) (TYP 2)

ELEVATED WALKWAY

HOSE BIBB & RACK (TYP)

CONTROL PANEL (TYP)

A D-1104

CONCENTRIC DUAL DRIVE (TYP)

PIPING TRAY (TYP)

LIME DOSING ASSEMBLY. SEE DWG D-1908 FOR DETAILS. (TYP OF 2)

EFFLUENT LAUNDER (TYP)

LIME SATURATOR NO. 1

LIME SATURATOR NO. 2

DOME COVER SUPPORTS (TYP)

LIME SOLUTION STORAGE TANK

GEODESIC DOME NOT SHOWN FOR CLARITY

12-CHS-PVC

12-CHS-PVC

GEODESIC DOME COVER

24" MANWAY (TYP OF 2)

10-CHS-PVC

TO PRESSURE FILTER INLET

TO PRESSURE FILTER INLET

10-CHS-PVC

4 D-1108

10-PW-DI

4-SL-DI

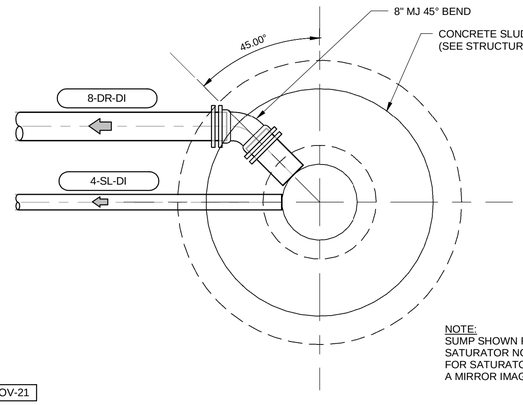
2 D-1106

FROM PROJECT COMPANY GST OUTLET

TO SLUDGE THICKENER

EQUIPMENT PLAN

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



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

ENLARGED SLUDGE SUMP

SCALE: 1/2" = 1'-0"

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100% SUBMITTAL

SAN ANTONIO WATER SYSTEM

MARK	DATE	DESCRIPTION	BY

SAN ANTONIO WATER SYSTEM

CENTRAL WATER INTEGRATION PIPELINE
PROJECT TERMINUS FACILITY

LIME SYSTEM OVERALL PLAN

INCOMPLETE DOCUMENT ISSUED FOR INTERIM REVIEW ONLY

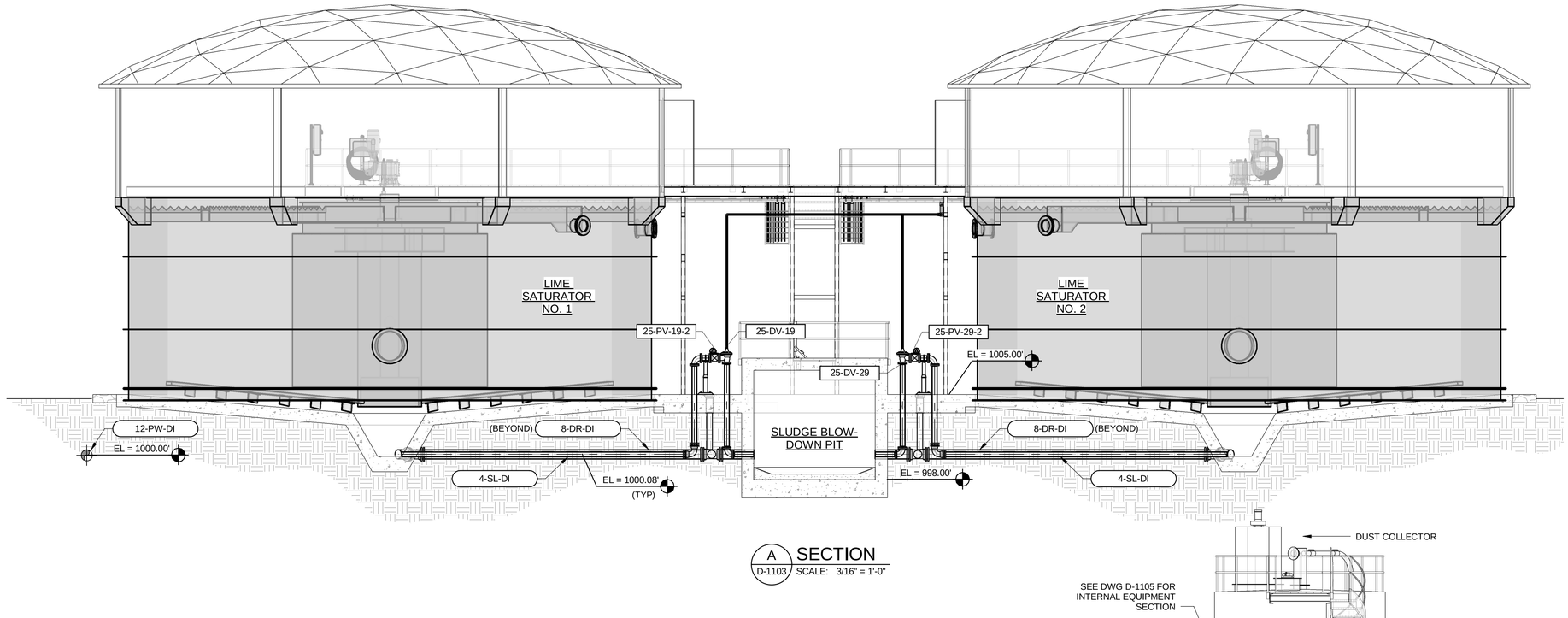
NOT RELEASED FOR REGULATORY APPROVAL, PERMIT OR CONSTRUCTION

JARRETT K. KINSLOW, P.E.
TEXAS REGISTRATION NO. 121441
JULY 2018

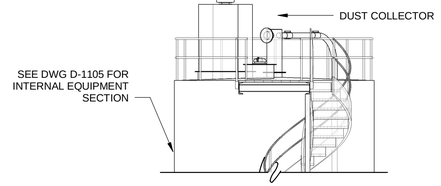
PROJ:	200-09308-18001
DESN:	JEC
DRWN:	JTE
CHKD:	JKK

