

**SECTION 23 10 00
FACILITY FUEL SYSTEMS**

PART 1 - GENERAL:**1.1 DESCRIPTION:**

- A. Diesel fuel oil tank, piping, and accessories located outside, underground or aboveground as shown on contract drawings. Refer to contract drawings for type of fuel and for tank capacities.
- B. Tank fluid level monitoring and alarm systems.
- C. Leak detection system for tanks and underground piping.
- D. Fuel oil quality maintenance system (water and particulate removal).

1.2 RELATED WORK:

- A. Excavation and backfill for piping: Section 31 20 00, EARTH.
- B. Concrete pads: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- C. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS.
- D. Fuel oil pumps for engine generators: Section 26 32 13, ENGINE GENERATORS.
- E. Underground conduit systems for tank fluid level monitors and tank and piping leak detectors: Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION.

1.3 QUALITY ASSURANCE:

- A. Approval by Contracting Officer is required of products or services of proposed manufacturers, suppliers and installers, and will be based on Contractor's certification that:
 - 1. Manufacturers regularly and currently manufacture tanks, tank and piping accessories, tank fluid level monitoring and leak detection systems, fuel quality management systems.
 - 2. Manufacturers of steel tanks participate in the Quality Assurance Program of the Steel Tank Institute (STI).
 - 3. The design and size of each item of equipment provided for this project is of current production and has been in satisfactory operation on at least three installations for approximately three years. Current models of fluid level and leak detection systems with less than three years service experience are acceptable if similar previous models from the same manufacturer have at least three years service experience.

- B. Apply and install materials, equipment and specialties in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract drawings and specifications shall be referred to the Contracting Officers Technical Representative (COTR) for resolution. Provide copies of installation instructions to the COTR two weeks prior to commencing installation of any item.
- C. All equipment shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components or overall assembly.
- D. Tanks, Secondary Containment Systems for Piping, Containment Systems, Tank Level Monitoring Systems, Leak Detection Systems, Fuel Quality Management Systems: Authorized manufacturers representatives shall provide on-site training of installers and supervision of the installation and testing of the equipment and systems to assure conformance to written instructions of manufacturers.
- E. Tank and piping installation contractor shall be certified as acceptable by local and state pollution control authorities.
- F. Entire installation shall conform to requirements of local and state pollution control authorities.
- G. Pipe Welding: Conform to requirements of ASME B31.1. Welders shall show evidence of qualification. Welders shall utilize a stamp to identify their work. Unqualified personnel will be rejected.
- H. Assembly of Glass Fiber Reinforced Plastic Piping: Installation personnel shall have been trained, tested and certified under a procedure approved by the manufacturer of the piping. Proof of certification, in writing, shall be provided to the COTR.
- I. Where specified codes or standards conflict, consult the COTR.
- J. Label of Conformance (definition): Labels of accredited testing laboratories showing conformance to the standards specified.
- K. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a safe, complete and fully operational system which conforms to contract requirements and in which no item is subject to conditions beyond its design capabilities.

1.4 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Aboveground Steel Tanks, Including Vault-type Tanks:
 - 1. Drawings of tanks, supports, ladders, platforms, heating coils, tank manholes, emergency relief vents and all accessories. Include overall dimensions and dimensional locations and sizes of pipe connections, and access openings.
 - 2. Recommended tank support locations.
 - 3. Weight of entire tank assembly, empty and flooded.
 - 4. Design and construction of primary tanks, insulation, secondary containment, supports, pipe connections, platforms.
 - 5. Application and performance data on coatings from manufacturer of coatings.
 - 6. Data certifying tanks are designed for surcharge loads of platforms shown.
 - 7. Certification of compliance with specified standards.
 - 8. Certification that steel tank manufacturer participates in Steel Tank Institute (STI) Quality Assurance Program.
 - 9. Design, construction, performance, dimensions of emergency relief vents.
 - 10. Seismic Data: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS.
- C. Fuel Piping:
 - 1. ASTM and UL compliance.
 - 2. Grade, class or type, schedule number.
 - 3. Manufacturer.
- D. Pipe Fittings, Unions, Flanges:
 - 1. ASTM and UL compliance.
 - 2. ASTM standards number.
 - 3. Catalog cuts.
 - 4. Pressure and temperature rating.
- E. Foot Valves, Check Valves, Overfill Prevention Valves:
 - 1. Catalog cuts showing design and construction.
 - 2. Pressure and temperature ratings.
 - 3. Pressure loss and flow rate data.

4. Materials of construction.
5. Accessories.
- F. Secondary Containment System for Fuel Piping:
 1. Sizes, materials, construction of containment system including end seals, sumps, coatings and pipe supports.
 2. Layout of system.
 3. Installation instructions.
 4. Design of cathodic protection system (steel casing).
- G. Leak Detection System:
 1. Drawings, description and performance data on sensors, control units.
 2. Description of operation.
 3. Layout of system.
 4. Installation and operating instructions.
 5. Data on interconnecting wiring systems to be furnished.
- H. Tank Fluid Level Monitoring Instrumentation System:
 1. Drawings showing instruments and in-tank sensing units, with dimensions.
 2. Design and construction of all elements of system.
 3. Installation instructions.
- I. Tank and Piping Accessories: Design, construction, and dimensions of vent caps, fill boxes, fill caps, spill containers and other accessories.
- J. Fuel Quality Maintenance System:
 1. Drawings and description of all components and arrangement of system.
 2. Design and performance of pumps, filters.
 3. Catalog data and operation of control system.
 4. Installation instructions.

1.5 DELIVERY, STORAGE AND HANDLING:

- A. Protection of Equipment:
 1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.

