

SECTION 231 000

DIESEL EMISSIONS FLUID SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install diesel emissions fluid (DEF) systems complete and operational with accessories for the generator engines Tier 4 emissions system.
2. The DEF system shall be an extension of the Work provided under Specification for Diesel Engine Driven Generator for single point responsibility by the Generator System Supplier.
3. Generator System Supplier shall secure the services of a single DEF System Supplier to provide complete and fully functioning integrated DEF systems meeting all requirements for a Tier 4 generator system.
4. CONTRACTOR is solely responsible for construction means, methods, techniques, sequences and procedures and for safety precautions and programs.
5. The Work includes:
 - a. Storage tanks and accessories.
 - b. Fill port complete with filling station and system control panel.
 - c. Transfer Pumps.
 - d. Dosing cabinet refill units.
 - e. DEF Dosing Cabinet overflow tank
 - f. Piping, valves and accessories.
 - g. Piping specialties.
 - h. Sleeves.
 - i. Hangers and supports.
 - j. Piping insulation.
 - k. DEF.
 - l. Painting.
 - m. Identification.
 - n. Anchorage.
 - o. Testing and startup.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the DEF system Work.

C. Related Sections:

1. Anchor Systems.
2. Structural Steel.

3. Miscellaneous Metal Fabrications.
4. Painting.
5. Identification Devices.
6. Diesel Engine Driven Generator.

D. The following index of this Section is included for convenience:

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- 3.1 Inspection
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- 3.4 Field Quality Control
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- 3.6 Cleaning

1.2 REFERENCES

- A. American National Standards Institute (ANSI).
 - 1. ANSI B1.1 – Unified Inch Screw Threads (ASME B1.1).

- B. American Society for Testing and Materials (ASTM).
 - 1. ASTM A36/A36M – Standard Specification for Carbon Structural Steel.
 - 2. ASTM A47/A47M – Standard Specification for Ferritic Malleable Iron Castings.
 - 3. ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 4. ASTM A153/A153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 5. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - 6. ASTM A575 – Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
 - 7. ASTM A668/A688M – Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
 - 8. ASTM D1998 - Standard Specification for Polyethylene Upright Storage Tank
 - 9. ASTM G93 - Standard Practice for Cleaning Methods and Cleanliness Levels for Material and Equipment Used in Oxygen-Enriched Environments

- C. American Welding Society (AWS):
 - 1. AWS B2.1 – Specification for Welding Procedure and Performance Qualification.

- D. Department of Environmental Protection (DEP).

- E. Federal Specifications (FS):
 - 1. FS WW H 171 – Hangers and Supports, Pipe.

- F. International Organization for Standardization (ISO):
 - 1. 22241-1 - Diesel engines - NOx reduction agent AUS 32 -- Part 1: Quality requirements.
 - 2. 22241-3 - Diesel engines - NOx reduction agent AUS 32 -- Part 3: Handling, transportation and storing.
 - 3. 5211 - Industrial valves - Part-turn actuator attachments.

- G. Manufacturers Standardization Society (MSS).
 - 1. MSS SP 58 – Pipe Hangers and Supports-Materials, Design and Manufacture.
 - 2. MSS SP 69 – Pipe Hangers and Supports - Selection and Application.

- H. Petroleum Equipment Institute (PEI):
 - 1. PEI/RP 1100 - Recommended Practices for the Storage and Dispensing of Diesel Exhaust Fluid

- I. National Fire Protection Association (NFPA):
 - 1. NFPA 70 - National Electric Code.
- J. Occupational Safety and Health Administration (OSHA):
 - 1. 29CFR 1910 Subpart I - Personal Protective Equipment.
 - 2. 29CFR 1926.650 Subpart P – Excavations.
- K. Underwriters Laboratories Inc. (UL):
 - 1. UL 429 - Standard for Electrically Operated Valves.

1.3 DEFINITIONS

- A. Generator System Supplier – An equipment supplier that is responsible for providing and integrating all components of the generator system including clean emissions, fuel oil, diesel emissions fluid, and exhaust systems with undivided responsibility for a complete and integrated generator system with single point responsibility.
- B. DEF System Supplier – An equipment supplier, working under the direction of the Generator System Supplier, that is responsible for providing and integrating all components of the DEF system with undivided responsibility for a complete and integrated DEF system as directed by the Generator System Supplier.

1.4 QUALITY ASSURANCE

- A. Qualifications:
 - 1. CONTRACTOR:
 - a. CONTRACTOR shall have at least 10 years experience in the installation of the Work specified. He shall employ only tradesmen with specific skills, training and experience in this type of Work.
 - 2. Manufacturer:
 - a. Minimum of 10 years of experience producing substantially similar equipment and able to show evidence of at least 10 installations in satisfactory operation for at least five years in the continental United States.
 - b. Manufacturer's service person that will be providing Manufacturer's Services in accordance with this Section shall have a minimum of 5 years full time experience directly with Manufacturer. Direct or independent sales representatives are not permitted to perform Manufacturer's services.
 - 3. Professional Engineer:
 - c. Engage a registered professional engineer experienced in providing engineering services of the kind indicated.
 - d. Submit name and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
 - 1) Names and telephone numbers of owners, architects or engineers responsible for projects.
 - 2) Approximate contract cost of the DEF system.

- e. Responsibilities include but are not necessarily limited to:
 - 1) Carefully reviewing performance and design criteria stated in the Contract Documents.
 - 2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to ENGINEER by CONTRACTOR.
 - 3) Preparing or supervising the preparation of design calculations and related drawings, Shop Drawings, testing plan development, test-result interpretation and a comprehensive engineering analysis verifying compliance with the requirements of the Contract Documents.
 - 4) Signing and sealing all calculations and design drawings, and Shop Drawings.
 - 5) Certifying that:
 - a) it has performed the design in accordance with the performance and design criteria stated in the Contract Documents, and
 - b) the said design conforms to all applicable local, state and federal codes, rules and regulations, and to the prevailing standards of practice.
 - 2. Welding:
 - a. Qualify processes and operators in accordance with AWS B2.1, B2.2, and B2.3 as appropriate for material to be welded.
 - b. Provide certification that operators employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.
 - 3. Testing Agency:
 - a. To qualify for approval, an independent testing agency shall demonstrate to ENGINEER's satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.
- B. Component Supply and Compatibility:
- 1. Obtain all equipment included in this Section regardless of the component manufacturer from a single DEF System Supplier.
 - 2. Require the DEF System Supplier to prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall system by the DEF System Supplier.
 - 4. DEF System Supplier shall review all materials of construction proposed to be used in the system and confirm material compatibility with DEF. If a conflict arises, alternate materials shall be provided at no additional cost to the OWNER.
- C. Regulatory Requirements:
- 1. Factory Mutual (FM).
 - 2. National Electrical Code (NEC).
 - 3. National Fire Protection Association (NFPA).

