SECTION 23 10 00
FACILITY FUEL SYSTEMS

PART 1 – GENERAL:

1.1 DESCRIPTION:

A. Diesel fuel oil tanks, 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.

1.2 RELATED WORK:

A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Section 03 30 00, CAST-IN-PLACE CONCRETE.

C. Section 05 50 00, METAL FABRICATIONS.

D. Section 09 91 00, PAINTING.

E. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

F. Section 23 07 11, HVAC and BOILER PLANT INSULATION.

G. Section 23 21 13, HYDRONIC PIPING.

H. Section 31 20 00, EARTHWORK.

I. Section 33 63 00, STEAM ENERGY DISTRIBUTION.

1.3 QUALITY ASSURANCE:

A. Approval by Resident Engineer (RE) 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 Resident Engineer (RE) for resolution. Provide copies of installation instructions to the RE 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, Plastic Piping and Containment Systems, Tank Level Monitoring Systems, Leak Detection Systems, Fuel Quality Management Systems, Cathodic Protection 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 RE.

I. Where specified codes or standards conflict, consult the RE.

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. Underground Tanks:

1. Drawings of tanks, anchoring devices, tank manholes, tank manhole enclosures, access doors for the tank manhole enclosures and all accessories. Include overall dimensions and dimensional locations and sizes of all anchoring devices, pipe connections, access openings.
2. Manufacturer's installation instructions describing recommended foundation, bedding and backfill material, support and anchoring devices, and method of installation.
3. Weight of entire tank assemblies, empty and flooded.
4. Certification of compliance with specified standards.
5. Certification that steel tank manufacturer participates in the Steel Tank Institute (STI) Quality Assurance Program.
6. Data certifying that tanks are designed for surcharge loads of backfill, traffic and other construction.
7. Design and construction of tanks, secondary containment, pipe connections, manholes, anchoring devices, access doors for tank manhole enclosures.
8. Application and performance data on tank coating (steel tanks) from manufacturer of coating.
9. Design of cathodic protection system (when specified) for steel tanks.

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. 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 plastic piping and tanks 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

31-11.....Installation of Oil Burning Equipment

70-11.....National Electrical Code

G. Underwriters Laboratories Inc. (UL):

58-98.....Steel Underground Tanks for Flammable and Combustible Liquids

142-10.....Steel Aboveground Tanks for Flammable and Combustible Liquids

971-06.....Non-Metallic Underground Piping for Flammable Liquids

1316-06.....Glass-Fiber-Reinforced Plastic Underground Storage Tanks for Petroleum Products

1746-07.....External Corrosion Protection System for Steel Underground Storage Tanks

2085-10.....Protected Above-ground Tanks for Flammable and Combustible Liquids

H. Steel Tank Institute (STI):

F001.....Standard for Fire Resistant Tanks

F841.....Dual Wall Underground Steel Storage Tanks

F894.....ACT-100 Specification for External Corrosion Protection of FRP Composite Steel Underground Storage Tanks

F911.....Standard for Diked Aboveground Storage Tank System

F941.....Standard for Fireguard Thermally Insulated Aboveground Storage Tanks

F961.....ACT-100-U Specification for External Corrosion Protection of Composite Steel Underground Storage Tanks

P3.....STI-P3 Specification and Manual for External Corrosion Protection of Underground Steel Storage Tanks

R891.....Recommended Practice for Hold Down Strap Isolation

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

J. American Petroleum Institute (API):

1631-01.....Interior Lining and Periodic Inspection of Underground Storage Tanks

1.7 PERMITS:

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

PART - 2 PRODUCTS:

2.1 UNDERGROUND STEEL TANKS:

A. Factory fabricated all welded double-wall steel, horizontal cylindrical configuration, atmospheric pressure, internal and external corrosion protection as specified. Tanks shall be fabricated in accordance with Steel Tank Institute (STI) design standards by manufacturer that participates in STI Quality Assurance Program.

B. Construction:

1. ASTM A36 steel, UL 58 double-wall, 360-degree secondary containment.
2. Conform to NFPA 30 or 31 as applicable.
3. The bottom 60 degrees of all lap or offset circumferential interior seams shall be seal welded 30 degrees each way from bottom centerline to retard corrosion.

4. Design for surcharge loads such as backfill and paving as shown. In addition, in paved areas, design for H-20 (14,500 kg) (32,000 pound) axle loading.
5. Leaks and abrasions are not permitted. Maximum out-of-roundness is one percent of the diameter.
6. Outer wall shall provide leak tight secondary containment that covers 100 percent of tank volume and shall permit migration of any inner tank leakage to the lowest part of the tank where leak detectors are located. Make provisions for leak detectors to be furnished at lowest part of interstitial space between tank walls.

C. Factory Cleaning: Clean interior and exterior. Remove all mill scale, dirt, rust, oil, welding debris, loose coatings and coatings and material incompatible with fuel stored or protective coating to be furnished. Sandblast exterior in accordance with NACE 3 and STI corrosion protection system requirements.

D. Factory Applied Exterior Corrosion Protection System: Steel Tank Institute (STI) ACT-100-U urethane coating (STI F961) technology. Tank shall be labeled to indicate compliance. Provide signed holiday test results. Provide STI standard limited 30 year warranty against internal and external corrosion penetrating the tank.