2. Place damaged equipment in first class, new operating condition; or, replace same as determined and directed by the RE/COTR. Such repair or replacement shall be at no additional cost to the Government.
3. Protect new equipment and piping systems against entry of foreign matter on the inside. Clean both inside and outside before painting or placing equipment in operation.
4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.
5. Protect tank from ultraviolet light (sunlight).

B. Cleanliness of Equipment and Piping:

1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping.
2. Piping systems shall be flushed, blown or pigged as necessary to provide clean systems.
3. Clean interior of all tanks prior to delivery for beneficial use by the Government.
4. Contractor shall be fully responsible for all costs, damages and delay arising from failure to provide clean systems and equipment.

1.6 APPLICABLE PUBLICATIONS:

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. Federal Specifications (Fed. Spec.):
- A-A-60005.....Frames, Covers, Grating, Steps, Sump and Catch Basin, Manhole
- C. ASTM International (ASTM):
- A36/A36M-08.....Carbon Structural Steel
- A53/A53M-10.....Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- A106/A106M-10.....Seamless Carbon Steel Pipe for High Temperature Service
- A126-04(R2009).....Gray Iron Castings for Valves, Flanges and Pipe Fittings

- A234/A234M-10.....Piping Fittings of Wrought Carbon Steel and
Alloy Steel for Moderate and High Temperature
Service
- B62-09.....Composition Bronze or Ounce Metal Castings
- D2996-01(2007).....Filament-Wound "Fiberglass" (Glass-Fiber-
Reinforced-Thermosetting-Resin) Pipe
- D. American Society of Mechanical Engineers (ASME):
- B16.5-09.....Pipe Flanges and Flanged Fittings (NPS ½-24).
- B16.11-09.....Forged Fittings, Socket-Welding and Threaded
- B31.1-10.....Code for Pressure Piping, Power Piping with
Current Amendments
- E. National Electrical Manufacturers Association (NEMA):
- 250-08.....Enclosures for Electrical Equipment (1000 Volts
Maximum)
- F. National Fire Protection Association (NFPA):
- 30-12.....Flammable and Combustible Liquids Code
- 70-11.....National Electrical Code
- G. Underwriters Laboratories Inc. (UL):
- 142-10.....Steel Aboveground Tanks for Flammable and
Combustible Liquids
- 2085-10.....Protected Above-ground Tanks for Flammable and
Combustible Liquids
- H. Steel Tank Institute (STI):
- F001.....Standard for Fire Resistant Tanks
- F941.....Standard for Fireguard Thermally Insulated
Aboveground Storage Tanks
- I. NACE International (Corrosion Engineers) (NACE):
- SP0169-07.....Control of External Corrosion on Underground or
Submerged Metallic Piping Systems
- NACE 3/SSPC-SP6-07.....Commercial Blast Cleaning
- NACE 4/SSPC-SP7-07.....Brush-off Blast Cleaning

1.7 PERMITS:

Contractor shall obtain and complete all tank permit and registration forms required by governmental authorities.

PART - 2 PRODUCTS:**2.1 ABOVEGROUND CONCRETE-INSULATED STEEL VAULT TANKS:**

- A. Type: All-welded steel tank, horizontal rectangular configuration, atmospheric pressure, concrete insulation, double-containment, for aboveground installation as shown. Entire unit factory-fabricated, including steel tank and concrete insulation. Provide tank supports that can be anchored to a concrete foundation.
- B. Construction:
1. Comply with UL-2085 for protected tanks, vehicle impact resistant and projectile resistant with secondary containment. Provide label of conformance.
 2. Inner tank ASTM A36 steel constructed in conformance with UL-142. Provide label of conformance. Steel tanks shall be supported as recommended by steel tank manufacturer. Top of secondary tank shall be sloped to shed rainwater. Test tanks for leaks with test pressure of 20 - 34 kPa (3 - 5 psi) gage. Furnish certificate that inner and outer tanks have been tested and are leak-free and pressure-tight.
 3. Concrete Insulation:
 - a. Shall consist of 25 MPa (3000 psi) minimum concrete.
 - b. Shall be structurally designed to support the filled tank and a top live load of 4.8 kPa (100 lb./sq. ft.).
 - c. Monolithic pour with no cold joints, heat sinks. As an alternate, there may be one continuous shiplap joint located at horizontal center of vault sealed with fire and fuel resistant gaskets.
 - d. Construct in accordance with ACI and AASHTO standards including concrete placement, vibration, and quality assurance.
 4. Conform to NFPA 30 or 31 fire safety standards as applicable. Design for two-hour fire exposure. Provide fittings for grounding per NFPA 70.
 5. The tank assembly shall have capability of physical monitoring for leaks between primary and secondary containment.
 6. Provide overfill containment (spill container) with internal drain and positive seal.
- C. Factory Cleaning: Clean interior and exterior. Remove mill scale, dirt, rust, oil, welding debris, loose coatings and coatings incompatible with fuel stored or protective coating.