4. Underwriters Laboratories Inc. (UL).
 5. Local and State Building Codes and Ordinances.
 6. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.
 7. Florida DEP
- D. Tested and inspected for approval as a unit by Underwriter's Laboratories, Inc., UL Label.
- E. Factory test equipment to ensure equipment has been properly fabricated and assembled, that all the controls function, and that equipment meets the specified performance requirements.

1.5 SUBMITTALS

- A. Action Submittals: Submit the following:
1. Shop Drawings:
 - a. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.
 - b. Minimum 1/4-inch scale layout drawings, dimensioned to show Work including but not limited to equipment, piping and conduit.
 - c. Detailed drawing of each individual component including:
 - 1) Control panel layout, bill of material, and data sheets.
 - 2) Panel wiring diagrams, schematics, and field interconnect wiring diagrams with wiring to and from the generator control panel.
 - 3) Power supply, communications, and grounding requirements.
 - 4) Complete annotated program listing and graphic panel display program listing with graphic printouts. Programs shall be OWNER accessible.
 - 5) Full MODBUS RTU data map for use by the Plant SCADA system.
 - 6) Installation.
 - d. Detailed equipment sequence of operations.
 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
 - b. Complete component list.
 - c. Detailed description of each component.
 - d. Catalog cut sheets for each component.
 - e. Performance curves with operating points.
 - f. Standard and custom color selection charts for finishing system.
 - g. Lubricant Specification: Furnish lubricant specification for type and grade required for equipment furnished.
 - h. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. CONTRACTOR shall be responsible for any additional expenses that may occur due to any exception made.

- i. Other technical data related to specified material and equipment as requested by ENGINEER.
- 3. Delegated Design Submittals:
 - a. Minimum 1/4-inch scale piping layout, dimensioned to show length of runs, with all expansion joints, alignment guides, anchors and appurtenances required for proper support and control of piping. The drawings shall include all forces acting on the piping, and equipment and the corresponding reactions of the compensation and anchor devices provided.
 - b. Equipment anchorage.
 - c. All drawings, design calculations, and a letter indicating that the hanger and support systems have been properly designed shall be signed and sealed by a registered professional engineer legally qualified to practice in the State of Florida.
- 4. Testing Plans, Procedures, and Testing Limitations:
 - a. Plan for performing required shop testing.
 - b. Plan for performing required field testing.

B. Informational Submittals: Submit the following:

- 1. Certificates:
 - a. Certification of painting systems, in accordance with “Finishing” Article in this Section.
 - b. Independent certification reports:
 - 1) UL Label or equal.
 - c. Material compatibility with DEF check and assurance statement.
- 2. Manufacturer Instructions:
 - a. Instructions and recommendations for handling, storing, protecting the equipment.
 - b. Installation Data.
 - c. Instructions for handling, start-up, and troubleshooting.
- 3. Source Quality Control Submittals:
 - a. Written report presenting results of required shop testing.
 - b. Factory test reports.
- 4. Field Quality Control Submittals:
 - a. Written report presenting results of required field testing.
- 5. Supplier Reports:
 - a. Submit written report of results of each visit to Site by Supplier’s service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
- 6. Qualifications Statements:
 - a. Manufacturer, when requested by ENGINEER.
 - b. Professional Engineer, when requested by ENGINEER.
 - c. Installer, when requested by ENGINEER.
 - d. Welder when requested by ENGINEER.
 - e. Testing Agency, when requested by ENGINEER.

- C. Closeout Submittals: Submit the following:
1. Maintenance Contracts:
 - a. Service shall be provided by a factory-trained and certified equipment manufacturer's representative during the One Year Correction Period. The equipment manufacturer's representative shall maintain all equipment furnished under this Section during the first year of operation.
 - b. Service provided shall include the following:
 - 1) On-Site Service: Service intervals shall be quarterly for a minimum of one day of eight hours each quarter. The service duration shall be increased, as necessary by the equipment manufacturer's representative, taking into consideration the equipment service requirements and equipment size. Equipment manufacturer's representative shall indicate the service duration and service scope. Prior to the visits, the equipment manufacturer's representative shall contact the OWNER and inquire as to problems encountered with the equipment. Service visits shall be scheduled at times agreeable to the OWNER at least one week in advance. The quarterly service shall include, but not limited to the following:
 - a) Provide manufacturer's recommended maintenance.
 - b) Check all controls and components, and recalibrate or adjust as necessary.
 - c) Perform necessary cleaning and services that are scheduled on a quarterly basis in accordance with the approved Operations and Maintenance Manuals. Provide all expendable materials, as necessary.
 - d) Review and provide recommendations concerning OWNER's operations.
 - e) Replace or repair defective controls and components.
 - f) Inspect control panels. Test control panel's indication lights and replace defective lights.
 - g) Provide a detailed field report to the OWNER.
 - 2) Technical Support: Technical support shall be provided between the hours of 8:00 AM and 4:00 PM local standard time, Monday through Friday when requested by the OWNER. Technical support shall include, but not limited to the following:
 - a) Telephone Technical Support.
 - b) On-Site Visits: If resolution of a problem is not achieved via the Telephone Technical Support, an on-site visit and field report shall be required.
 2. Operations and Maintenance Data:
 - a. Complete set of approved shop drawing submittal data.
 - b. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
 - c. Submit control system documentation, full annotated program listings, and electronic copies of the PLC programs and Display programs. Provide an

OWNER software license for any program not in Siemens S7 (TIA Portal) format.

- d. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01781, Operations and Maintenance Data.
3. Warranty Documentation:
 - a. General warranty.
 - b. Special warranties on materials and equipment.
4. Record Documentation:
 - a. During progress of the Work keep an up-to-date set of the Drawings showing field and Shop Drawing modifications. Immediately upon completion of the Work, submit "pdf" of CADD drawings showing the actual in place installation of all Work installed under this Section at a scale satisfactory to the OWNER. The drawings shall show Work in plans and in sections, with all reference dimensions and elevations required for complete Record Drawings of the systems. Two paper prints shall also be furnished. The prints and electronic copies of the CADD files shall be furnished no later than 30 days after completion of the Contract and prior to final payment.
5. Construction Documentation:
 - a. CONTRACTOR shall provide three sets of the installation instructions and tank certificates to allow registration in the State of Florida.

D. Maintenance Material Submittals: Furnish the following:

1. Spare Parts:
 - a. Spare parts list and recommended quantities.
2. Extra Stock Materials:
 - a. Touch up paint for each unit.
3. Tools:
 - a. Two sets of special tools, if any, required for normal operation and maintenance.
4. Spare parts, extra stock materials, and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER at the conclusion of the Project.