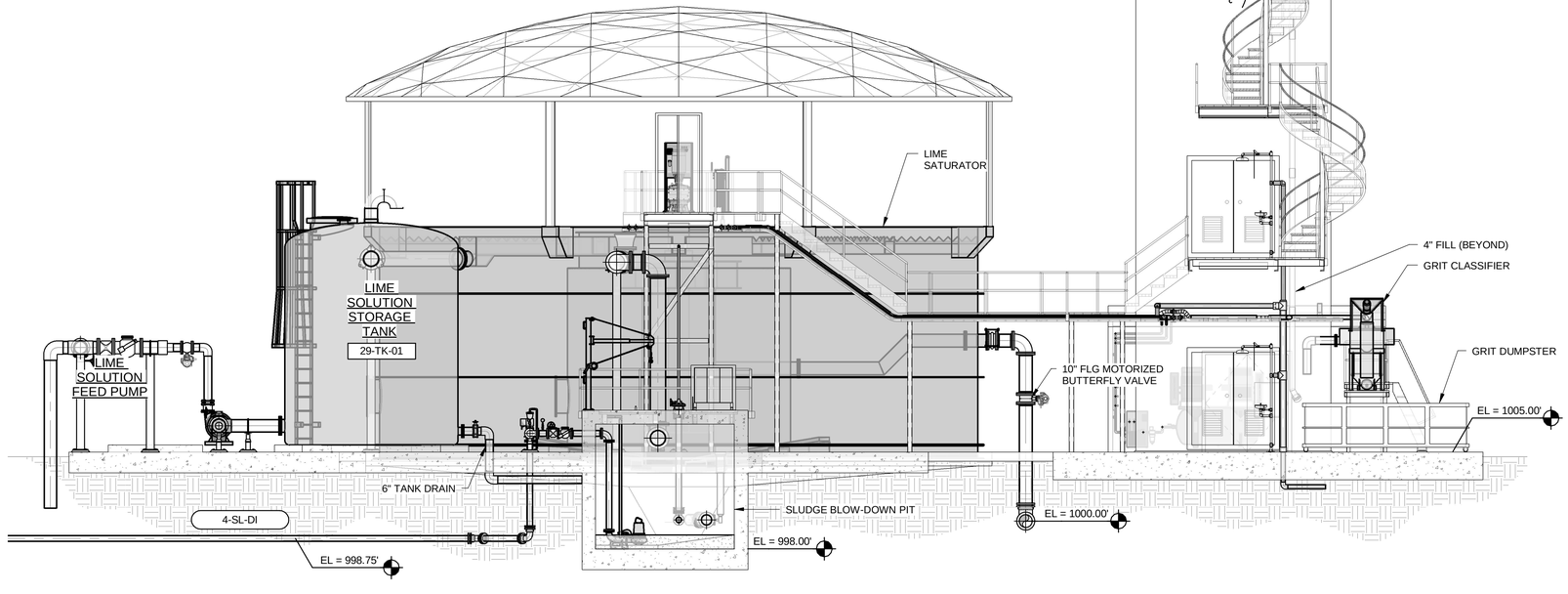
D-1103

Bar measures 1 inch, otherwise drawing is not to scale



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





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

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SAN ANTONIO WATER SYSTEM

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

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CHKD:	JKK

D-1104

Bar measures 1 inch, otherwise drawing is not to scale

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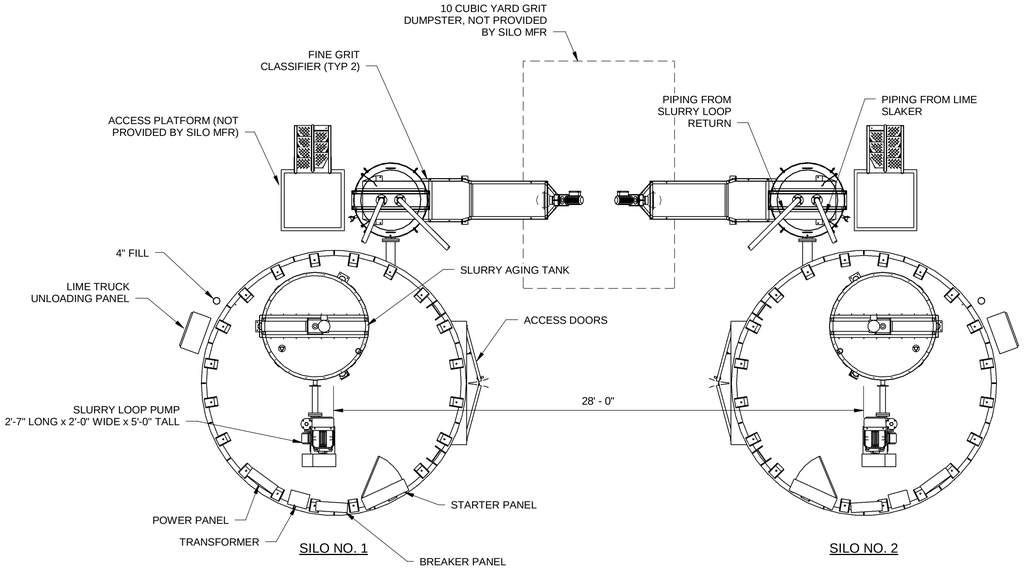
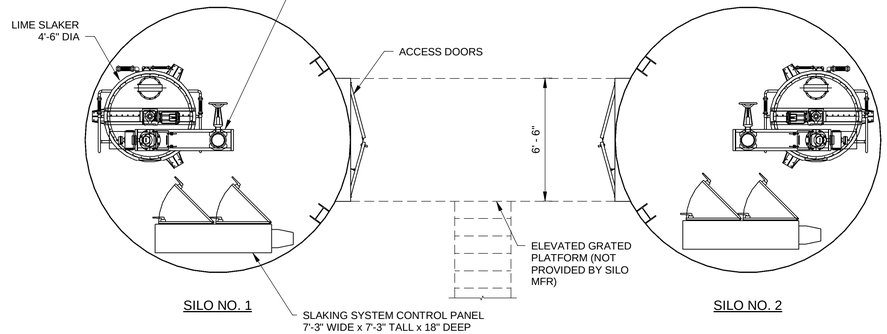


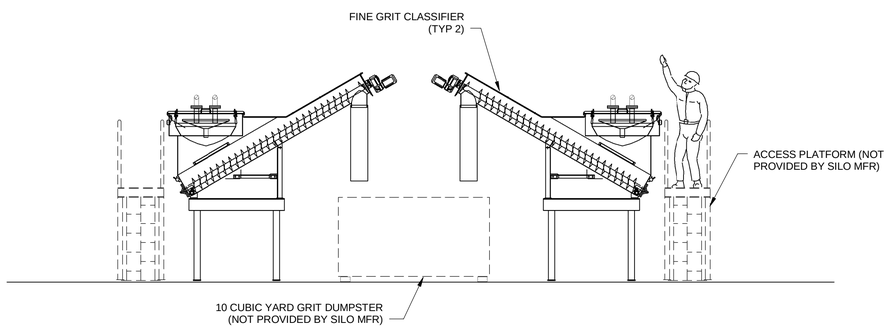
1 D-1103 SILO PLAN-FIRST FLOOR

SCALE: 1/4" = 1'-0"



1 D-1103 SILO PLAN-SECOND FLOOR

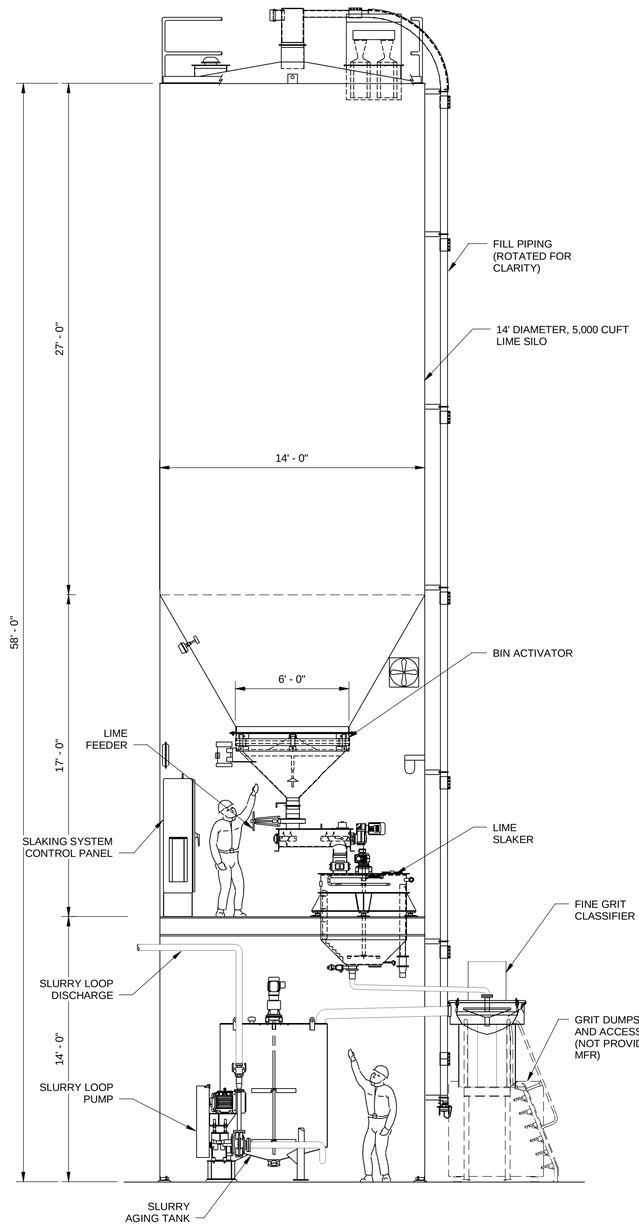
SCALE: 1/4" = 1'-0"



GRIT CLASSIFIER

SCALE: 1/4" = 1'-0"

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



SILO SECTION

SCALE: 1/4" = 1'-0"