- D. Factory Coatings: Provide coating of rust resistant red oxide primer on non-fuel side of steel tanks. For tanks with interior access, coat interior of primary tank from bottom to 1 m (3 feet) above bottom in conformance with API RP 1631. Provide two coats of fuel resistant epoxy coating on exposed surfaces of the external concrete tank.
- E. Provide Platforms, Ladders, Stairs, Handrails: Shall be welded steel assemblies conforming to OSHA requirements. Paint as required. Galvanizing is an acceptable alternative.
- F. Pipe Connections to Tanks:
1. Pipe shall terminate 75 mm (3 inches) minimum from top of unit.
 2. Conform to UL 142.
 3. Pipe sizes 50 mm (2 inches) and smaller, threaded. Pipe sizes 65 mm (2 1/2 inches) and larger, 1025 kPa (150 pound) ASME flanged.
 4. Welded joints required on steel piping located inside tanks.
 5. Provide and coordinate tank connection quantities, sizes and types with requirements of tank level gage unit; leak detector sensor; sounding rod; vent, fill, supply and return pipes; and other pipes as shown.
 6. Provide valved drain on interstitial space.
- G. Tank Manholes: Provide quantity and size shown. Bolted cover type, gasketed.
- H. Emergency Relief Vents for Fire Exposure: Venting capacity shall conform to NFPA 30 or 31 as applicable. Provide separate vents for primary and secondary tanks. Standard product of a manufacturer, designed to automatically open at tank pressure of 17 kPa (2.5 psi). Aluminum or cast iron construction, with Teflon-coated seating surface.
- I. Internal Ladder: Provide as shown with 50 mm x 6 mm (2 inch x 0.25 inch) sides and 20 mm (0.75 inch) diameter rungs at 300 mm (12 inches) on center. Provide slide supports to allow for tank movement.
- J. Wear (Striker) Plates: Provide 300 mm (12 inch) square, 6 mm (0.25 inch) thick steel plates welded to tank bottom directly under the sounding opening, the fuel return discharge, and the fill discharge.
- K. Lifting Lugs: Provide for rigging tanks.
- L. Seismic Design: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS.

M. The tank is insulated Secondary Containment Aboveground Storage Tank Systems for Flammable and Combustible Liquids, Protected Type: Vehicle Impact Protected, and Projectile Resistant shall be tested to and listed for the following:

1. UL - 142, aboveground steel tanks for flammable and combustible liquids.
2. UL - 2085, two-hour furnace fire test and two hour simulated pool fire test for insulated and protected tanks.
3. UL - 2085 and UFC Test Standard (Article 79 or APPENDIX #A-II-F-1), for both Vehicle Impact Protection and Projectile Resistance.
4. UL - 2085, Protected aboveground tanks for flammable and combustible liquids.
5. UL - 2085, Non-Metallic Secondary Containment protected tanks for flammable and combustible liquids with secondary containment Emergency Venting by "Form of Construction".
6. CAN/ULC - S601 (ORD - 142.18), Standard for shop fabricated steel aboveground horizontal tanks for flammable and combustible liquids.
7. CAN/ULC - S655 (ORD - C 142.16), Standard for protected aboveground tank assemblies for flammable and combustible liquids
8. CAN/ULC - (ORD - C 142.5), Standard for concrete encased aboveground tank assemblies for flammable and combustible liquids.
9. CAN/ULC - (ORD - C 142.16), the furnace burn requirements for two hour fire rating.
10. CAN/ULC - (ORD - C 142.25), the open (pool) fire testing for two-hour flammable liquid fire test.
11. CAN/ULC - (ORD - 142.23), for aboveground tanks for used oil.
12. The requirement for Uniform Fire Code (UFC) for two-hour (firewall) test.
13. To be tested and certified by the California Air Resources Board (CARB) for Balanced Phase 1 and Phase 2 Vapor Recovery including methanol and ethanol.
14. High Explosive (HE) Blast Resistance: The tank system design shall be the subject of a Blast Effects Analysis (BEA) for resistance under the following blast threat load scenarios:

- a. A 50-pound HE man-portable improvised explosive device (MPIED) at the standoff distance of 5 feet;
 - b. A 500-pound HE vehicle-born improvised explosive device (VBIED) at the standoff distance of 20 feet; and
 - c. A vapor cloud explosion (VCE) with a load of 10 psi. The BEA shall conclude that the tank system shall resist the explosion loads and remain intact, without failure of the primary tank. The engineering consultants performing the BEA shall be a nationally recognized firm with over 10 years experience offering comprehensive services related to blast and impact effects analysis, explosive safety design, vulnerability assessments and threat mitigation.
- N. The primary steel tank shall be rectangular in shape and have continuous welds on all exterior seams, manufactured in accordance with UL listing requirements and UL Standard 142.
- The primary steel tank shall be pressure tested at 5 psig for 24 to 48 hours.
 - The primary steel tanks shall have "emergency vent" system as per NFPA 30 Code requirements.
 - The protected and insulated AST systems shall have a thru-tank leak detector tube to allow for physical checkup and monitoring capability between the primary and the secondary containment.
 - The primary steel tank shall be pressurized at 5 psig during concrete encasement.
 - The outer surface of the primary steel tank shall be covered by a minimum of 1/4" thick (6.4 mm) Styrofoam insulation panels.
 - The secondary containment shall consist of a 30 Mil thick (0.76 mm) High-Density Polyethylene membrane enclosing the steel tank and insulation material.
 - The primary steel tank and the secondary containment shall be encased in six inches of monolithic reinforced concrete, with minimum design strength of 4,000 and 5,000 psi at 28 days depending on the tank size. The concrete design shall include the following for long-term durability: air entrainment, water reducing admixture, and steel reinforcement. Concrete encasements with seams will not be approved.

- The protected and insulated AST systems shall be of concrete exterior and a continuous and visually verifiable monolithic (seamless) pour on top, bottom, ends, and sides and contain no cold joints or heat sinks (heat transfer points). The AST must be shop fabricated and tested in accordance with the UL listings. Designs that use two layers of steel with insulation material between them will not be approved.
- No steel or insulating material shall come in contact with the concrete or other corrosive material.
- All openings shall be from the top only.
- All exposed metal with the exception of stainless steel must be powder coated to inhibit corrosion.
- The protected and insulated AST systems shall include a 7 or 15-gallon powder coated or stainless steel, UL listed spill containment, and shall include normally closed valve to release spilled product into the primary steel tank. Spill containment which route the spilled product into interstitial area will not be approved.
- The protected and insulated AST systems shall have a coated concrete exterior to resist weather and reflect sunlight. Models with steel exteriors will not be approved.
- The protected and insulated AST systems shall have a warranty of 30 years for systems 2,000 gallon capacity and larger.
- The protected and insulated AST systems design shall have been in use for a minimum of twenty (20) years. The manufacturer must stipulate no reportable AST containment system failure in 30,000 units produced.
- The protected and insulated AST systems shall have two (2) bolts for connecting grounding conductors for lightning protection in accordance with NFPA 780.