1.6 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Comply with manufacturer's recommendations.

B. Storage and Protection:

1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.

C. Acceptance at Site:

1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.7 WARRANTY

- A. General Warranty: The special warranties specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranties.
- B. Special Warranties on Materials and Equipment:
 1. Provide manufacturer's written warranty, running to the benefit of OWNER, agreeing to correct, or at option of OWNER, remove or replace materials or equipment specified in this Section found to be defective during a period of years after the date of Substantial Completion as indicated below.
 - a. Bulk storage tanks: 5 years.

PART 2 - PRODUCTS

2.1 SYSTEM GENERAL REQUIREMENTS

- A. The Drawings show the general arrangement of all systems. Should rearrangement of the Work be required to suit field conditions or optimize piping layout, CONTRACTOR, before proceeding with the Work, shall prepare and submit complete drawings showing all details of the proposed rearrangement for written approval.
- B. The connections shown to the various units are intended as an indication only. The actual connections at the time of installation to be made and arranged to suit the requirements of each case and to adequately provide for equipment servicing and dismantling.
- C. The Drawings do not show all offsets, fittings, accessories and details, which may be required. CONTRACTOR shall carefully examine all of the General Construction, Electrical, Mechanical, Structural and other Drawings and the respective Specifications for conditions which may affect the installation of the Work, and shall arrange the Work accordingly, furnishing all required items to meet such conditions which are not specified as work "by others," to complete the systems to meet the intent of the Contract Documents.

- D. Materials in contact with DEF shall be compatible for intended use. Refer to ISO 22241-3 for a list of compatible materials.

2.2 STORAGE TANK

- A. General Requirements:
 - 1. CONTRACTOR shall ensure that all equipment, accessories and installation materials comply with the specification and that adequate provisions are made in the tank design and fabrication for mounting the specified system equipment and accessories.
 - 2. Storage tank shall be designed for use aboveground, to provide DEF to emergency power generation equipment, and shall include integral secondary containment.
- B. Manufacturer: Provide one of the following:
 - 1. Snyder Tank
 - 2. Poly Processing
 - 3. Assmann
- C. Design and Construction:
 - 1. Tank Details:
 - a. Capacity: As noted on Drawings
 - b. Diameter: As Noted on Drawings
 - c. Height: As noted on Drawings
 - d. Fluid Stored: DEF
 - 2. Type: Vertical cylindrical double wall.
 - 3. Tank shall be rotationally molded high density polyethylene designed for a minimum 1.1 specific gravity. All polyethylene resin material shall contain a minimum of a UV 15 stabilizer.
 - 4. Primary Tank: The primary tank walls shall be minimum 0.18 inch thick and designed in accordance with ASTM D1998.
 - 5. Secondary Containment with Leak Monitoring: The secondary tank walls shall be minimum 0.18 inch thick and designed in accordance with ASTM D1998. Integral secondary containment shall provide at minimum 100% containment of the primary storage tank.
 - 6. Finish: The tank exterior shall be opaque white color.
 - 7. Provide an interstitial monitoring port for monitoring the tank's interstice for liquids.
- D. Tank Accessory Equipment
 - 1. Inspection Port Adapter Cap: Tank shall be equipped with a 4" adapter and lockable cap for inspection of fluid level.
 - 2. Manway: Provide a minimum 20-inch diameter manway with bolted cover.

3. Ladder: Provide a fiberglass reinforced plastic (FRP) or stainless steel access ladder for tank top inspection and access. Ladder shall be designed in accordance with OSHA requirements.
- E. Ports: Tank shall include minimal number of ports as shown on the Drawings for attaching piping and equipment. Additional ports shall be provided as required to accommodate all required system components complete with spares.
- F. Venting Requirements:
 1. Venting: Provide a minimum 2 inch opening for a pressure / vacuum type normally closed vent.
- G. Monitoring and Gauging System:
 1. Provide a local digital display tank liquid quantity display mounted on the wall adjacent to the tank for local monitoring of tank volume. The information shall be provided from the tanks level monitoring system.
- H. Bulkhead Fittings and Seals:
 1. Provide bulkhead fittings and seals for passing piping and electrical cable through the tank top.

2.3 REMOTE FILL PORT AND DEF CONTROL SYSTEM PANEL

- A. Provide a common remote DEF fill station as shown on the Contract Drawings. The fill station shall be designed for remote filling of storage tanks from a pump equipped delivery truck.
- B. The fill station shall be a factory-packaged system.
- C. The fill station shall provide storage tank filling, spill containment, overflow prevention, automatic fill shutoff, leak and level monitoring, and supply pump control.
- D. The fill station shall include capability to select one of multiple tanks for filling. Provide electrically actuated stainless steel ball valves for individual tank filling and high level shutoff. High level fluid conditions in any tank shall disable the fill function for that tank but shall allow for filling of other tanks.
- E. The fill station shall be wall mount design with stainless steel lockable enclosure and welded stainless steel liquid tight 5-gallon spill containment sump. The fill station shall include a 2-inch quick-disconnect hose coupling for the DEF delivery vehicle connection. The type of quick-disconnect hose coupling shall be coordinated with the OWNER's DEF supplier to ensure a compatible connection.
- F. The fill station shall include the following primary components:
 1. DEF system control panel.
 2. Electrically-operated fill/shut-off valves.
 3. Check valve

4. Spill sump drain valve.

G. DEF System Control Panel:

1. Multi-function control panel shall be mounted on exterior of fill station enclosure and include a PLC controller with 6-inch color touch-screen graphic user interface.
2. The controller shall monitor status of all individual system elements, provide an operator interface, and provide output contacts for remote monitoring.
3. The controller shall be capable of the following:
 - a. Integration of operating status information for all system control modules.
 - b. Central alarm annunciation.
 - c. Multi-tank filling control and shut-off.
 - d. Multi-Tank liquid and leak monitoring.
 - e. Multi-Tank submersible supply pump monitoring and control.
4. Power Requirements: 120 VAC, 5 amps.
5. Tank Level Transmitter: Each DEF storage tank shall include an ultrasonic or pressure transducer type probe capable of detecting the DEF level in the tank to the nearest 0.125-inch.
6. Interstitial Monitor: A sensor shall be provided for installation in the space between the primary tank and the secondary containment barrier to detect a leak in the primary tank. The sensor shall set off an audible and visual alarm on the control panel.
7. Overfill Alarm and Acknowledgment Switch: Audible and visible overfill alarm and manual acknowledgment/reset switch for mounting. The panel shall have a 0-3 minute adjustable timer for automatic shutoff.
8. The system controller shall provide the following:
 - a. Alarm horn and acknowledge switch.
 - b. Display the tank volume in gallons. The panel shall indicate alarm conditions for high level, low level, and tank leak.
 - c. Duplex Pump Control Monitoring: Monitoring of pump selection, alternation, and start / stop control. Pump monitoring for flow. Pump operating hour monitoring. Normal pump operation is by the associated duplex control panel.
 - d. DEF Refill Unit Monitoring: Pressure switch monitoring and motorized control valve monitoring.
 - e. Temperature control by time scheduled system circulation.
 - f. Multi-Tank Filling: Monitoring of high level sensors, control of inlet control valves. Annunciation of tank level and alarms at fill station.
 - g. CEM Dosing Cabinet Overflow Tank Monitoring: Overflow tank vent monitoring and pump interlock.
 - h. Indicating graphic panel LEDs for normal and alarm conditions including the following for each tank and pump where applicable:
 - 1) Panel power available.
 - 2) Control power on/off switch.
 - 3) 95% "High Level" visual alarm.
 - 4) 90% "Tank Full" visual alarm.
 - 5) 20% "Low Level" visual alarm.