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CENTRAL WATER INTEGRATION PIPELINE
PROJECT TERMINUS FACILITY

LIME SYSTEM SILO INTERIOR PLANS & SECTION

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D-1105

Bar measures 1 inch, otherwise drawing is not to scale

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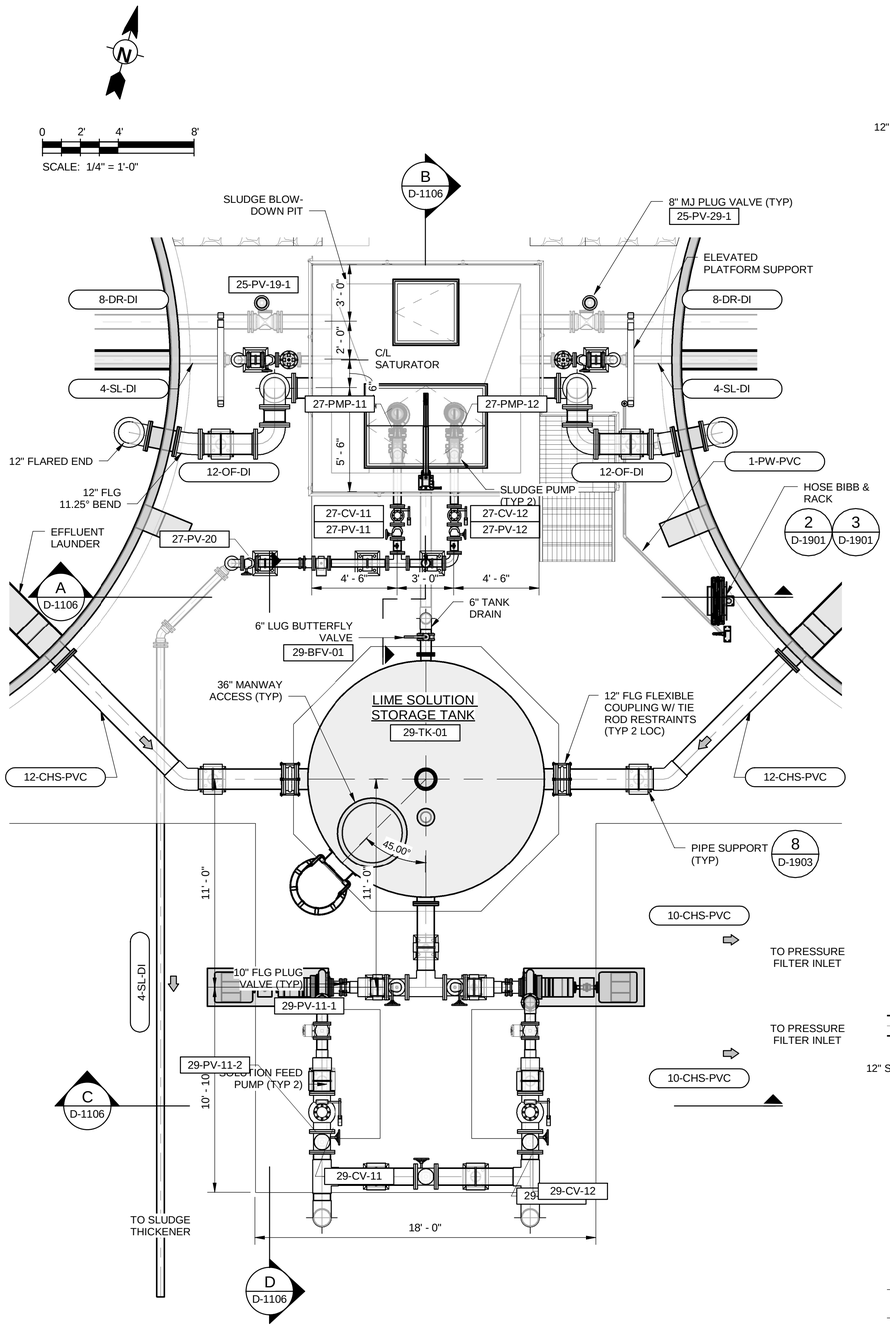
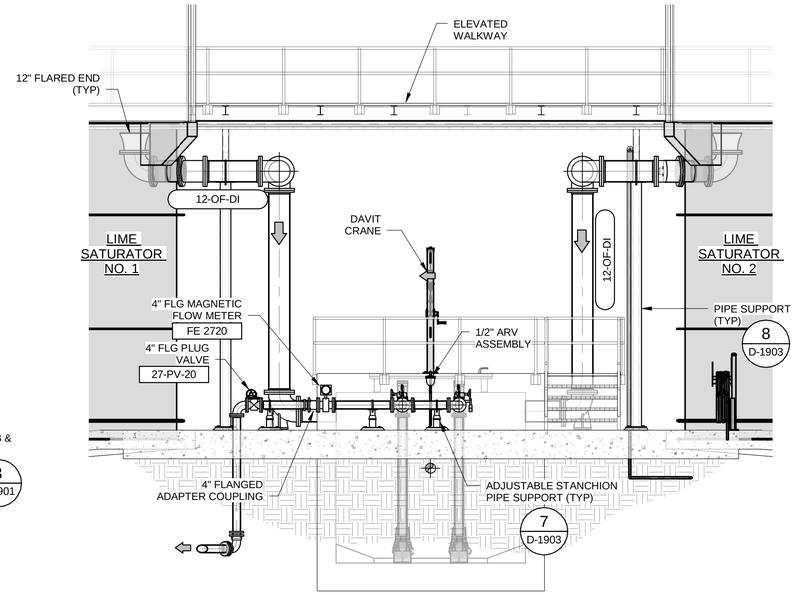


2 D-1103 **LIME SOLUTION FEED**
SCALE: 1/4" = 1'-0"



A D-1106 **SECTION**
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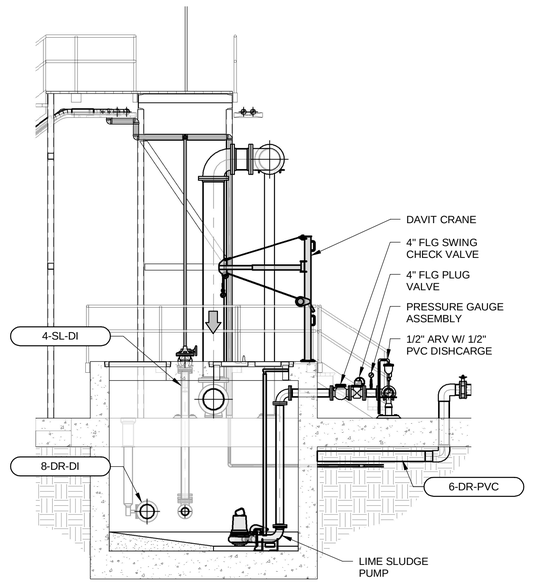

B D-1106 **SECTION**
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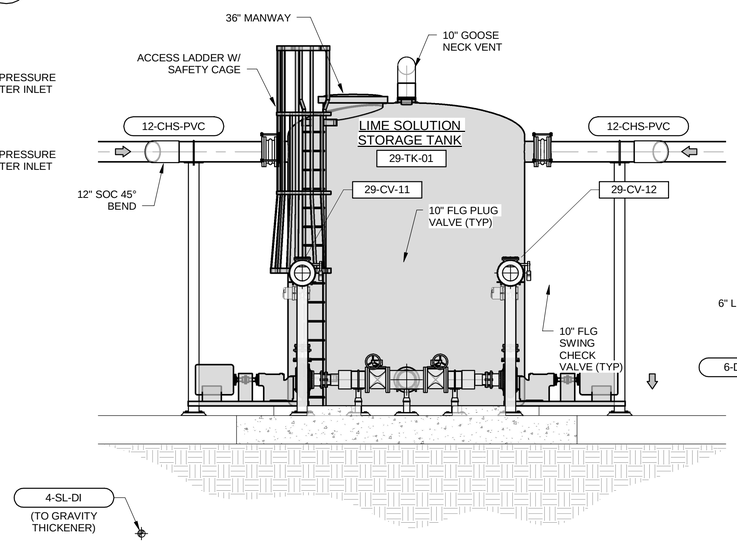

C D-1106 **SECTION**
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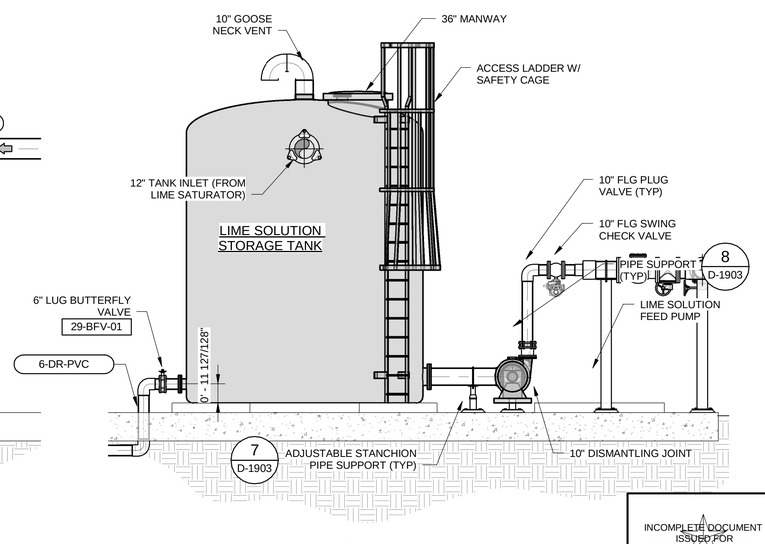

D D-1106 **SECTION**
SCALE: 1/4" = 1'-0"