2.2 SOIL SEPARATOR MAT:

- A. Material: Porous, non-woven polypropylene geotextile, Weight: 135 g per sq. meter (4 ounces per square yard), resistant to all alkalies and weak acids.

2.3 TANK AND PIPING ACCESSORIES:

- A. Vent Caps: Galvanized cast iron or cast aluminum with brass or bronze screens, arranged to permit full venting and to prevent entry of foreign material into the vent line. Same pipe size as vent pipe.
- B. Fill Boxes:
 - 1. Spill-container type enclosing a fill cap assembly with camlock hose connector with closure coordinated with fittings used by fuel supplier.
 - 2. Watertight assembly, cylindrical body, quick-opening corrosion-resistant watertight sealable cover, polyethylene spill containment compartment with minimum 15 gallon capacity. Integral drain valve with discharge to fill pipe.
 - 3. Fill cap shall be lockable, tight-fill design with provision for padlock on the top of the cap. Fill cap shall screw onto threaded adapter that can be removed without removing fill box. Entire assembly shall seal tight with no leakage during filling and when cap is in place.
 - 4. Provide special tools necessary for opening fill boxes and fill caps.
- C. Fill caps located above grade without fill boxes shall be lockable, tight-fill design, operated by special wrench that shall be furnished. Entire assembly shall seal tight with no leakage during fill and when cap is in place.
- D. Support horizontal portion of pipes located inside tank every 2100 mm (7 feet) maximum.
- E. Furnish gauging chart, liters versus mm and gallons versus inches depth.
- F. Furnish sounding rod for each tank size. Mark rods in increments representing five percent of tank capacity. Provide length of rod suitable for tank burial depth (if applicable). Rods shall be graduated in gallons.
- G. Fill Point Identification:
 - 1. Fill Boxes at Grade Level: Aluminum, brass or bronze plate, anchored to concrete fill box pad with stamped or engraved letters 18 mm (0.75 inch) high.

2. Fill Caps above Grade: Aluminum, brass or bronze plate, clamped to fill pipe, with stamped or engraved letters 18 mm (0.75 inch) high.
3. Legend: "DIESEL FUEL FILL" or "SOUNDING" as appropriate.

2.4 PIPING, VALVES, FITTINGS:

- A. Fuel supply and return, tank fill, vents, sounding, pump out, steam and condensate.
- B. Steel Pipe and Fittings:
 1. Piping: Steel, seamless or electric resistance welded (ERW), ASTM A53 Grade B or ASTM A106 Grade B, Schedule 40. Aboveground piping shall be painted. Refer to Section 09 91 00, PAINTING.
 2. Joints: Socket or butt-welded. Threaded joints not permitted except at valves, unions and tank connections.
 3. Fittings:
 - a. Butt-welded joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe.
 - b. Socket-welded joints: Forged steel, ASME B16.11, 13 700 kPa (2000 psi) class.
 4. Unions: Malleable iron, 2050 kPa (300 psi) class.
 5. Companion flanges: Flanges and bolting, ASME B16.5.
 6. Welding flanges: Weld neck, ASME B16.5, forged steel ASTM A105, 1025 kPa (150 psi).
- C. Glass Fiber Reinforced Plastic (FRP) Pipe and Fittings:
 1. Conform to UL 971 and ASTM D2996 using a filament-winding process and epoxy or vinyl ester resins.
 2. Design pipe, fittings and joining system for required fuel service, 66 °C (150 °F), 1030 kPa (150 psi) pressure, 68 kPa (20 inches HG) vacuum.
 3. Provide an integral resin-rich liner, 0.5 mm (0.020 inches) minimum thickness to enhance the corrosion resistance. Outer layer shall include ultra-violet inhibitors. Joining adhesive shall be designed for the pipe furnished and shall be supplied by the pipe manufacturer.
- D. Check Valves - Fuel Pump Suction.
 1. Pipe Sizes 50 mm (2 inches) and under: Rated for 1375 kPa (200 psi) water-oil-gas, swing-type, threaded ends, ASTM B62 bronze body. Provide union adjacent to valve.

2. Pipe Sizes 65 mm (2 1/2 inches) and above: Rated for 1375 kPa (200 psi) water-oil-gas, swing-type, 850 kPa (125 pounds) ASME flanged ends, ASTM A126 class B cast iron body.
- E. Foot Valves - Fuel Pump Suction: Double poppet, lapped-in metal-to-metal seats, double-guided stems, 20 mesh inlet screen, same size as fuel suction piping. Foot valve shall be removable to above grade through the tank manhole enclosure or through extractor fitting.
- F. Extractor Fittings: Arranged to permit removal of foot valves, overflow prevention valves, and other devices that are located below grade. Access point shall be through a cast iron fill box-type manhole located at grade. Provide extractor wrench.
- G. Overflow Prevention Valve: Aluminum automatic valve designed for underground or aboveground tanks, as applicable. Locate valve near the top of the tank in the fill pipe. On aboveground tanks, or tanks pressure-filled, provide single stage valve, rated for fill flow and pressure, which stops flow completely at 95 percent of tank capacity. Valve shall include method for draining oil trapped above the valve into the tank.