- 6) "Tank Leak" visual alarm.
 - 7) Digital level indicator scaled in percent and gallons.
 - 8) Audible alarm horn activated by alarms above.
 - 9) Valve open/close pushbuttons.
 - 10) 4-20ma level transducer with loop isolator for remote output.
 - 11) Refill control unit fill indicator.
 - 12) Lead Pump Control switch for "Manual-Off-Automatic".
 - 13) Lead Pump Control Switch "In Automatic".
 - 14) Lead Pump Running.
 - 15) Lead Pump Failure
 - 16) Lag Pump Control switch for "Manual-Off-Automatic".
 - 17) Lag Pump Control Switch "In Automatic".
 - 18) Lag Pump Running
 - 19) Lag Pump Failure
 - 20) Pump "Loss of Flow" failure (each pump).
 - 21) Leak.
 - 22) CEM dosing cabinet overfill alarm.
- i. Outputs:
- 1) Tank #1 lead pump start.
 - 2) Tank #1 lag pump start.
 - 3) Tank #1 fill valve open.
 - 4) Tank #1 fill valve close.
 - 5) Tank #1 liquid volume for digital display at tank.
 - 6) Tank #1 refill control unit valve open.
 - 7) Tank #1 refill control unit valve close.
 - 8) Generator #1 CEM dosing cabinet overfill.
 - 9) Tank #2 lead pump start.
 - 10) Tank #2 lag pump start.
 - 11) Tank #2 fill valve open.
 - 12) Tank #2 fill valve close.
 - 13) Tank #2 liquid volume for digital display at tank.
 - 14) Tank #2 refill control unit valve open.
 - 15) Tank #2 refill control unit valve close.
 - 16) Generator #2 CEM dosing cabinet overfill.

- j. Inputs:
- 1) Tank #1 analog level sensor.
 - 2) Tank #1 leak sensor.
 - 3) Tank #1 fill valve opened.
 - 4) Tank #1 fill valve closed.
 - 5) Tank #1 lead pump control switch in automatic.
 - 6) Tank #1 lead pump running.
 - 7) Tank #1 lead pump fail.
 - 8) Tank #1 lead pump overload.
 - 9) Tank #1 lag pump control switch in automatic.
 - 10) Tank #1 lag pump running.
 - 11) Tank #1 lag pump fail.
 - 12) Tank #1 lag pump overload.
 - 13) Tank #1 pump loss of flow.
 - 14) Tank #1 refill control unit pressure switch.
 - 15) Tank #1 refill control unit valve opened.
 - 16) Tank #1 refill control unit valve closed.
 - 17) Generator #1 CEM dosing cabinet overfill.
 - 18) Tank #2 analog level sensor.
 - 19) Tank #2 leak sensor.
 - 20) Tank #2 fill valve opened.
 - 21) Tank #2 fill valve closed.
 - 22) Tank #2 lead pump control switch in automatic.
 - 23) Tank #2 lead pump running.
 - 24) Tank #2 lead pump fail.
 - 25) Tank #2 lead pump overload.
 - 26) Tank #2 lag pump control switch in automatic.
 - 27) Tank #2 lag pump running.
 - 28) Tank #2 lag pump fail.
 - 29) Tank #2 lag pump overload.
 - 30) Tank #2 pump loss of flow (future).
 - 31) Tank #2 refill control unit pressure switch.
 - 32) Tank #2 refill control unit valve opened.
 - 33) Tank #2 refill control unit valve closed.
 - 34) Generator #2 CEM dosing cabinet overfill.

- k. The control system shall provide all information via Modbus RTU data mapping for monitoring at the Plant SCADA system:
- 1) Tank #1 95% full high level alarm.
 - 2) Tank #1 90% full alarm.
 - 3) Tank #1 20% full low level alarm.
 - 4) Tank #1 level scaled in percent and gallons.
 - 5) Tank #1 leak alarm.
 - 6) Tank #1 fill valve opened.
 - 7) Tank #1 fill valve closed.
 - 8) Tank #1 lead pump control switch in automatic.
 - 9) Tank #1 lead pump running.
 - 10) Tank #1 lead pump fail.
 - 11) Tank #1 lead pump overload.
 - 12) Tank #1 lag pump control switch in automatic.
 - 13) Tank #1 lag pump running.
 - 14) Tank #1 lag pump fail.
 - 15) Tank #1 lag pump overload.
 - 16) Tank #1 pump loss of flow.
 - 17) Tank #1 refill control unit pressure switch

- 18) Tank #1 refill control unit valve opened.
- 19) Tank #1 refill control unit valve closed.
- 20) Generator #1 CEM dosing cabinet overflow.
- 21) Tank #2 95% full high level alarm.
- 22) Tank #2 90% full alarm.
- 23) Tank #2 20% full low level alarm.
- 24) Tank #2 level scaled in percent and gallons.
- 25) Tank #2 leak alarm.
- 26) Tank #2 fill valve opened.
- 27) Tank #2 fill valve closed.
- 28) Tank #2 lead pump control switch in automatic.
- 29) Tank #2 lead pump running.
- 30) Tank #2 lead pump fail.
- 31) Tank #2 lead pump overload.
- 32) Tank #2 lag pump control switch in automatic.
- 33) Tank #2 lag pump running.
- 34) Tank #2 lag pump fail.
- 35) Tank #2 lag pump overload.
- 36) Tank #2 pump loss of flow.
- 37) Tank #2 refill control unit pressure switch
- 38) Tank #2 refill control unit valve opened.
- 39) Tank #2 refill control unit valve closed.
- 40) Generator #2 CEM dosing cabinet overflow.