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SAN ANTONIO WATER SYSTEM

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PROJECT TERMINUS FACILITY

LIME SYSTEM SLUDGE & SOLUTION FEED PLAN & SECTIONS

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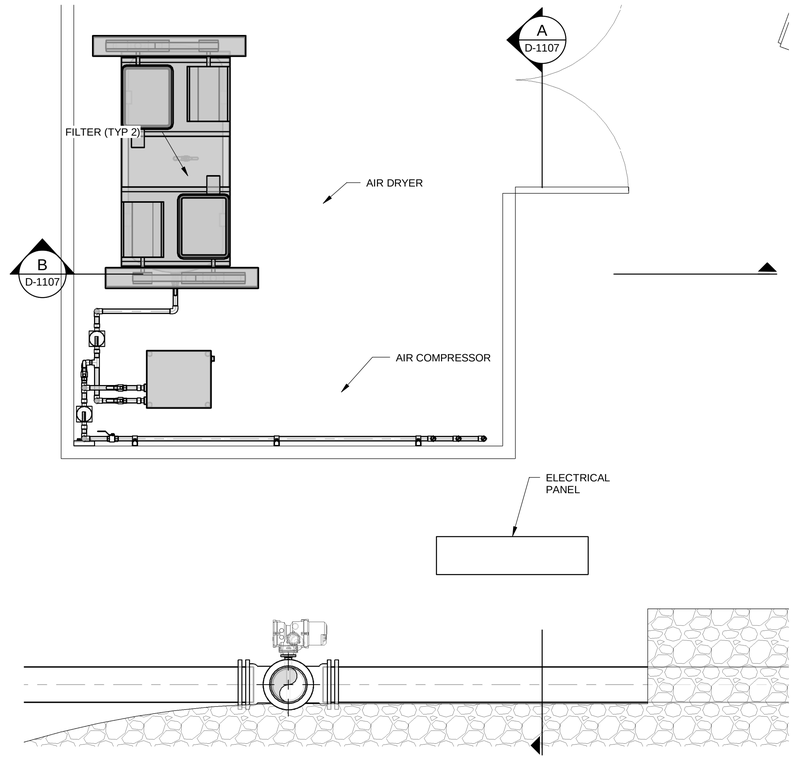
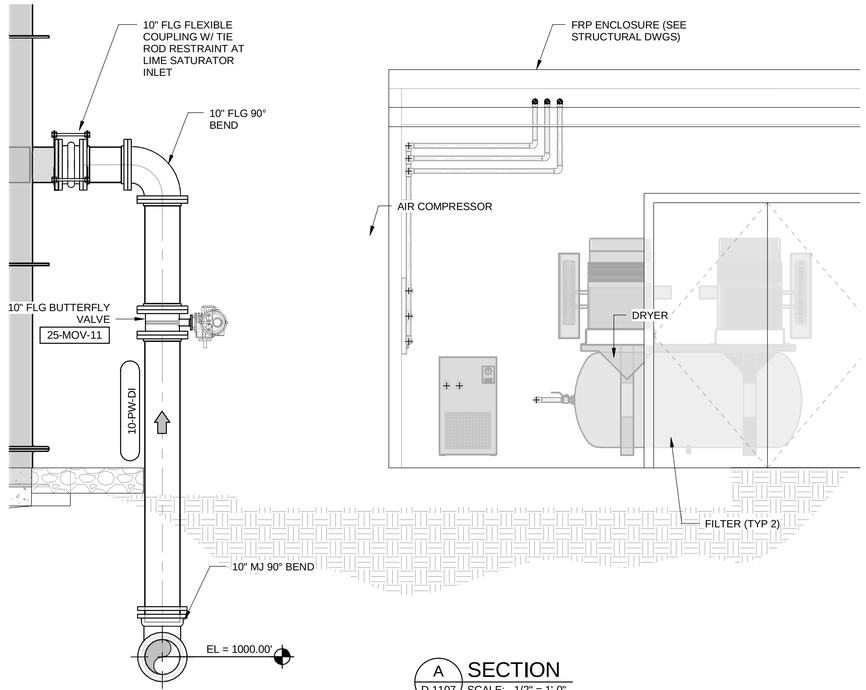


3 D-1103 AIR COMPRESSOR BUILDING
SCALE: 1/2" = 1'-0"



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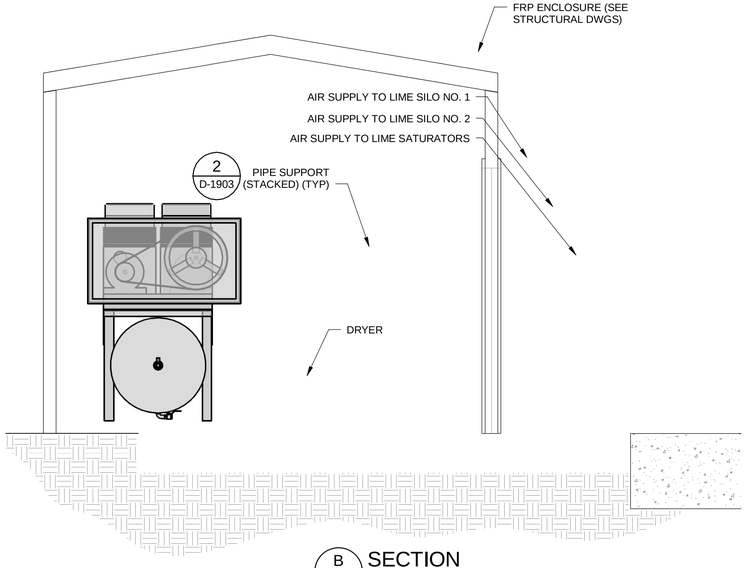
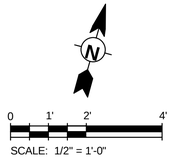


B D-1107 SECTION
SCALE: 1/2" = 1'-0"



SCALE: 1/2" = 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 AIR COMPRESSOR BLDG PLAN & SECTIONS

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D-1107

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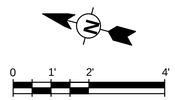
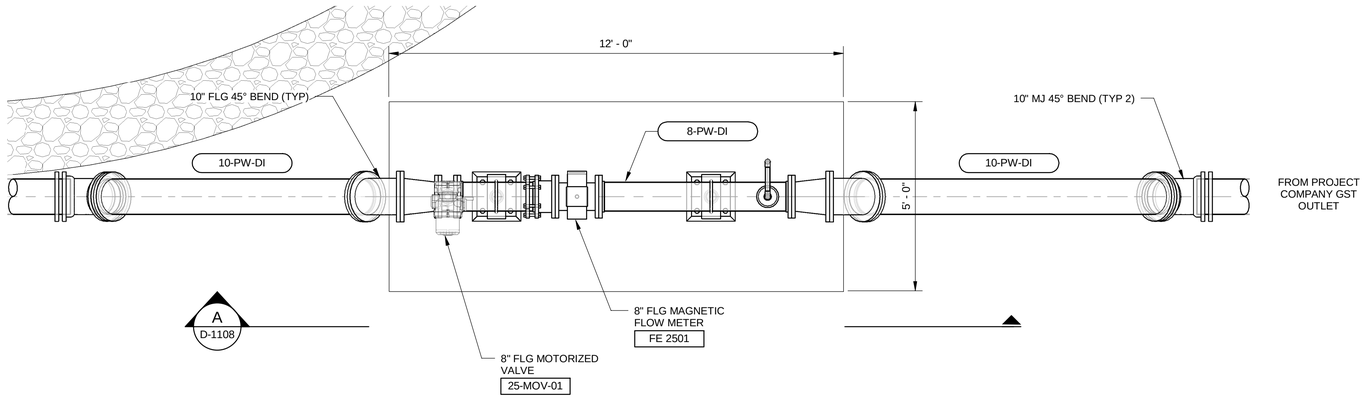
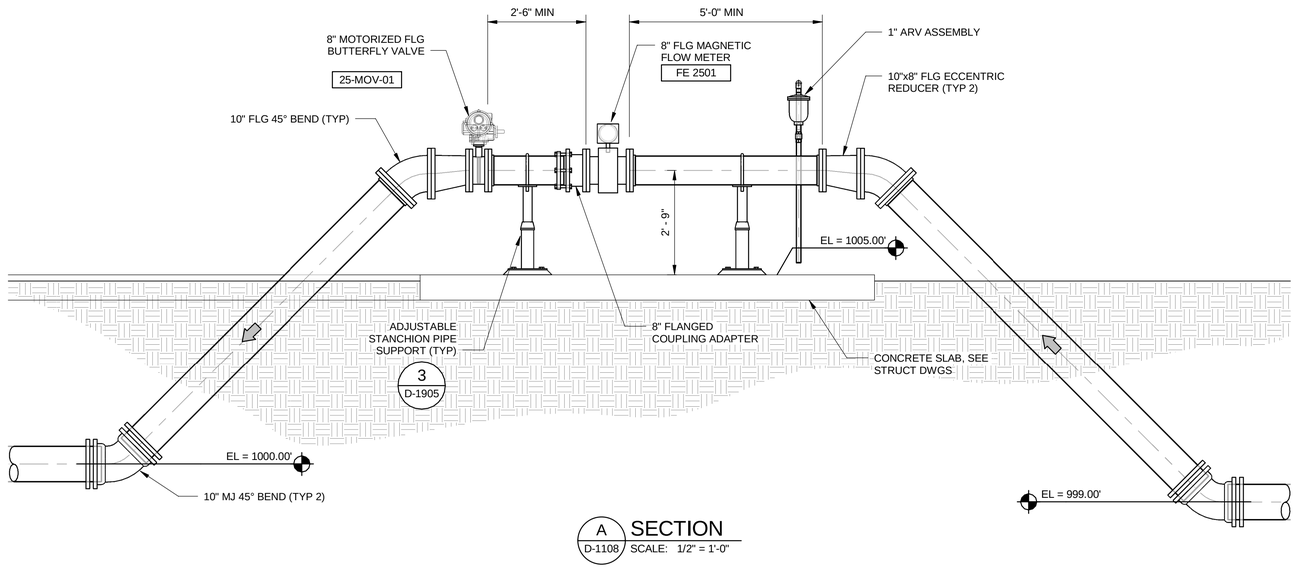




4 D-1103 **FLOW METER PLAN**
SCALE: 1/2" = 1'-0"



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

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SAN ANTONIO WATER SYSTEM

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CENTRAL WATER INTEGRATION PIPELINE
PROJECT TERMINUS FACILITY

LIME SYSTEM INFLUENT FLOW METER PLAN & SECTION

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JARRETT K. KINSLOW, P.E.
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JULY 2018

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DESN:	JEC
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CHKD:	JKK