2.5 SECONDARY CONTAINMENT FOR UNDERGROUND FUEL PIPING SYSTEMS:

- A. Enclose the fuel supply, return and fill pipes in factory-engineered and fabricated secondary containment conduit systems. The systems shall be complete with end seals, with 25 mm (1.0 inches) minimum continuous annular space, 37 mm (1.5 inches) between carrier pipes, which shall contain all leakage and which has provisions for leak detection system as specified.
- B. Steel Conduit with Fusion-Bonded Epoxy Coating and Cathodic Protection:
1. Galvanized carbon steel pipe, ASTM A53, Grade B, Schedule 40 for diameters through 125 mm (5 inches), 3.4 mm (0.134 inch) thick for diameters greater than 125 mm (5 inches) up through 650 mm (26 inches). All welded construction.
 2. Sand blast exterior per NACE 3.
 3. Coat exterior with 0.5 mm (20 mils) thick fusion-bonded epoxy.
 4. Provide cathodic protection designed by corrosion specialist and consisting of galvanic anodes, test stations, interconnecting wiring in conformance with UL 1746 and NACE RP-0169. Electrical isolation required between all connecting systems in manholes and buildings.

- C. Steel Conduit with Fiberglass Reinforced Plastic (FRP) Coating:
1. Carbon steel pipe, ASTM A53, Grade B, Schedule 40 for diameters through 125 mm (5 inches), 3.4 mm (0.134 inch) thick for diameters greater than 125 mm (5 inches) up thru 650 mm (26 inches). All welded construction.
 2. Blast clean exterior per NACE 4.
 3. Apply fiberglass reinforced polyester (FRP) external cladding at least 2.5 mm (0.10 inches) thick with ultra-violet inhibitor. Cladding on field joints shall be equivalent to factory-applied cladding applied on remainder of system.
 4. Test entire system for holidays using a 35,000 volt holiday detector.
 5. This system not permitted when carrier pipe or tracing system contains steam or condensate.

- D. Glass Fiber Reinforced Plastic (FRP) Conduit:
1. Conform to UL 971 and ASTM D2996 using a filament-winding process and epoxy or vinyl ester resins.
 2. Design pipe, fittings and joining system for carrier pipe fuel service, 66 °C (150 °F), 1030 kPa (150 psi) pressure, 68 kPa (20 inches Hg) vacuum.
 3. Provide an integral resin-rich liner, minimum thickness 0.25 mm (0.010 inch). Outer layer shall include ultra-violet inhibitors.
 4. Minimum total wall thickness 1.8 mm (0.07 inch) for diameters below 200 mm (8 inches), 2.8 mm (0.11 inch) for diameters 200 mm (8 inches) and 250 mm (10 inches), 5 mm (0.20 inch) for diameters 250 mm (10 inches) through 500 mm (20 inches), and 6 mm (0.25 inch) for diameters above 500 mm (20 inches).
 5. This conduit system is not permitted when carrier pipe or tracing system contains steam or condensate.

- E. Pipe Supports: Provide supports within conduit for fuel carrier pipes spaced 2100 mm (7 feet) apart except 3000 mm (10 feet) apart for carrier pipe size 50 mm (2 inches) through 100 mm (4 inches). Support design shall permit differential movement of pipes, allow drainage of leakage to sumps, and maintain alignment of carrier pipes.

- F. Conduit End Seals: Same material and coating as conduit; leak tight.

G. Leak Detector Sensor Locations: On each piping system, provide sumps at the low points with water-tight openings above grade for access to leak detector sensors. Design sumps to intercept all potential leakage.

Maximum spacing between sumps, 3000 mm (100 feet).

2.6 LEAK DETECTION SYSTEMS:

A. Automatic digital continuous monitoring systems responsive to the presence of water and hydrocarbons in the interstitial space of the double-wall tanks, in the tank manhole access enclosures, and in the secondary containment of fuel piping systems. System shall distinguish between hydrocarbon and water and identify location of leak as to individual tank and piping system. System may be combined with tank fluid level monitor and alarm system specified in Article, TANK FLUID LEVEL MONITOR AND ALARM SYSTEM.

B. Functions and Arrangement:

1. Single control station to monitor all sensing probes.
2. Visual indicator to monitor and identify leaks as water or hydrocarbon and location.
3. Indicators showing system status including faults and alarms.
4. On board printer that provides complete reports of all system functions upon command.
5. Panel circuit test button.
6. 95 dB audible alarm with silencing control to sound when leak is detected.
7. Eight hour memory backup system with battery.
8. NEMA 250 Type 4 cabinet.
9. UL or other accredited testing laboratory listing.
10. RS232 Modbus communications with engineering control system, boiler plant computer workstation to indicate system in service and alarm conditions.

C. Sensors:

1. Designed for required locations including: Insertion between walls of double-wall tanks, in sumps in double-wall piping systems and in tank manhole enclosures. Sensing points shall be at lowest point of each tank or sump. Intrinsically safe design.

2. Sensing units shall detect presence of water and a minimum 3 mm (0.125 inch) thick layer of hydrocarbon on surface of water and minimum 50 mm (2 inch) thickness of hydrocarbon in area that has no water present.
3. Sensors shall be arranged to allow replacement of individual sensors without disturbing other portions of leak detection system or fuel storage and piping system. Underground sensors shall be accessed through caps as grade.
4. Materials of construction shall be non-corroding.
5. Transmit status signal to control unit.

D. Components:

1. Provide manholes at grade for each sensor cap similar in construction to fill boxes. Manholes shall be cast iron, quick-opening cover, watertight, minimum size necessary to accommodate sensor caps. Provide identification plates, similar to those specified for fill points, labeled "MONITORING/OBSERVATION WELL-DO NOT FILL". Provide special tools if necessary for opening covers.
2. Sensor housings from tank and piping to grade shall be Schedule 40 PVC, or stainless steel.
3. Underground wiring between probes and control unit: Place in water-tight corrosion-resistant conduit system conforming to Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION.

2.7 TANK FLUID LEVEL MONITOR AND ALARM SYSTEMS:

- A. Digital systems for central monitoring of fuel and water levels in all fuel oil storage tanks in the project. High and low level visual and audible alarms. Volumetric tank-tightness testing. Complete with all transducing, transmitting, and receiving devices. On board printer to provide complete report of all system functions upon command. System may be combined with leak detection system specified in Article, LEAK DETECTION SYSTEMS.