- H. Manufacturer:
1. Provide remote fill port by:
 - a. Earthsafe UM400
 - b. Morrison Brothers
 - c. Franklin Fueling Systems
 2. Provide system controller by:
 - a. Earthsafe C9
 - b. Fueltech Inc.
 - c. Grundfos

2.4 CENTRIFUGAL PUMPS

- A. General:
1. Duplex centrifugal pumps shall be mounted and integrated with a 120VAC duplex pump control panel to provide motor control, system status, and alarm indication.
 2. The duplex pump control panel shall include main disconnect, combination motor starters, alternator relay, HOA switches, power on light, pump status and alarms lights, low flow alarm, and overload reset push buttons.
 3. The duplex pump control panel shall receive pump run requests from the DEF Refill Unit, DEF control system panel, and from the generator control panel. The lead submersible pump shall be energized upon any of the following:
 - a. Low pressure start command from the Refill Unit pressure switch.
 - b. Start command from the DEF control system panel:
 - 1) Temperature cycling.

- 2) Generator run contact.
 4. The duplex pump control panel shall include outputs for the pumps status, alarms, HOA status, valve status, pressure switch, low flow alarm for display at the DEF Control Panel and the Plant SCADA system, and outputs for Refill Unit Control Valve open command.
- B. Performance Requirements (each pump):
1. Capacity: 10 GPM.
 2. Maximum Discharge Pressure: 105 Ft of Head.
 3. Motor Horsepower: 3/4 HP.
 4. Electrical Data: 120 VAC / 1 Phase.
- C. Construction:
1. Multi stage centrifugal pump.
 2. Number of Impellers: 3
 3. Discharge: 1-inch.
 4. Motor built in thermal and current overload
- D. Accessories:
1. The pump discharge piping shall include but not be limited to the following components:
 - a. Type 304 stainless steel check valve.
 - b. Type 304 Stainless high pressure relief valve.
 2. Provide pressure gauge mounted at the pump supply pipe /tank interface.
 3. Provide supply flow switch for pump flow status.
- E. Manufacturer:
1. Provide pumps of one of the following:
 - a. Grundfos
 - b. Veeder Root
 - c. Franklin Fueling Systems

2.5 REFILL CONTROL UNIT

- A. General:
1. Provide a DEF refill unit (DRU) for each generator engine dosing cabinet as shown on the Drawings.
 2. The DRU is used to supply DEF to the dosing cabinet buffer tank when the dosing cabinet inlet DEF control valve opens and the pressure in the DEF supply pipe drops. On low pressure, the DEF duplex pump control panel shall operate the associated DEF lead pump. On high pressure, the DEF lead pump shall stop unless called to operate by the duplex pump control panel.

- B. Construction:
1. Cabinet: 12-inches wide by 12-inches high by 8-inches deep type 304 stainless steel NEMA 4 rated.
 2. Cabinet shall be mounted from structural steel channel attached to the floor slab.
 3. Cabinet Mounted Equipment:
 - a. Type 304 stainless steel inlet and outlet pressure gages.
 - b. Type 304 stainless steel motorized ball valve.
 - c. Type 304 stainless steel pressure reducing valve set for 2-3 psig outlet pressure not to exceed 5 psig.
 - d. Type 304 stainless steel pressure switch wired back to the DEF control system. When the pressure switch detects a pressure drop, the associated DEF supply pump located in the bulk storage tank shall be energized. On an increase in pressure, the pump shall be de-energized.
 4. Inlet and Outlet Connections: 1/2-inch
- C. Manufacturer:
1. Provide refill control unit of one of the following:
 - a. Earthsafe Model 676001
 - b. Fueltech Inc.
 - c. Grundfos

2.6 DEF DOSING CABINET DAY TANK AND AIR COMPRESSOR

- A. Refer to Diesel Engine Driven Generator for:
1. Clean air emissions module (CEM) dosing/buffer cabinet which includes an integral buffer tank for 9 gallons of DEF storage.
 2. CEM dosing/buffer cabinet air compressor.

2.7 DEF DOSING CABINET OVERFLOW TANK

- A. General:
1. Provide overflow tanks at the CEM dosing/buffer cabinets to collect DEF in the unlikely event that the buffer tank becomes overfilled.
 2. Tanks shall be anchored to the floor slab at the bottom chime with type 316 SS angle brackets and hardware.
 3. Provide adaptors for connecting standard pipe thread to buttress thread.
- B. Manufacturer: Provide one of the following:
1. Earthsafe
 2. Bonar Plastics
 3. Poly Processing
- C. Design and Construction:
1. Tank Details:
 - a. Capacity: 15 gallons
 - b. Diameter: 19.2"
 - c. Height: 25.5"

- d. Fluid Stored: DEF
- 2. Blow molded from high molecular weight, high density polyethylene.
- 3. Durable top and bottom chime construction with molded-in hand holds in top chime.
- 4. (2) 2" buttress thread bungs.
- 5. Integral sloped sump in tank bottom.
- 6. Volume calibrations in gallons and liters.

2.8 PIPING, VALVES AND ACCESSORIES

- A. General:
 - 1. Piping shall be Type 304 stainless steel with mechanical connections, fittings, valves, and piping accessories designed as an integrated compression tube fitting fluid handling system.
 - 2. Piping and accessories shall be provided by the same manufacturer.
- B. Piping:
 - 1. Instrumentation grade seamless.
 - 2. Chemically cleaned and passivated to comply with ASTM G93 Level A and CGA 4.1
- C. Piping Accessories: Type 304 stainless steel consisting of the following:
 - 1. Fittings
 - 2. Vertical check valve
 - 3. Pressure gauge
- D. Manufacturer: Swagelok or equal

2.9 PIPING SPECIALTIES

- A. Combined Pressure and Vacuum Vent:
 - 1. General:
 - a. Provide a normally closed pressure and vacuum vent for venting the bulk storage tank during filling and pumping operations.
 - 2. Construction:
 - a. Type 304 stainless steel body.
 - b. Type 304 regenerable pleated mesh filter element.
 - 3. Filter Area: 1.9 square feet for 10-inch element.
 - 4. Connection Size.
 - a. Same size as vent.
 - b. Provide multiple units when vent piping exceeds vent size.
 - 5. Manufacturer: Bencor or equal.
- B. Back Pressure Regulating Valve (BPRV):
 - 1. General:
 - a. Provide a BPRV where shown on the Drawings for regulation of loop line pressure.