D-1108

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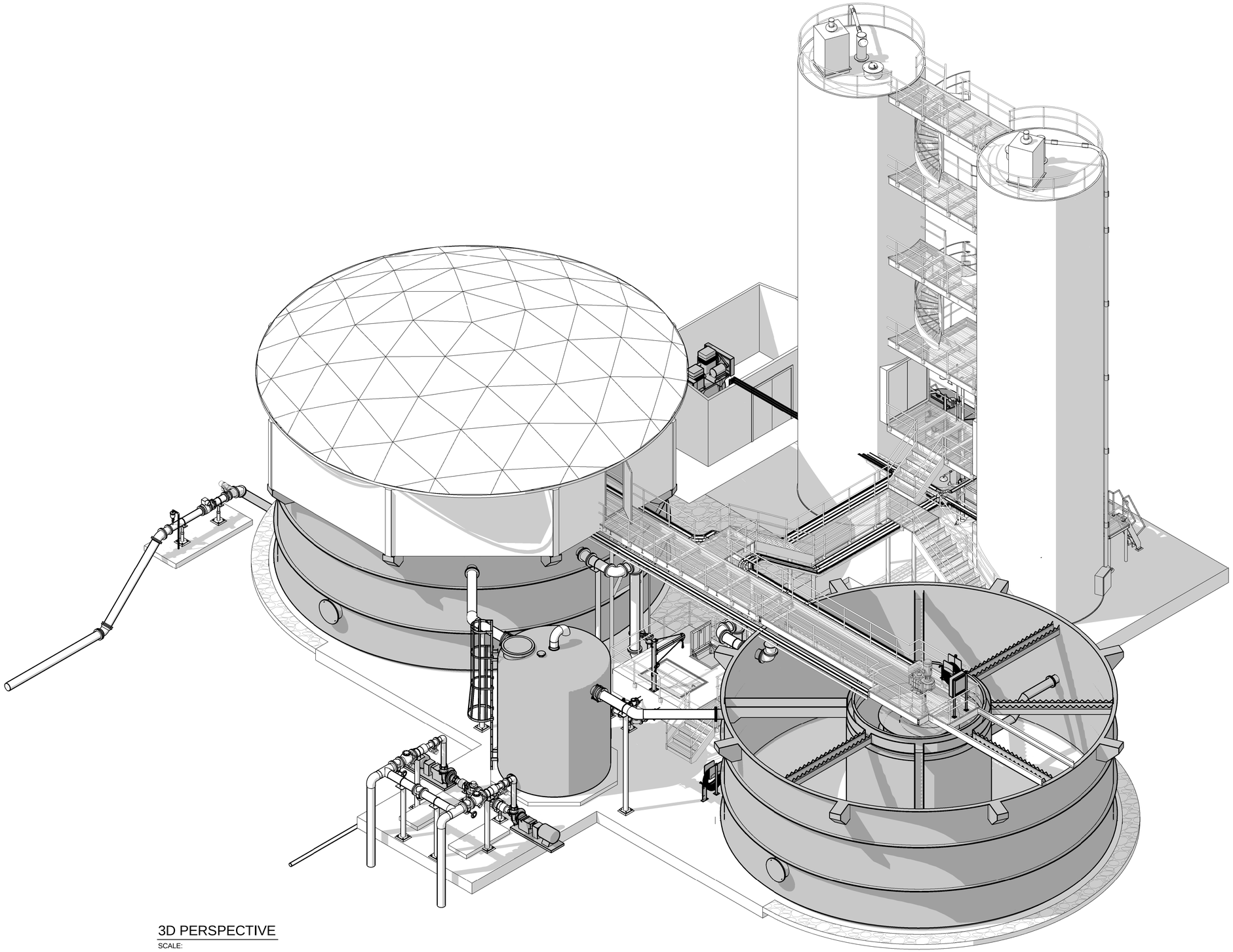

3D PERSPECTIVE

SCALE:

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SAN ANTONIO WATER SYSTEM

MARK	DATE	DESCRIPTION	BY

SAN ANTONIO WATER SYSTEM

CENTRAL WATER INTEGRATION PIPELINE
PROJECT TERMINUS FACILITY

LIME SYSTEM 3D PERSPECTIVE

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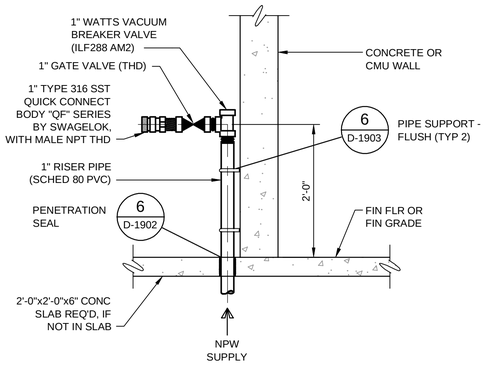
CHKD:	JKK

D-1109

Bar measures 1 inch, otherwise drawing is not to scale

7/3/2018 5:05:54 PM BIM 360://200-09308-18001 CWIPP/09308-01-01-LISAT-D-2017.rvt

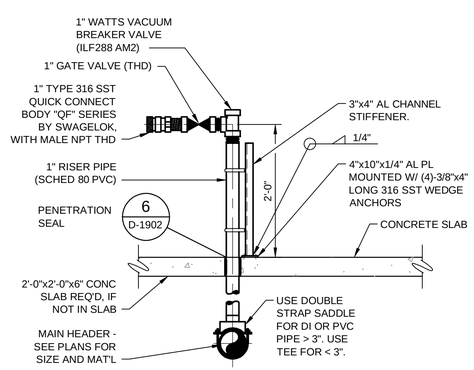
HOSE VALVE - WALL MOUNTED



NOTES:
PROVIDE 50' LONG, 1" DIA (0.47 LB/LF) ABRASION AND WEATHER RESISTANT EPDM RED COVER RAYON BRAIDED HOSE, AS MANUFACTURED BY AMAZON HOSE & RUBBER CO., OR EQUAL, WITH THE FOLLOWING 1" FITTINGS:
NOZZLE END: BRASS MALE HOSE BARB (NPSH THD), METAL HOSE SHUT-OFF VALVE, AND BRASS PLAIN HOSE NOZZLE (ALL FITTINGS AS MANUFACTURED BY AMAZON HOSE & RUBBER CO., OR EQUAL).
SUPPLY END: 1" 316 SST TUBE CONNECTION STEM, SERIES "QF" AS MANUFACTURED BY SWAGELOK, OR EQUAL.

1 **DETAIL**
SCALE: NTS

HOSE VALVE - POST MOUNTED



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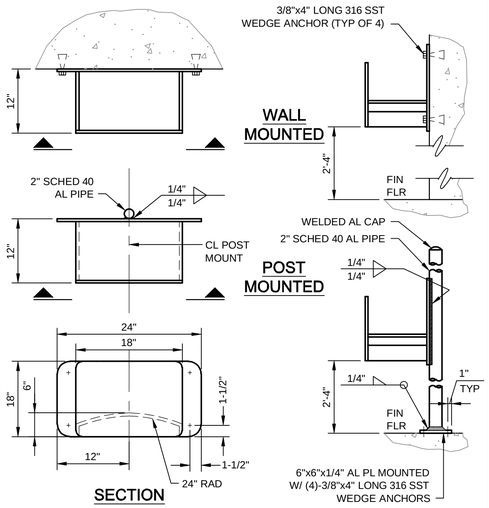
NOZZLE END: BRASS MALE HOSE BARB (NPSH THD), METAL HOSE SHUT-OFF VALVE, AND BRASS PLAIN HOSE NOZZLE (ALL FITTINGS AS MANUFACTURED BY AMAZON HOSE & RUBBER CO., OR EQUAL).
SUPPLY END: 1" 316 SST TUBE CONNECTION STEM, SERIES "QF" AS MANUFACTURED BY SWAGELOK, OR EQUAL.

2 **DETAIL**
SCALE: NTS

HOSE RACK

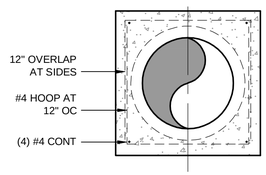


SECTION

NOTES:
1. FABRICATE UNIT FROM 1/4" 6061-T6 AL ALLOY PLATE.

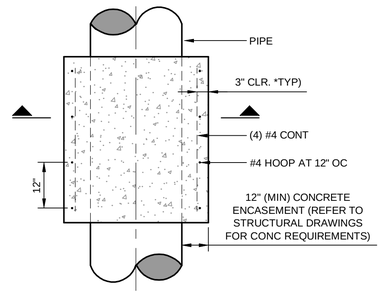
3 **DETAIL**
SCALE: NTS

CONCRETE ENCASEMENT



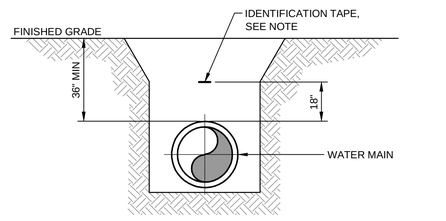
SECTION

NOTES:
1. EXTEND ENCASEMENT 2'-0" PAST OUTSIDE EDGE OF STRUCTURE (i.e. FOOTING, SLAB, ETC.)
2. ENCASE TO BOTTOM OF SLAB WHERE SHOWN ON DRAWINGS.
3. PROVIDE 3" CONC. COVER OVER REINFORCEMENT.