B. Fluid Level Monitor:

1. Digital continuous readout, showing tank oil and water levels in gallons, smallest reading one gallon. Provide identification of product measured, measuring units, and the tank number.
 2. Tank and fuel characteristics contained in preprogrammed non-volatile field-replaceable databases. Protected power supply.
- C. High and Low Fluid Level Alarm System:
1. Automatic continuous on-line monitoring of all tanks.
 2. Visual and audible indicators combined with fluid level monitor. Identify the tank that is in alarm condition.
 3. Manual alarm test and silencing controls.
 4. Low level alarm actuation adjustable 0-25 percent of tank capacity. High level alarm actuation adjustable 75-100 percent of tank capacity.
- D. Locate all indicators, selector switches, alarms on face of wall-mounted NEMA 250, Type 4 panel.
- E. Remote Alarm Annunciator:
1. Visual and audible high level alarms adjacent to tank fill box locations. Locate in NEMA 250 Type 4X weatherproof exterior wall or pole-mounted panels.
 2. Alarm shall include flashing red light with 180 degree visibility for each tank and 95 dB horn or 100 mm (4 inch) diameter bell. Provide alarm silence control.
 3. Provide identification sign: "WHEN ALARM SOUNDS - FUEL TANK FILLED TO CAPACITY - DO NOT OVERFILL".
- F. Modbus communication to engineering control system, boiler plant computer workstation to indicate tank fluid level and alarm conditions. Telephone modem communication capability.
- G. System Performance: Accuracy plus or minus 2.5 mm (0.01 inch) of fluid height in inventory mode and 0.25 mm (0.001 inch) in leak detection mode. Automatic compensation for fluid temperature changes. Volumetric tank tightness sensitivity of 0.4 lph (0.1 gph).
- H. Sensors:
1. Provide sensor types such as magnetostrictive, capacitance, float, hydrostatic and other types as necessary for the applications.
 2. Apply in accordance with manufacturer's instructions with provisions for easy future replacement without need for excavation.

3. Provide for each hydrostatic sensor a constant flow differential pressure regulator and pneumatic transmitter protected from fuel contamination. Air supply shall include filter and over-pressure protection. Provide desiccant-type dryer on air supply designed for removal of water vapor. Dryer rating, minimum 280 cubic liters per minute (10 scfm). Provide moisture indicator. Dryer may be deleted if air supply source has a refrigerated dryer.
4. Float-type units shall be designed for installation and removal through a 100 mm (4 inch) diameter vertical pipe mounted in the top of the tank.
- I. Underground Wiring and Piping: Enclose in water-tight corrosion-resistant conduit system sized and arranged as recommended by system manufacturer and conforming to Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION.
- J. Code Conformance: NFPA-70.

2.8 FUEL OIL QUALITY MAINTENANCE SYSTEMS:

- A. Complete factory-assembled automatic particulate filtration and dewatering and fuel additive injection system to maintain the purity of No. 2 fuel oil in storage. The system shall circulate the oil from the storage tank, through the system, and back to the storage tank. Provide quantity and capacity of systems to serve tanks as shown, connected to the tank, suction, pump-out and return pipes. Drawings may show multiple tanks served by one system. Smaller systems without large water storage tanks and without fuel additive injection shall be wall-mounted. Units with water storage tanks and/or additive injection shall be floor-mounted on steel skids on concrete foundations. Digital controls.
- B. Performance: Design for nearly 100% water removal. Provide 2 micron particulate filtration. Each system shall have capacity to turn over the largest connected full tank one time within 11 hours maximum. System shall be designed to allow continuous operation with brief interruptions to manually change filters and clean strainers.
- C. Components:
 1. Strainer: 100 mesh perforated stainless steel basket. Clamped covers. 860 kPa (125 psi) design pressure.

2. Water Separation Unit: Two stage, designed to reduce water content of fuel to less than 10 ppm. Centrifugal separator for removal of large droplets and renewable resin-impregnated cellulose water coalescing elements. Water removed shall flow to water holding sump in the unit. Water sensing probe to alert the operator when water level in bowl has reached capacity. Automatic pumped drain to holding tank actuated by electronic water level sensing devices in the separation unit.
3. Filter: 2 micron filtration with 96% removal efficiency, valved manual drain. Replaceable elements.
4. Filtration Pump: Positive displacement base-mounted pump with cast iron or bronze housing, for circulating the oil from the storage tank, through the water separation and filter units and back to the storage tank. Pump shall have carbon bushings, stainless steel shaft and Teflon mechanical seal, ODP motor.
5. Controls:
 - a. Digital PLC electronic controls for all system control and alarm functions. Relay logic not acceptable.
 - b. Control panel with selector for modes of operation, indicators to show system status, and visual and audible alarms to signal the need for operator intervention. Operator interface shall be 2 x 20 LCD and keypad.
 - c. Controls shall include:
 - 1) Control power "on-off".
 - 2) "Cycle Start".
 - 3) "Cycle Cancel".
 - 4) "Hand-off-Auto" for filtration pump.
 - 5) Pump cycle timer set function.
 - 6) Cycle duration selector.
 - 7) "Auto-Off" switch for water transfer pump.
 - 8) "Auto-Off" for chemical additive pump.
 - d. Indications shall include:
 - 1) "Control Power On".
 - 2) "Pump Run".
 - 3) "Pump Failure".
 - 4) "Excess Water in Fuel".