- b. Provide a BPRV where shown on the drawings for pump protection.
 - 2. Construction:
 - a. Type 300 series stainless steel body and spring.
 - b. DEF compatible O-Ring.
 - 3. Pressure Range:
 - a. Adjustable between 7-35 psig for loop pressure regulation.
 - b. Adjustable between 35-100 psig for pump protection.
 - 4. Connections: Screwed.
 - 5. Manufacturer: Fulflo Series FV or equal.
- C. Electrically Actuated Ball Valve:
 - 1. Features:
 - a. Power-to-open and power to close, stays in last known position with loss of power.
 - b. Valve is direct mounted to the actuator using the international standard ISO5211 mounting pad.
 - 2. Ball Valve:
 - a. Type 316 stainless steel body
 - b. 600 PSI working pressure
 - c. Full port
 - d. 316 Stainless steel ball and stem
 - e. Blow out proof stem
 - f. Reinforced Teflon (RTFE) ball seats
 - g. Leak free triple RTFE/Viton stem seal packing
 - 3. Electric Actuator:
 - a. Power Requirements: 24 VAC or 120 VAC
 - b. Quarter turn operation with mechanical stops
 - c. NEMA 4X weatherproof aluminum alloy enclosure
 - d. Visual valve position indicator
 - e. Manual override
 - f. Heavy duty motor with overload protection
 - g. Thermostatically controlled anti-condensation heater
 - h. Two auxiliary limit switches to confirm valve positions
 - i. Self-locking all metal gear drive, no additional brake required
 - j. CSA Listed per UL429 and CSA C22.2, CE mark
 - 4. Manufacturer:
 - a. Valworx, Series 5676
 - b. Sharpe Series 13
 - c. Apollo Series AE actuator with Series 76-AR valve.

2.10 SLEEVES AND WALL PIPES

- A. General:
 - 1. Wall pipes and wall sleeves shall be provided in accordance with the following schedule when passing through new or existing concrete or masonry structures, except where noted otherwise:

<u>From</u>	<u>To</u>	<u>Fitting</u>
Dry area	Wet area	Wall Pipe
Dry area	Earth Exterior	Wall Pipe
Dry area	Dry area	Plain Sleeve
Earth	Earth	Plain Sleeve
Exterior	Exterior	Plain Sleeve

- Material of construction shall be Type 316 stainless steel where located in wet areas and hot dipped galvanized steel in accordance with ASTM A123/A123M and ASTM A153/A153M in all other areas.

B. Sleeves:

- Wall sleeves shall be Schedule 40.
- Shall be of sufficient size to accommodate the pipe and insulation covering the pipe.
- Shall extend 2-inches above the finished floor.
- Shall be provided with split type escutcheon plates at the floor and wall openings.
- Shall terminate flush with walls and ceilings.
- Shall not be required in existing concrete walls where walls are core drilled and the resulting hole has a smooth inside surface.
- Shall be caulked with a fire-retardant caulking compound at firewalls and a gas tight caulking compound at gas tight walls.

C. Wall Pipes:

- Wall pipes shall be equipped with a waterstop.
- Shall be of sufficient length to pass through the wall and provide adequate clearance for fastening.
- The end of the wall pipes shall be of a type consistent with the piping to be connected to them and shall conform to their standards and specifications.
- All wall pipes shall have the same interior protection as specified for the connecting piping. Exterior protection shall be as specified for the yard piping.

2.11 HANGERS AND SUPPORTS

A. Design Criteria:

- Designs generally accepted as exemplifying good engineering practice and using stock or production parts shall be utilized wherever possible.
- Accurate weight balance calculations shall be made to determine the required force at each hanger and support location and the weight load at each force concentration point.
- Hangers and supports shall be capable of supporting and restraining piping and equipment in all conditions of operation. They shall allow free expansion and contraction, and prevent excessive stress resulting from transferred weight being induced into the system.
- Hangers and supports shall be designed so that they cannot become disengaged by movements of the supported piping and equipment.

5. Piping, and equipment that cannot be hung by rod and hanger arrangement shall be floor or wall supported.
 6. All structural components shall be designed based on static and dynamic loads imposed by the supported piping and equipment and shall include a safety factor of 2 for the yield strength. Minimum angle sizes shall be 2-inch x 2-inch x 1/4-inch.
 7. Load ratings, materials and installation shall be consistent with the recommendations from the latest edition of MSS SP 58, MSS SP 69, and FS WW-H-171.
 8. Hanger and support design calculations shall be signed and sealed by a registered professional engineer legally qualified to practice in the State of Florida.
- B. Manufacturer:
1. Manufacturer: Provide product of one of the following:
 - a. Erico International Corporation.
 - b. Anvil International.
 - c. B-Line.
- C. Materials:
1. Hangers, supports, restraints, and appurtenances shall be Type 304 stainless steel.
- D. Components of hangers and supports shall conform to the following:
1. Bolts: ASTM A307, Grade A, unless otherwise specified below.
 2. Forgings: ASTM A668/A688M.
 3. Malleable Iron: ASTM A47/A47M.
 4. Rods and Bars: ASTM A575.
 5. Threads: Unified Screw Threads, Class 2A and 2B, ANSI B1.1.
 6. Structural Steel: ASTM A36/A36M.
- E. Hanger Attachments: The following types of attachments shall be considered acceptable:
1. Adjustable Steel Clevis: FS WW H 171E, Type 1.
 2. Steel Double Bolt Pipe Clamp: FS WW H 171E, Type 3.
 3. Steel Pipe Clamp: FS WW H 171E, Type 4.
 4. Adjustable Swivel Pipe Ring: FS WW H 171E, Type 6.
 5. Adjustable Steel Band Hanger: FS WW H 171E, Type 7.
 6. Riser Clamp: FS WW H 171E, Type 8.
 7. Light-Duty Clevis Hanger: FS WW H 171E, Type 12.
 8. Long Clips: FS WW H 171E, Type 26.
 9. Offset J Hooks: FS WW H 171E, Type 27.
 10. Steel Pipe Covering Protection Saddle: FS WW H 171E, Type 40A.
 11. Insulation Protection Shield: FS WW H 171E, Type 41.
 12. Pipe Saddle Support: FS WW H 171E, Type 37.
 13. Pipe Stanchion Saddle: FS WW H 171E, Type 38.
 14. Pipe Saddle Support with Base: FS WW H 171E, Type 36.

15. Adjustable Roller Hanger: FS WW-H-171E, Type 42.
- F. Structural Attachments: The following types of attachments shall be considered acceptable:
1. Side Beam Clamp: FS WW H 171E, Type 20.
 2. Center I Beam Clamp: FS WW H 171E, Type 21.
 3. Welded Steel Bracket: FS WW H 171E, Types 32 and 33.
 4. Side Beam Bracket: FS WW H 171E, Type 35.
- G. Hanger Rod Attachments: Use as required to complete assembly:
1. Forged Steel Clevis: FS WW H 171E, Type 14.
 2. Adjustable Turnbuckle: FS WW H 171E, Type 15.
 3. Forged Steel Welders Eye Nut: FS WW H 171E, Type 17.
- H. Hangers Spacing and Rod Size:
1. Spacing:
 - a. Piping shall be supported at distances not exceeding the spacing specified below or in accordance with MSS SP 69:
 - b. Steel Pipe:
 - 1) Maximum Horizontal Spacing: 12 feet.
 - 2) Maximum Vertical Spacing: 15 feet.
 2. Hanger Rod Sizes:
 - a. Hanger rods shall be sized based on static and dynamic loads imposed by the supported piping and shall include a safety factor of 2 for the yield strength.
 - b. Rod load shall not exceed rod manufacturer's recommended capacity.
 3. Hangers and Supports for Equipment:
 - a. Provide spacing and hanger rod sizes in accordance with equipment manufacturer's installation instructions.