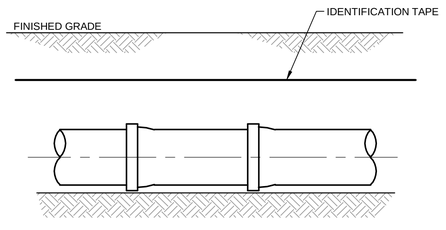


4 **DETAIL**
SCALE: NTS

LOCATING TAPE



SECTION

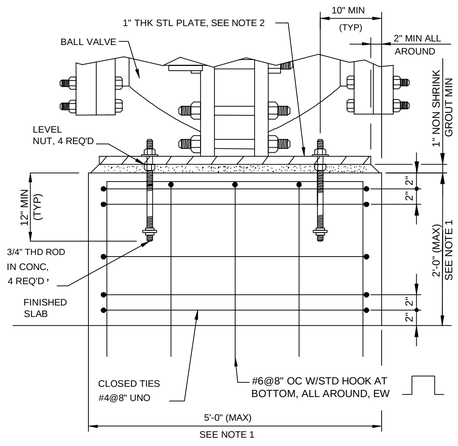


PROFILE

NOTE:
DETECTABLE IDENTIFICATION TAPE SHALL BE INSTALLED DIRECTLY OVER CENTERLINE OF THE PIPE AT 18-INCHES ABOVE THE PIPE.

5 **DETAIL**
SCALE: NTS

BALL VALVE SUPPORT

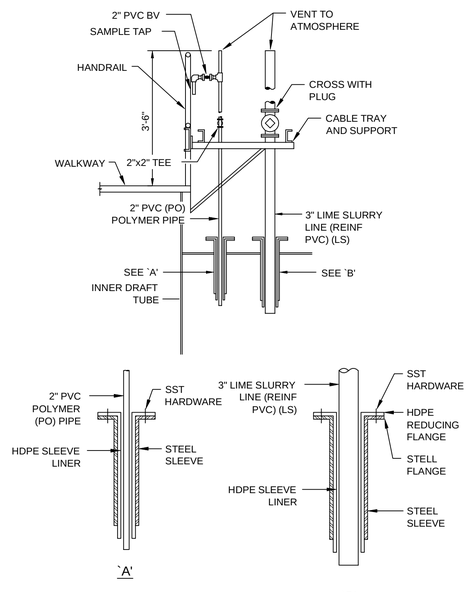


NOTES:

1. DIMENSION WILL VARY WITH VALVE SUPPLIED. REFER TO MECHANICAL SECTIONS FOR VALVE CENTERLINE AND FINISHED SLAB ELEVATIONS.
2. STEEL PLATE LENGTH AND WIDTH PER VALVE MANUFACTURER'S RECOMMENDATION.
3. MINIMUM CONCRETE COMPRESSIVE STRENGTH SHALL BE 4000 PSI AT 28 DAYS.
4. SEE STRUCTURAL GENERAL NOTES FOR ADDITIONAL REINFORCEMENT DESIGN REQUIREMENTS.

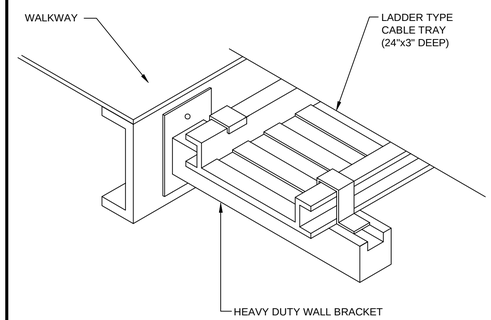
6 **DETAIL**
SCALE: NTS

CHEMICAL INJECTION SLEEVE DETAIL



7 **DETAIL**
SCALE: NTS

CHEMICAL TRAY



8 **DETAIL**
SCALE: NTS

TETRA TECH
Texas Registration No. F-3924
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100% SUBMITTAL

SAN ANTONIO WATER SYSTEM

MARK	DATE	DESCRIPTION	BY

SAN ANTONIO WATER SYSTEM
CENTRAL WATER INTEGRATION PIPELINE
PROJECT TERMINUS FACILITY

STANDARD PROCESS DETAILS

INCOMPLETE DOCUMENT
ISSUED FOR INTERIM REVIEW ONLY
NOT RELEASED FOR REGULATORY APPROVAL, PERMIT OR CONSTRUCTION

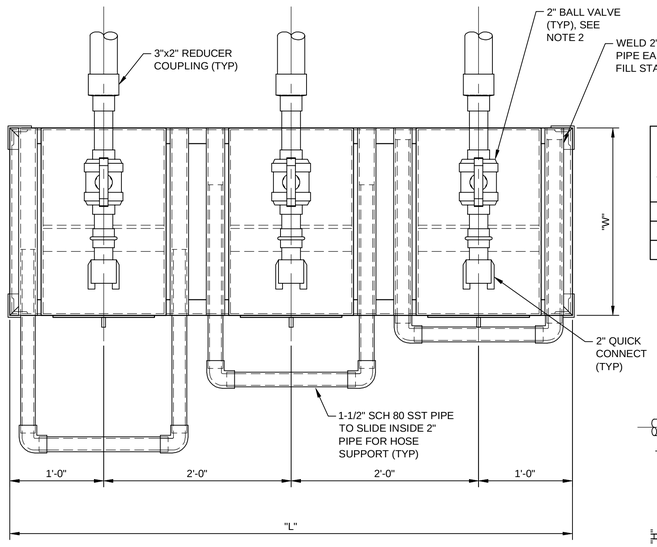
JARRETT K. KINSLOW, P.E.
TEXAS REGISTRATION NO. 121441
JULY 2018

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

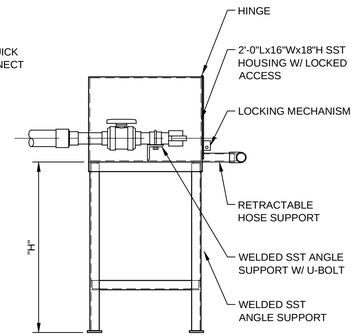
D-1901

Bar measures 1 inch, otherwise drawing is not to scale

CHEMICAL FILL STATION



FILL STATION	WIDTH (W)	HEIGHT (H)	LENGTH (L)
SINGLE	2'-0"	3'-0"	2'-0"
DOUBLE	2'-0"	3'-0"	4'-0"
TRIPLE	2'-0"	3'-0"	6'-0"

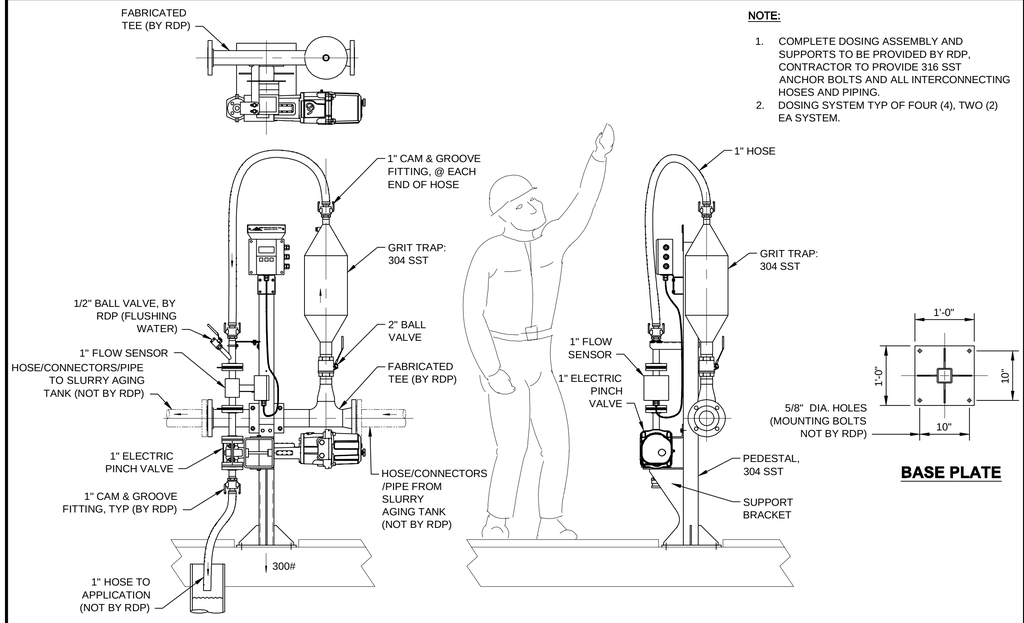


NOTES:

1. ALL STAINLESS STEEL SHALL BE TYPE 316.
2. BALL VALVES SHALL NOT BE INSTALLED FOR THE CALCIUM ADDITION SYSTEM FILL STATION.