- 5) "Filter Water Level High".
 - 6) "Rupture Basin Leak" alarm.
 - 7) "High Pressure Drop in Strainer" alarm.
 - 8) "High Pressure Drop in Filters" alarm.
 - 9) "High Pressure" alarm and automatic shut down.
 - 10) "High Water Level" in water storage tank.
 - e. Filter and strainer differential pressure gages, differential pressure switches and control. Provide indication when filters should be changed.
 - f. Over pressure switch and control to shut down pump if filter inlet pressure exceeds limits.
 - g. All primary wiring exiting the enclosure shall be encased in conduit.
 - h. Magnetic motor starters with overload protection.
 - i. Circuit breakers.
 - j. Control enclosure shall be NEMA 12, fully gasketed doors with 3 point lockable latching. Interior shall have white gloss finish; exterior shall be chemical-resistant gray enamel. All controls and indicating devices shall be mounted on front of enclosure and labeled with black Phenolic labels with white lettering.
 - k. Modbus communication to engineering control system, boiler plant computer workstation for alarms and system status.
- D. Fuel conditioning systems:
1. Fuel circulation and transfer is accomplished via an on-board, high-performance, cast-iron, positive-displacement gear pump direct-driven via an industrial, heavy-duty motor. The pump combines high vacuum prime maintenance with linear flow versus pressure performance. An integral pressure relief valve is included. Drive motors are NEMA class industrial type, conservatively applied and include ball-bearings, class H insulation, continuous duty ratings.
 2. Provide shutoff ball valves, check valves, flow switches, pressure and differential pressure gauges, and differential pressure sensors across each filtration element.
 3. The system shall be UL508 listed and labeled industrial control panel features a user programmable cycle timer and rugged,

industrial-analog operator interface. The controller provides full automatic operation of the system and is operator field programmable to set filtration cycle duration, time of day, day of week operation. Manual override capability is included. Differential pressure sensors across each filtration element and a high water level sensor are included with alarms.

4. System shall Includes,

- Outdoor, weatherproof, pad-mountable enclosure, also suitable for indoor installation. 1-inch NPT.
- On-board, integrated controller, UL508. See Controller Section
- Inlet, outlet ball-type shutoff valves
- Check valve
- Pressure differential gauges across pre-filter and across final filter-separator
- Differential pressure switches, high water detector. See Controller Section
- Circulation pump, 7 GPM @ 0.5hp
- Filtration elements:
 - Strainer, 40 mesh, wye-type
 - Pre-filter, 10 micron, spin-on type, disposable media
 - Final filter-separator, 5 micron, 10 PPM, canister type with replaceable cartridge
- 120v cabinet heater with thermostat
- 7.8 gallon, aluminum construction, water retention tank with secondary containment. Includes control solenoid valve and check valve. Includes gauge and vent. Includes pump-out hand pump with hose. Includes dual redundant high level sensing float switches

5. Provide the controller, UL508 Listed, NEMA-3R enclosed:

- a. Auto-off-manual switch
- b. Time of day, day of week, interval programmable timing
- c. Control devices
 - Pump motor starter
 - Control power fuses
 - Terminal blocks

- Valve control relays
 - d. Automatic water drain control
 - Water detection sensor
 - Back-up oil detection sensor to prevent transfer of fuel to holding tank
 - Automatic control of water drain solenoid valve
 - High level, water tank alarm
 - e. Heated control box with thermostatic control
 - f. High pressure differential alarms
 - g. Main power disconnect switch
- D. Enclosure - Wall Mounted Units: 14 gauge steel, NEMA 12/13 standards, continuously welded, framed cabinet. Provide doors for complete access to all equipment. Doors shall have a turned edge, piano hinges, three-point locking mechanisms. Corrosion-resistant prime and finish coatings on all interior and exterior surfaces.
- E. Waste Water Holding and Removal System: Automatic system with gear pump and 100 gallon holding tank. System shall sense water in the filter enclosure, automatically start the pump to remove water from the water separation/filter system and pump it into the holding tank. If water collected in the filter enclosure exceeds the pumping capacity, the filtration system shall automatically stop. Provide hand pump with outlet hose connection for emptying water from holding tank. Provide automatic valves that prevent oil flow into the tank or water flow out of the tank back into the oil system when the system is idle. Tank construction shall be centrifugally cast fiberglass reinforce isophthalic polyester resin. Tank shall have high level alarm and interlock to shut down the filtering system when the tank is full.
- F. Water Drainage System: Sealed bowl (bottle) with high level alarm system. Water collected in filters shall drain to a sealed bowl that can be easily removed and emptied.
- G. Chemical Additive System: Provide welded steel chemical storage tank and chemical pump that shall automatically add chemical to the fuel being circulated. Tank shall be sized to hold five years supply of additive as recommended by additive supplier. Pump shall be positive displacement metering type with totally enclosed 250 watt (1/3 hp)

motor, cast iron pump body, stainless steel trim and Teflon diaphragm. Output of pump shall be adjustable for 0 to 100% of capacity. Control system shall automatically operate the pump for an adjustable time period during each filtration cycle.

2.9 CONCRETE FOUNDATIONS:

Concrete pads for aboveground tanks, Day-tank and fuel conditioning systems are specified under Section 03 30 00, CAST-IN-PLACE CONCRETE. Ballast foundations shall be sized for buoyancy of entire tank when empty. Credit for overburden is allowed.

2.10 BURIED UTILITY WARNING TAPE:

Tape shall be 0.1 mm (0.004 inch) thick, 150 mm (6 inches) wide, yellow polyethylene with a ferrous metallic core, acid and alkali-resistant and shall have a minimum strength of 12,000 kPa (1750 psi) lengthwise and 10 300 kPa (1500 psi) crosswise with an elongation factor of 350 percent. Provide bold black letters on the tape identifying the type of system. Tape color and lettering shall be unaffected by moisture and other substances contained in the backfill material.