2.12 PIPING INSULATION

- A. Fiberglass Thermal Insulation:
1. Product and Manufacturer: Provide one of the following:
 - a. Model FIBERGLAS SSL II – ASJ, as manufactured by Owens Corning.
 - b. Model Micro-Lok HP, as manufactured by Johns Manville.
 - c. Or equal.
 2. Type: Heavy density sectional pipe insulation with a smooth, reinforced, wrinkle resistant all-service vapor retarder jacket and self sealing adhesive lap.
 3. Density: Minimum three pound per cubic foot.
 4. Thermal Conductivity: Maximum 0.23 Btu-in/hr-ft²-degree F at 75 degrees F mean temperature.
 5. Water Vapor Transmission: Maximum 0.02 perm.
 6. Fittings: Molded fiberglass, or pre-cut fiberglass inserts.
 7. Fittings Covers: One piece high impact polyvinyl chloride fitting covers.
 8. Jointing Materials: Manufacturer's recommended adhesives and tape.

9. Valve Insulation: Miter cut nesting size covering segments of same thickness as pipeline, for insulation of valves.

B. Insulation Jacketing:

1. Product and Manufacturer: Provide one of the following:
 - a. VentureClad Plus as manufactured by VentureTape.
 - b. Or equal.
2. Material: Heavy duty multilayered laminate coated with acrylic pressure sensitive adhesive.
3. Thickness: 24 mills.
4. Tensile Strength: 188 Lbs/in
5. Puncture: 80 Lbs.
6. Emittance: 0.03
7. Water Vapor Transmittance: 0.00 Perm
8. Temperature Rating: -40 to 248 degrees F.
9. Fastening: Self-adhering adhesive.
10. Finish: Embossed Aluminum

- C. All piping, valves and accessories located in the generator room shall be insulated with 1-inch thick insulation to prevent condensation. Piping located in the air conditioned DEF storage tank room shall not be insulated.

- D. Piping insulation shall be provided with embossed aluminum insulation jacketing in addition to the integral all service jacket provided with the insulation.

2.13 DIESEL EMISSIONS FLUID

- A. CONTRACTOR shall provide selective catalytic reduction (SCR) Grade AUS 32 (aqueous urea solution made with 32.5% urea and 67.5% deionized water) with quality properties per ISO 22241-1.
- B. CONTRACTOR shall provide DEF for genset testing and for genset operation extending to final Contract completion. At final completion, the bulk storage and day tank fluid levels shall be topped off to 90%.

2.14 FINISHING

A. General:

1. Protect equipment from corrosion by painting or with a coating which is compatible with DEF and the conditions of exposure.

B. Shop Primer and Finish Coats:

1. Equipment shall be primed and finish coated by the manufacturer. Unless otherwise noted within the description of equipment, provide manufacture's high-performance coating system.

2. Piping insulation shall be field painted in accordance with Section 09900, Painting.

2.15 IDENTIFICATION

- A. All equipment and component identification shall be provided in accordance with 10400, Identification Devices.
- B. All electrical wiring shall be color-coded and labeled for simplified identification. Power wiring shall be coded per OWNER standards.

2.16 SOURCE QUALITY CONTROL

- A. Shop Tests:
 1. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
 - a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
 - b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that all the controls function as specified herein and that the package meets the specified design and performance requirements.
 2. Control System Tests:
 - a. Factory-test the control system and control panel prior to shipment.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
- B. Take field measurements prior to installation to ensure proper fitting of Work.

3.2 PREPARATION

- A. Protection of Surrounding Areas/Surfaces:
 1. Openings and penetrations shall be sealed to protect the building from outside conditions.
 2. Properly plug or cap equipment openings and piping at the end of each day's Work or other stopping point throughout the construction to protected against debris and water intrusion.
 3. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.3 INSTALLATION

A. General:

1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from ENGINEER in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
2. Install in accordance with Laws and Regulations.
3. Do not modify structures to facilitate installation of equipment, unless approved in writing by ENGINEER.
4. Installation to conform to requirements of all local and state codes.
5. Calibration and start-up of equipment shall be performed by factory-trained and qualified personnel.

B. Storage Tanks:

1. The pad shall be prepared to ensure adequate support for the tank system.
2. The foundation and tank supports shall be capable of supporting the weight of the tank and associated equipment when full.
3. The foundation shall be comprised of concrete, and designed to prevent tank movement, and must be rated for the seismic zone.
4. Tanks shall be handled, lifted, stored and secured in accordance with the manufacturer's instructions.
5. No modifications shall be made to any tank without the prior written approval of the manufacturer and the ENGINEER. This includes adding penetrations in the tank structure, or repairing damage which might affect the integrity of the inner or outer tank.

C. Piping:

1. General:

- a. Piping shall be installed in accordance with the Contract Documents in a neat workmanlike manner and shall be set for accurate line and elevation. All piping shall be thoroughly cleaned before installation, and care shall be taken to keep the piping clean throughout the installation.
- b. Before setting wall sleeves, pipes, castings and pipes to be cast-in-place, CONTRACTOR shall coordinate with the Drawings, which may have a direct bearing on the pipe locations. CONTRACTOR shall be responsible for coordinating the proper location of the pipes and appurtenances during the construction with all trades.
- c. Piping shall be attached to pumps, valves, equipment, etc., in accordance with the respective manufacturer's recommendations.
- d. Mechanical connections shall be provided close to main pieces of equipment to permit dismantling of piping without disturbing main pipe lines or adjacent branch lines for servicing equipment.
- e. All changes in directions or elevations shall be made with fittings.
- f. Piping shall be installed free of traps and with sufficient slope so that all of the various piping systems may be drained to one or several points. In the event that it is impossible to drain to a common point due to structural

obstructions and finished ceiling heights, furnish and install all additional drain valves that may be required to completely drain piping systems. Location of all drain valves shall be approved by ENGINEER prior to installation.