1 **DETAIL**
SCALE: NTS

RDPRECISION DOSING ASSEMBLY - TYP OF FOUR (4), TWO (2) EACH SYSTEM



NOTE:

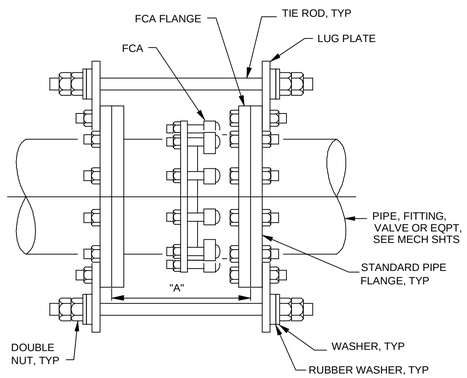
1. COMPLETE DOSING ASSEMBLY AND SUPPORTS TO BE PROVIDED BY RDP, CONTRACTOR TO PROVIDE 316 SST ANCHOR BOLTS AND ALL INTERCONNECTING HOSES AND PIPING.
2. DOSING SYSTEM TYP OF FOUR (4), TWO (2) EA SYSTEM.

2 **DETAIL**
SCALE: NTS

FLANGED COUPLING ADAPTER W/ THRUST HARNESS

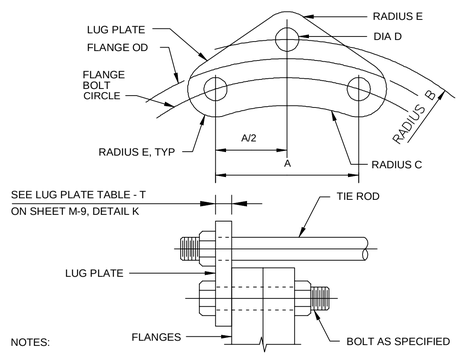
NOTES:

1. FOR NUMBER AND SIZE OF TIE RODS, SEE TABLE I, DETAIL 6/D-1908. FOR MATERIAL OF TIE RODS, NUTS AND WASHERS, SEE DETAIL X/D-190X.
2. LUG PLATE THICKNESS SHALL BE AS PER LUG PLATE TABLE, DETAIL 5/D-1908.
3. LAY LENGTH "A" EQUALS COMPRESSED LENGTH OF COUPLING + 2", MINIMUM, FOR EASE OF DISASSEMBLY. REFER TO MANUFACTURER'S INFORMATION FOR COUPLING LENGTH.



4 **DETAIL**
SCALE: NTS

LUG PLATE FOR FLANGED PIPE



NOTES:

1. ALL DIMENSIONS ARE IN INCHES. DIMENSION "A" AS REQUIRED BY FLANGE SPECIFIED.
2. RADIUS "B" = $\frac{\text{(FLANGE OD) + DIA D + 1/4"}}{2}$
3. RADIUS "C" = $\frac{\text{(BOLT CIRCLE) - RADIUS E}}{2}$
4. DIAMETER "D" = ROD DIAMETER + 1/8"
5. RADIUS "E" = BOLT DIAMETER X 1.25
6. INSTALL TIE ROD ASSEMBLIES SUCH THAT ALL RODS ARE EQUALLY SPACED AROUND FLANGE. ON PIPING 20 INCHES AND LARGER, RODS MAY BE GROUPED IN PAIRS BUT GROUPS MUST BE EQUALLY SPACED AROUND FLANGE. THE TOTAL NUMBER OF THE RODS SHALL BE INCREASED ABOVE THAT TABULATED AS NECESSARY TO MEET SPACING REQUIREMENTS.
7. SEE DETAIL X, ON SHEET D-190X, FOR MATERIAL OF TIE RODS, NUTS AND WASHERS.

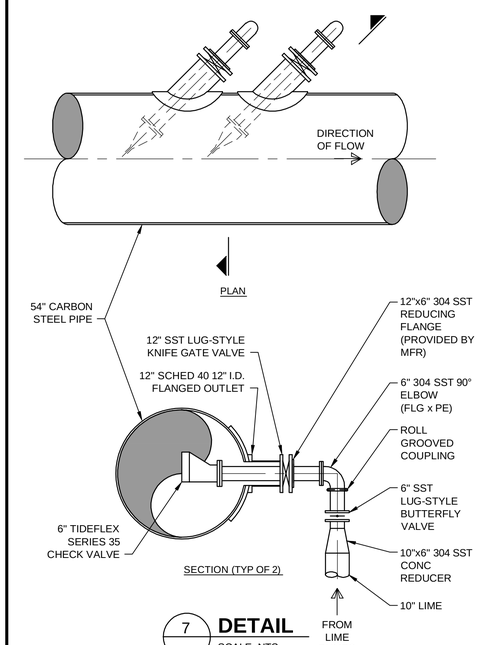
5 **DETAIL**
SCALE: NTS

HARNESS LUG PLATE TABLE

HARNESS LUG PLATE TABLE						
	150 psi		200 psi		250 psi	
PIPE SIZE (inch)	NO LUGS	LUG THICK (T)	NO LUGS	LUG THICK (T)	NO LUGS	LUG THICK (T)
3	4	3/8	4	1/2	4	1/2
4	4	1/2	4	3/4	4	3/4
6	4	3/4	4	1	4	1
8	4	1	4	1	4	1
10	4	1 1/4	4	1 1/4	4	1 1/4
12	4	1 1/4	4	1 1/4	4	1 1/4
14	4	1 1/4	4	1 1/4	4	1 1/2
16	4	1 1/4	4	1 1/2	4	1 1/2
18	4	1 1/4	4	1 1/2	4	1 3/4
20	4	1 1/2	4	1 1/2	4	1 3/4
24	4	1 1/2	4	2	4	2 1/4
30	6	1 3/4	6	2	6	2 1/4
36	6	2	6	2	6	2 1/4

6 **DETAIL**
SCALE: NTS

LIME SOLUTION DIFFUSER ASSEMBLY



7 **DETAIL**
SCALE: NTS

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SAN ANTONIO WATER SYSTEM

MARK	DATE	DESCRIPTION	BY

SAN ANTONIO WATER SYSTEM
CENTRAL WATER INTEGRATION PIPELINE
PROJECT TERMINUS FACILITY
STANDARD PROCESS DETAILS

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TEXAS REGISTRATION NO. 121441
JULY 2018

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

D-1908

Bar measures 1 inch, otherwise drawing is not to scale

7/3/2018 5:07:16 PM - O:\PROJECTS\ORLANDO\IER\09308\200-09308-18001-BICAD\SHEETFILES\TREATMENT_FACILITY\D-190X STANDARD PROCESS DETAILS.DWG - EVANS, JON

DUST COLLECTOR FAILED XA 2001
DUST COLLECTOR LOCAL REMOTE YL 2001
DUST COLLECTOR RUNNING YL 2001
LIME SILO LEVEL LI 2001
LIME SILO LEVEL ALARM HIGH LAH 2001
LIME SILO LEVEL ALARM LOW LAL 2001
WATER SUPPLY PRESSURE PI 2090
BIN AGITATOR RUNNING YL
BIN AGITATOR FAILED XA
SOLENOID VALVE (TYPICAL OF 5): OPEN YC, POSITION OPEN ZIO
LIME SLAKER TEMP. TI 2121
LIME SLAKER LEVEL LI 2121
LIME SLAKER LEVEL HIGH LAH 2121
LIME SLAKER LEVEL LOW LAL 2121
SLURRY AGING LEVEL LI 2301
SLURRY AGING LEVEL HIGH LAH 2301
SLURRY AGING LEVEL LOW LAL 2301
SLURRY LOOP PUMP (TYPICAL OF 2): LOCAL/REMOTE YL, RUNNING YL, FAILED XA, LEAK ALARM XA, START/STOP HS, SPEED COMMAND SC, SPEED SIR
TYPICAL OF 2: EFFLUENT FLOW TO LIME SATURATOR FI 2411

HMI

PLC - CHEM (01-CP-02)

E-NET

LIME TRUCK UNLOADING PANEL

ON/OFF HS; ON YL; LOW LEVEL LIL 2001; HIGH LEVEL LIH 2001
MANUAL/AUTO HS; ON HS; FAULT XA

LIME ADDITION CONTROL PANEL (SEE NOTE 1)

20-CP-01

POWER ON HS; HORN SILENCE HS; BATCH STOP HS
CALIBRATION RESET HS; RESET HS; LIME SILO LEVEL LI 2001
E-STOP HS; BATCH START HS

SYSTEM AUTO CONTROLS: MAN-OFF-AUTO HS; AUTO START HS; MAN-OFF-SINGLE-MULTIPLE HS; AUTO STOP HS; RESIDUAL BUILDUP AL

LIME SILO: LEVEL LI 2001

BIN AGITATOR: ON HS; OFF HS; STATUS YL

LIME SLAKER MIXER: ON HS; OFF HS; STATUS YL
LIME SLAKER: FAULT TAH 2121; TEMP. TI 2121
LIME FEEDER: ON HS 2101; OFF HS 2101; STATUS YL 2101
LIME SLAKER: LEVEL LI 2121; HIGH LEVEL ALARM LAH 2121; LOW LEVEL ALARM LAL 2121
LIME SLAKER INLET DAMPER VALVE: OPEN HS 2111; CLOSE HS 2111; STATUS YL 2111
LIME SLAKER DISCHARGE VALVE: OPEN HS; CLOSE HS; STATUS YL
SLURRY AGING TANK: LEVEL LI 2301; HIGH LEVEL ALARM LAH 2301; LOW LEVEL ALARM LAL 2301
SLAKER FEED WATER VALVE: OPEN HS; CLOSE HS; STATUS YL
SLURRY LOOP PUMP: MAN-OFF-AUTO HS; STATUS YL; START HS; STOP HS
SLAKER CLEANING WATER VALVE #1: OPEN HS; CLOSE HS; STATUS YL
SLURRY PUMP HIGH PRESSURE: FAULT YL 2401
SLAKER CLEANING WATER VALVE #2: OPEN HS; CLOSE HS; STATUS YL
MIXER BASIN NO.1 PINCH VALVE: FLOW RATE FI 2411; % OPEN ZI 2411
SLAKER DUST ARRESTOR VALVE: OPEN HS; CLOSE HS; STATUS YL
MIXER BASIN NO.2 PINCH VALVE: FLOW RATE FI 2421; % OPEN ZI 2421
FINE GRIT CLASSIFIER: ON HS; OFF HS; STATUS YL
SLIME AGING TANK MIXER: MAN-OFF AUTO HS; ON HS; FAULT YL