E. Factory Applied Interior Coating: API 1631 coating from bottom of tank to 1 m (3 feet) from bottom.

F. Tank Manhole Enclosures:
1. Rectangular or cylindrical enclosures, sized as shown, designed to contain fuel spills from leaking piping. Locate all tank manholes and tank piping connections within the enclosure. Watertight pipe penetrations.
2. Steel, fiberglass or polyethylene. Reinforce to prevent deflection. Leak-tight attachment to tank. Clean and coat interior and exterior of steel enclosure as specified for exterior of tank.
3. In traffic areas, enclosure must be designed to withstand traffic loads (H-20 wheel loading, 14 500 kg, (32,000 lb)) and must have flexible isolation system to prevent wheel loads being transmitted to tank.
4. For steel enclosures, provide cathodic protection system and test station as specified for the tanks.

5. Access to Manhole Enclosure: Cast iron manhole frames and covers, rated for traffic, minimum opening as shown. Comply with Fed. Spec. A-A-60005.

G. Pipe Connections to Tanks:
1. Conform to UL 58.
2. Pipe sizes 100 mm (4 inches) and smaller, threaded. Pipe sizes 150 mm (6 inches) and larger, raised faced slip-on flanges, 1025 kPa (150 pound) ASME rating.
3. Welded joints required on steel piping located inside tanks.
4. Provide and coordinate tank connection quantities, sizes and types with requirements of fluid level gage unit; leak detector sensor; sounding rod; vent, fill, supply and return pipes; and other pipes as shown.
5. Dielectric insulation on all connections to steel piping.
6. All tank piping connections, except vent, shall be within the tank manhole enclosure.

H. Tank Manholes: Provide quantity shown. Bolted cover type, gasketed. Zinc plated bolts, nuts, washers.

I. Internal Ladder: Provide as shown and shall have 50 mm x 6 mm (2 inch x 0.25 inch) sides, 20 mm (0.75 inch) diameter rungs on 300 mm (12 inch) centers. 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 rolled and seal-welded to bottom of tank directly under all openings.

K. Lifting Lugs: Provide for rigging tanks.

L. Hold Down Straps: Provide quantity and design of EPDM-type rubber encased steel straps as recommended by tank manufacturer to anchor tank to concrete ballast slab. Hold down strap electrical isolation shall conform to STI R891. Straps shall have tension load capability equal to hold-down capability of ballast slab, with a minimum safety factor of two. Provide complete anchorage devices, including turnbuckles, for adjusting tension.

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 5 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.
5. Protect spill container from traffic by ramped, drain-slotted cast iron body ring and cover. Design shall prevent transmission of traffic loads to the underground tank. Spill-container type not required at locations designated only for sounding tanks.

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. Refer to Section 05 50 00, METAL FABRICATIONS, for access platforms shown for aboveground tanks.

E. Support horizontal portion of pipes located inside tank every 2100 mm (7 feet) maximum.

F. Furnish gauging chart, liters versus mm and gallons versus inches depth.

G. 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.

H. 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.

4. Plastic pipe and fittings are not permitted on steam or condensate service. Plastic piping allowed in underground use only.

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, overfill 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. Overfill Prevention Valve: Aluminum automatic valve designed for underground or aboveground tanks, as applicable. Removable through the extractor fitting on underground tanks. Locate valve near the top of the tank in the fill pipe. On underground tanks with gravity fill, provide two stage automatic float-operated valve. First stage operation at 92 percent tank capacity shall reduce flow to 19 L per minute (5 gallons per minute) or less. Second stage operation shall stop flow completely when tank is no more than 95 percent full. 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 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 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 CONCRETE FOUNDATIONS:

A. Concrete ballast foundations for underground tanks and concrete pads for aboveground tanks 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.

2.9 BURIED UTILITY WARNING TAPE:

A. 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, UNDERGROUND STEEL TANKS:

A. Conform to NFPA 30 or 31 as applicable.

B. Install tanks on 150 mm (6 inch) thick beds of clean, washed, inert sand that is placed on concrete foundation. Secure tank to concrete ballast foundation with specified straps. Slope tank. Completed tank installation shall successfully resist buoyant forces of flooding to top of tank when tank is empty.

C. After tanks are set in place, prior to backfilling, test tanks by applying internal air pressure of 35 kPa to 48 kPa (5 - 7 psi). Also test air space between tank walls at pressure recommended by tank manufacturer. Repair leaks in steel tanks by chipping to bare metal and rewelding. Repair leaks in plastic tank jackets (if furnished) as recommended by tank manufacturer. Retest tanks until all leaks are repaired. Test manhole enclosures by filling with water and proving no leakage for 24 hours. Tests shall be witnessed by Resident Engineer (RE).

D. Prior to backfilling, repair all damage to tank coating with the same coating material. Coat all metal parts that will be below grade, including tie-down fittings and straps, bolts, rings, pipes, with the tank coating material. Perform 10,000 volt holiday test on all areas of coating which have been repaired.

E. Excavation, trenching and backfilling around the tanks is specified under Section 31 20 00, EARTHWORK. Backfill material shall be same as bedding material and shall conform to printed instructions of tank manufacturer. In addition, there shall be no stones, ashes, or corrosive materials in contact with the tanks. Unstable and unsuitable soil shall be removed and replaced with suitable material. Provide a soil separation mat to keep soil separate from sand and pea gravel. Minimum depth of cover shall conform to NFPA 30 or 31 as applicable. After completion of backfilling, measure tanks internally for out-of-roundness (deflection).

F. Do not place fluid in the tank until the backfilling and the piping connections to the tanks are complete, and the tanks have been inspected internally by the RE. Keep the tank excavation dewatered.

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. Steel Fuel and Tracing Media Carrier Piping: All joints butt or socket welding. Threaded piping is not permitted. Piping ends shall be accurately cut, true, and beveled for welding.

C. 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.

D. 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.

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:

A. 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 TANK MANHOLE ENCLOSURES:

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

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