2. Joints:
 - a. Swagelok or equal mechanical connections.
3. Valves:
 - a. All valves shall be manually opened and closed before installation to check their operation, and the interior of the valves shall be cleaned. Joints shall be made as specified.
 - b. Install the valves so that they can be conveniently operated. Do not place operators at angles other than parallel to the floors or walls.
 - c. Valves shall be supported as integral components of the piping systems.
4. Piping Layout:
 - a. Fluid shall circulate freely with no evidence of trapping or air binding.
 - b. Install drain valves with hose end connections in low points of piping.
 - c. Install manual air vents at high points.
 - d. Flange connections shall be provided for removal of each piece of equipment or device without major dismantling.
 - e. Provide flexible connectors for each pipe passing through building expansion joints.
 - f. Do not block openings or passageways with piping.
 - g. Install straight runs true to construction line.
 - h. Install vertical pipe truly plumb in all directions.
 - i. Install piping without sags and bends.
 - j. Install piping parallel or perpendicular to walls. Piping at odd angles and 45 degrees runs across corners shall not be accepted.
5. Install fine mesh start-up screens in all strainers and replace with final stainless steel screens after 30 days of pump operating time.
6. Provide all supporting steel, brackets, etc. as required to support all equipment in an approved manner.
7. Provide mechanical link seals with sleeves or wall pipes at all piping penetrations through wall, roof and floor slabs.
8. Escutcheon plates shall be provided for all exposed piping penetrations.
9. All connections between ferrous and nonferrous piping materials shall be made with dielectric unions or nipples.
10. Care shall be taken so as not to leave tool marks or abrasions on plated, polished or soft metal piping.
11. Wherever changes in sizes of piping occur, changes shall be made with eccentric reducing fittings with flat bottom down. The use of bushings is not permitted, unless shown otherwise. Bushings are permitted at connection to tank openings.
12. Provide shutoff valves to each piece of equipment furnished.
13. Provide clearance for access to valves and fittings.

- D. Pipe Hangers and Supports:
1. Attachment to hollow core slabs or double tee slabs shall be provided in accordance with details shown on the structural drawings to prevent damage to pre-stressing strands.
 2. Insulated pipes with vapor barriers shall have an insulation protection shield conforming to FS WW H 171E, Type 41 tack-welded to hanger.
 3. Insulated pipes without vapor barriers shall have a steel protection saddle conforming to FS WW-H-171E, Type 40A.
 4. All piping shall be braced as required, to prevent sway in any direction.
 5. All insulated piping 3-inch diameter and larger shall be supported by roller hangers conforming to FS WW-H-171E, Type 42.
 6. Additional supports shall be placed immediately adjacent to any change in direction.
 7. Supports for Vertical Piping:
 - a. Provide riser clamp placed under hub, fitting or coupling with approved solid bearing on steel sleeve at each floor level.
 - b. Support spacing shall not exceed code requirements.
 8. Allow clearances for expansion and contraction of piping.
- E. Anchorages and Base Plates:
1. Provide anchorages in new or existing concrete, as applicable, in accordance with equipment manufacturer's recommendations and the Contract Documents.
 2. Where used, pour concrete bases up to one inch below equipment baseplate or support leg as applicable. Base with equipment mounted shall then be accurately shimmed to grade and spaces between filled with non-shrink grout. After grout has reached its initial set, exposed edges shall be neatly cut back 1/2 inch.
- F. Anchorage shall be provided in accordance with Section 05051, Anchor Systems.
- G. Structural steel shall be provided in accordance with Section 05120, Structural Steel.
- H. Miscellaneous metal fabrications shall be provided in accordance with Section 05501, Miscellaneous Metal Fabrications.

3.4 FIELD QUALITY CONTROL

- A. Field Tests:
1. After equipment installation is complete, CONTRACTOR and a qualified field service representative of unit manufacturer shall perform an operating test of each unit and associated controls, in presence of ENGINEER. Equipment will pass the test when each unit and its controls are demonstrated to function correctly.
 2. Running Tests:
 - a. Field-test each equipment together with its controls and appurtenances and as part of an overall integrated test with other system equipment. Tests shall demonstrate to ENGINEER that each part and all parts together

- function in accordance with the Contract Documents. Provide all necessary testing equipment, labor, and appurtenances.
- b. Verify that equipment operates as intended, that vibration limits are not excessive and beyond manufacturer's recommendations, and that equipment operates smoothly without excessive noise, temperature rise, or other defects under all operating conditions. Verify that all controls work as intended in both manual and automatic mode. Successfully test-operate each equipment for at least 24 hours.
 - c. If equipment does not comply with the Contract Documents and does not pass the tests, CONTRACTOR shall adjust, modify, and retest the equipment as often as necessary until tests are successfully passed.
3. Pressure Tests:
 - a. Piping shall be air tested at 100 psi for 24 hours in the presence of the ENGINEER. All equipment, valves and accessories that can be damaged from the test shall be isolated.
 4. Storage Tank:
 - a. The CONTRACTOR is responsible for testing all installed systems for liquid tightness and proper operation, including:
 - 1) Pre-installation inspection of all materials.
 - 2) Product, containment and vent piping.
 - 3) Containment sump integrity.
 - 4) System tightness test after all work is completed and before the system is placed in service.
 - b. Air pressure testing of the inner tank and secondary containment tank shall be conducted on-site, in the presence of the ENGINEER, before placing the tank in service.
 - c. Other integrity tests may be required by the local authority having jurisdiction.
 5. Remote Fill Port:
 - a. Operational test of controls, alarms and communications to other system panels and the Plant SCADA system.
 6. Pumps:
 - a. Operational test of controls, alarms and communications to other system panels and the Plant SCADA system.
 - b. Flow test, pressure test, ampere/voltage test, load test, overload test.
 7. Refill Control Unit:
 - a. Operational test of controls, alarms and communications to other system panels and the Plant SCADA system.
- B. Manufacturer's Services:
1. Provide a qualified, factory-trained service person to perform the following:
 - a. Instruct CONTRACTOR in installing equipment.
 - b. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
 - c. Instruct operations and maintenance personnel in operation and maintenance of the equipment.

2. Manufacturer's service person shall make visits to the Site as follows:
 - a. First visit shall be for instructing CONTRACTOR in proper equipment installation and assisting in installing equipment. Minimum number of hours on-Site: 40 hours.
 - b. Second visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 40 hours.
 - c. Third visit shall be to instruct operations and maintenance personnel.
 - 1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
 - 2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01821, Instruction of Operations and Maintenance Personnel.
 - d. Technician shall revisit the Site as often as necessary until installation is acceptable.
3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.5 ADJUSTING

- A. Adjust equipment and controls for proper operation in accordance with the Contract Documents and manufacture's recommendations.

3.6 CLEANING

- A. Thoroughly clean all equipment and accessories prior to installation.
- B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.
- C. Remove and dispose of all debris and waste from the Site resulting from installation.

++ END OF SECTION ++