DUST COLLECTOR *
PI 2001
LE 2001
QUICK LIME SUPPLY
20-SI-01 *
STORAGE SILO (5,000 CF)
AGITATOR M *
KNIFE GATE
1"
LS 2101
SCREW CONVEYOR FEEDER *
21-SCV-01
21-AOV-11 M *
38"
COMPRESSED AIR
1-AIR-SST
1"
FROM PLANT WATER SUPPLY
BFP
20-PV-90
PIT 2090
PE 2090
DRAIN
6-SS-PVC
3-PW-PVC

LIT 2121
LE 2121 *
TIT 2121
2-SV-21-4
2-SV-21-3
2-SV-21-2
2-SV-21-1
LIME SLAKERS
21-MXR-21 *
21-SLK-21 *
3"
21-AOV-31
INTERNAL STAND PIPE
WE 2121A
WE 2121B
WE 2121C
3/8"

21-SAG-01 *
LE 2301 *
SLURRY AGING TANK (3,000 GAL)
23-MXR-01 *
23-BFV-01
23-BV-01
OVERFLOW
23-PV-51

23-PV-21-1
23-PV-21-2
LOR
HS S/S
HS S VFD
SC
GRIT CLASSIFIER
23-GC-01 *
GRIT CART
M

24-PRV-01
PI 2401
24-BV-01
24-SV-01 S *
PS 2401
24-PV-01
SLURRY LOOP PUMP
24-PMP-01 *
AIR GAP (TYP)

LIME SLURRY DOSING ASSEMBLY (BY SYSTEM SUPPLIER) *
FIT 2411
FE 2411
M
TO LIME SATURATOR NO. 1
24-BV-11
24-PIV-11
LIME SLURRY DOSING ASSEMBLY (BY SYSTEM SUPPLIER) *
FIT 2421
FE 2421
M
TO LIME SATURATOR NO. 2
24-BV-21
24-PIV-21

SCOPE OF SUPPLY NOTES

1. ALL EQUIPMENT ON THIS DRAWING SHALL BE SUPPLIED BY THE LIME SYSTEM SUPPLIER AS SPECIFIED IN SECTION 11292, INCLUDING ALL CONTROL VALVES AND MANUAL ISOLATION VALVES.
2. SLURRY LOOP FROM PUMPS TO DOSING POINTS SHALL BE SCHEDULE 80 CPVC FOR STRAIGHT RUNS AND HOSE ELBOWS FOR ALL BENDS. MINIMUM RADIUS FOR BENDS SHALL BE 5 TIMES THE PIPE DIAMETER. SLURRY LOOPS SHALL BE INSTALLED BY CONTRACTOR.
3. SERVICE WATER SUPPLY AND COMPRESSED AIR SUPPLY INCLUDING ALL PIPING AND VALVES SHALL BE FURNISHED AND INSTALLED BY THE CONTRACTOR UNLESS OTHERWISE MARKED WITH (*) SYMBOL.

NOTES

1. LIME ADDITION CONTROL PANEL COMPONENTS, SWITCHES, TO BE COORDINATED WITH VENDOR.
2. TAGS SHOWN FOR LIME SILO NO. 1. TAGS FOR LIME SILO NO. 2 SIMILAR.

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TIMOTHY D. GOBROGGE
TEXAS REGISTRATION NO. 128455
JULY 2018

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100% SUBMITTAL

SAN ANTONIO WATER SYSTEM

MARK	DATE	DESCRIPTION	BY

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

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

I-1003

Bar measures 1 inch, otherwise drawing is not to scale

7/3/2018 3:25:02 PM - O:\PROJECTS\ORLANDO\ER\09308\200-09308-18001-B\CAD\SHEETFILES\TREATMENT_FACILITY\I-1003_1004 LIME SYSTEM P&ID.DWG - EVANS, JON

LIME SLUDGE PUMP (TYPICAL OF 2)
LOCAL/ REMOTE
RUNNING
FAILED
LEAK ALARM
START/ STOP
RAW WATER FLOW
MOTOR OPERATED VALVE (TYPICAL OF 3)
OPEN
CLOSED
LOCAL/ REMOTE
OPEN
CLOSE
EFFLUENT LIME SLUDGE FLOW
pH INDICATION
CARBONATED WATER FLOW
SOLENOID VALVE (TYPICAL OF 4)
OPEN
POSITION OPEN
pH INDICATION
TURB INDICATION
TURB INDICATION
SOLUTION FEED PUMP (TYPICAL OF 2)
LOCAL/ REMOTE
RUNNING
FAILED
LEAK ALARM
START/ STOP
SPEED COMMAND
SPEED
YL YL XA XA HS FI ZIO ZIC YL HS HS FI 2720 AI FI 2590 HS ZIO AI AI AI YL YL XA XA HS SC SIR
E-FIO
HMI
PLC - CHEM (01-CP-02)
E-NET
FROM LME SILO NO. 2
I-1003
TO LIME SILO NO. 1
I-1003
TO LIME SILO NO. 2
I-1003
FROM LME SILO NO. 1
I-1003
FROM PC TANK OUTLET
I-1002
FROM POLYMER SUPPLY
AIR
SERVICE WATER
CARBONATED WATER FROM 10 MG GROUND STORAGE TANK
I-1002
3-CH-CPVC
10-PW-DI
XX-POL-XX
1/2-PW-PVC
54-CPW-CS
42-CPW-CS
FIT 2501
FE 2501
25-ARV-01
25-BV-01
8"
25-MOV-01
1/2"
25-BV-21-7
25-BV-11-7
AE 2511
AIT 2511
pH
M
25-MOV-11
25-MOV-21
LIME SATURATOR NO. 1
25-SAT-11
LIME SATURATOR NO. 2
25-SAT-21
25-BV-11-6
25-BV-11-5
25-BV-11-4
25-BV-11-3
25-BV-11-2
25-BV-11-1
25-BV-21-6
25-BV-21-5
25-BV-21-4
25-BV-21-3
25-BV-21-2
25-BV-21-1
12-OF-DI
12-CHS-PVC
25-BV-19
25-BV-29
25-PV-19-2
25-PV-19-1
25-PV-29-2
25-PV-29-1
L/O/R S/S
HS HS
S
VFD
SLC
LE 2901
LIME SOLUTION STORAGE TANK
29-TK-01
25-BV-28
29-BFV-01
TURB
AE 2528
AIT 2528
25-BV-18
25-NV-18
25-NV-28
1/2"
1/4"
8-DR-DI
4-SL-DI
25-DV-19
25-DV-29
25-SV-19-1
25-SV-19-2
25-SV-29-1
25-SV-29-2
1-CHS-PVC
6-DR-PVC
54-CPW-CS
SLUDGE BLOWDOWN PIT
LIME SLUDGE PUMP NO. 1
27-PMP-11
LIME SLUDGE PUMP NO. 2
27-PMP-11
PI 2712
27-ARV-20
27-BV-20
27-BV-12
27-PV-12
27-CV-12
FIT 2720
FE 2720
PI 2711
27-BV-11
27-PV-11
27-CV-11
27-PV-20
4"
TO GRAVITY THICKENER
I-1014
4-SL-DI
CONTROL VALVE
SOLUTION FEED PUMP NO. 2
29-PMP-12
SOLUTION FEED PUMP NO. 1
29-PMP-11
29-PV-12-1
29-MOV-12
29-PV-12-2
29-CV-12
PI 2922
PIT 2922
29-BV-22
29-PV-11-1
29-MOV-11
29-PV-11-2
29-CV-11
PI 2921
PIT 2921
29-BV-21
29-PV-20
29-BV-20
FROM POLYMER SYSTEM
I-1012
SPARE FROM POLYMER SYSTEM
I-1012
10-CHS-PVC
2-POLS-PVC
29-BFV-91
29-BFV-92
29-GV-91
29-GV-92
67-BV-90-1
54-FLS-CS
TO PRESSURE FILTERS
I-1005

NOTES

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

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

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

I-1004

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7/3/2018 3:25:05 PM - O:\PROJECTS\ORLANDO\ER\09308200-09308-18001-BVCAD\SHEET\FILES\TREATMENT_FACILITY\I-1003_1004 LIME SYSTEM P&ID.DWG - EVANS, JON