PART 3 - EXECUTION

3.1 INSTALLATION AND TESTING, ABOVEGROUND TANKS:

- A. Conform to NFPA 30 or 31 as applicable.
- B. Support tanks on steel saddles welded to the tanks. Anchor to concrete foundations. Provide molded neoprene isolation pads between the steel supports and the concrete foundation.
- C. After tanks are installed, test steel tanks with air pressure of 20 kPa to 35 kPa (3 - 5 psi), using soapsuds to locate leaks. Repair leaks by chipping to bare metal and rewelding. Retest until all leaks are repaired. Repair all damaged areas of prime coat on tanks and steel dikes (if furnished). Test interstitial area between steel tank walls with air at pressure recommended by tank manufacturer. Tests shall be witnessed by the COTR.
- D. Surface finish coating for tanks and steel dikes (if furnished) is specified under Section 09 91 00, PAINTING.
- E. Provide electrical grounding in accordance with NFPA 70.

3.2 INSTALLATION AND TESTING, UNDERGROUND PIPING SYSTEMS:

- A. Leak Detection System: Arrange fuel and tracing media (if required for heated oil) carrier piping, enclosed in secondary containment piping, to accommodate leak detection system. Slope piping down toward tanks and leak detectors at 25 mm in 10 m (1 inch in 40 feet).
- B. Glass Fiber Reinforced Plastic (FRP) Fuel Carrier Piping and Secondary Containment Piping: Install in accordance with printed instructions of pipe manufacturer. Installation personnel trained in accordance with Article, QUALITY ASSURANCE. Plastic piping not permitted in same secondary containment system with steam or condensate piping.
- C. Secondary Containment Piping:
 - 1. Provide sand bedding and backfill material for steel piping and pea gravel for FRP piping.
 - 2. Top of system 450 mm (18 inches) minimum below grade.
 - 3. Design and locate leak detector sumps to intercept all potential leakage. Maximum spacing along each system, 3000 mm (100 feet).
 - 4. Seal all building and manhole wall penetrations with a modular, watertight flexible penetration seal system. The modular penetration seal shall have a nitrile rubber seal, or if a fire separation is required, a high temperature silicone fire seal.
 - 5. After placing system, prior to backfill, repair all damage, including coatings, as recommended in printed instructions of system manufacturer. Perform 10,000 volt holiday test on coated steel systems.
 - 6. On steel systems that do not have FRP cladding, install cathodic protection system.
- D. Anchorage of System: When heated oil system is provided, anchor systems and provide expansion loops and bends as shown and as recommended by manufacturer of system. Pipe stress due to thermal expansion shall not exceed the limits in ASME B31.1.
- E. Leak Test: Test carrier pipes with air pressure at 690 kPa (100 psi), and test the containment piping with air pressure at 55 kPa (8 psi). Systems shall hold the pressure for 30 minutes. Repair all leaks and retest.
- F. Coatings for Steel Piping not in Secondary Containment System: Provide urethane coating and cathodic protection.

G. Buried Utility Warning Tape: Install tape 300 mm (12 inches) below grade above the piping system.

3.3 INSTALLATION, FILL BOXES AND ACCESS MANHOLES AT GRADE:

Provide for tank fill, tank sounding, leak detector sensors, and extractor fittings. Set at grade in concrete pads. Refer to fill box detail. Provide identification plate set into the concrete pad that identifies the purpose of the device and type of fuel in the tank.

3.4 INSTALLATION AND TESTING, LEAK DETECTOR SYSTEMS FOR TANKS AND PIPING:

- A. Wiring shall conform to NFPA-70.
- B. Locate control monitor panels 1500 mm (5 feet) above the floor on inside wall of boiler room, generator room or garage, depending on type of fuel tank served, unless shown otherwise.
- C. Test operation of each probe, and monitoring system with fuel and water. If type of probe utilized is damaged by exposure to fuel, provide temporary probe for testing monitoring system.

3.5 INSTALLATION, TANK FLUID LEVEL INDICATOR AND ALARM SYSTEM:

- A. Wiring shall conform to NFPA-70.
- B. Locate level indicator and alarm panel 1500 mm (5 feet) above the floor on inside wall of boiler room, generator room or garage, depending on type of fuel tank served, unless shown otherwise.
- C. Locate remote high level alarm on exterior wall or pole in view of tank fill point, 2400 mm (8 feet) above grade.

3.6 INSTALLATION, FUEL OIL QUALITY MAINTENANCE SYSTEMS:

- A. Locate systems within easy reach of persons standing on floor, with sufficient elevation to allow gravity flow of water from system to water storage tank sitting on the floor.
- B. Connect to tank suction and return piping systems with isolation valves. Provide compound pressure gages at suction and discharge piping connections.

3.7 TANK MANHOLE ENCLOSURES:

All pipe penetrations shall be leak tight permitting no groundwater into enclosure.

3.8 INSTALLATION, CATHODIC PROTECTION TEST STATIONS:

Provide separate station for each tank and each piping system, anchor firmly, locate so that terminal board is 600 mm (2 feet) minimum above

grade. Connect wiring from all anodes and protected structures to the test stations.

3.9 TESTING, CATHODIC PROTECTION:

- A. Testing performed by NACE-certified corrosion specialist; witnessed by COTR.
- B. Test Instruments:
 - 1. Volt-Ammeter.
 - 2. Saturated copper-copper sulfate reference electrode.
 - 3. Other instruments as required.
- C. Procedures: Conform to NACE RP-0169.
- D. Test Results Required for Acceptance:
 - 1. Potential of minus 0.85 volt between protected structure and reference electrode.
 - 2. Minimum shift of minus 300 millivolts upon application of protective current. Voltage measured between protected structure and reference electrode.
 - 3. Minimum shift of minus 100 millivolts upon interruption of protective current. Voltage measured between protected structure and reference electrode.
- E. Test Report: Provide complete report to COTR showing all test measurements, calculations, list of instruments used.

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