SECTION 33 56 13.13

STEEL TANKS WITH FIXED ROOFS
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API MPMS 2.2A	(1995; R 2007) Measurement and Calibration of Upright Cylindrical Tanks by the Manual Strapping Method
API RP 2009	(2002; R 2007; 7th Ed) Safe Welding, Cutting, and Hot Work Practices in Refineries, Gasoline Plants, and Petrochemical Plants
API Std 2000	(2009) Venting Atmospheric and Low-Pressure Storage Tanks
API Std 650	(2007; Addendum 1 2008; Addendum 2 2009; Addendum 3 2011; Errata 2011) Welded Tanks for Oil Storage

ASME INTERNATIONAL (ASME)

ASME B16.11	(2011) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2011) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.5	(2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2007) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.3	(2010) Process Piping

ASTM INTERNATIONAL (ASTM)

ASTM A216/A216M	(2008) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A269	(2010) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A351/A351M	(2010) Standard Specification for Castings, Austenitic, for

	Pressure-Containing Parts
ASTM A492	(1995; R 2009) Standard Specification for Stainless Steel Rope Wire
ASTM B 241/B 241M	(2010) Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B 247	(2009) Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings
ASTM B 345/B 345M	(2002) Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube for Gas and Oil Transmission and Distribution Piping Systems
ASTM B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C33/C33M	(2011a) Standard Specification for Concrete Aggregates
ASTM C88	(2005) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM D2565	(1999; R 2008) Xenon Arc Exposure of Plastics Intended for Outdoor Applications
ASTM D3389	(2010) Coated Fabrics Abrasion Resistance (Rotary Platform, Double-Head Abrader)
ASTM D3453	(2007) Flexible Cellular Materials - Urethane for Furniture and Automotive Cushioning, Bedding, and Similar Applications
ASTM D471	(2010) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D543	(2006) Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
ASTM D747	(2010) Apparent Bending Modulus of Plastics by Means of a Cantilever Beam
ASTM D751	(2006; R 2011) Coated Fabrics
ASTM E96/E96M	(2010) Standard Test Methods for Water Vapor Transmission of Materials

AMERICAN WELDING SOCIETY (AWS)

AWS A5.10/A5.10M	(1999; R 2007) Specification for Bare Aluminum and Aluminum-Alloy Welding

Electrodes and Rods

NACE INTERNATIONAL (NACE)

NACE SP0178	(2007) Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to be for Immersion Service

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-83133	(2011; Rev H) Turbine Fuels, Aviation, Kerosene Type, JP-8 (NATO F-34), NATO F-35 and JP-8 + 100 (NATO F-37)
MIL-P-24396	(1994; Rev A) Packing Material, Braided PTFE (Polytetrafluoroethylene)
MIL-PRF-6855	(2009; Rev F) Rubber, Synthetic, Sheets, Strips, Molded or Extruded Shapes, General Specification for
MIL-PRF-907	(2004; Rev F) Antiseize Thread Compound, High Temperature
MIL-R-83248	(Rev C; Notice 1; Notice 2) Rubber, Fluorocarbon Elastomer, High Temperature, Fluid, and Compression Set Resistant

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS SS-S-1614	(Rev A; Am 1) Sealants, Joint,Jet-Fuel-Resistant, Hot-Applied, for Portland Cement and Tar Concrete Pavements
FS SS-S-200	(Rev E; Am 1; Notice 1) Sealant, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.23	Guarding Floor and Wall Openings and Holes
29 CFR 1910.24	Fixed Industrial Stairs
29 CFR 1910.27	Fixed Ladders

U.S. NAVAL FACILITIES ENGINEERING COMMAND (NAVFAC)

NAVFAC P-355	(1992) Seismic Design for Buildings

UNDERWRITERS LABORATORIES (UL)

UL 698	(2006) Industrial Control Equipment for

	use in Hazardous (Classified) Locations
UL 886	(1994; Reprint Nov 2005) Standard for Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Steel tank; G,DR

Floating pan; G,DR

SD-03 Product Data

Structural steel; G,DR

Pipe and fittings; G,DR

Gaskets; G,DR

Mastic seal; G,DR

Floating pan; G,DR

Gage hatch; G,DR

Mechanical tape level gage; G,DR

Servo level gage; G,DR

Level alarm system; G,DR

Sand cushion

Venting

Grating or anti-slip floor plate for stairway

Roof manholes

Shell access holes

Flexible membrane liner (FML); G,DR

Oil-resistant coating system

High Liquid Level Control Valve; G,DR

SD-04 Samples

FML Samples

SD-05 Design Data

Steel tank design calculations; G,DR

Floating pan design; G,DR

SD-06 Test Reports

Structural steel tests (including toughness test data)

FML inspections

FML tests

FML factory test

Sand cushion tests

Fire test; G,DR

SD-07 Certificates

Welding procedures and procedure qualifications

Qualifications of nondestructive test examiners

Tank calibration experience

Qualifications of FML field engineer

FML Manufacturer's Representative

SD-08 Manufacturer's Instructions

Mechanical tape level gage

Servo level gage

Level alarm system

Flexible membrane liner (FML)

SD-10 Operation and Maintenance Data

Mechanical tape level gage, Data Package 2; G,DR

Servo level gage, Data Package 2; G,DR

Level alarm system, Data Package 2; G,DR

Venting, Data Package 2; G

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Tank calibration record

Weld inspection reports

Submit reports for inspection of welds, and radiographs , to the Contracting Officer

1.3 COPIES OF API PUBLICATIONS

Provide four copies of API RP 2009, API Std 650, API Std 2000, and API MPMS 2.2A.

1.4 RELATED REQUIREMENTS

Materials, design, fabrication, welding, erection, testing, and appurtenances shall be in accordance with API Std 650 and API Std 2000, except as otherwise specified herein. Product to be stored in the tank is JP-8 fuel.

1.5 DESIGN REQUIREMENTS

Tank shall be designed to resist the following loads and forces:

a. Wind: 135 mph

b. Seismic Design Category: A

c. Roof Live Load: 20 pounds per square foot

d. The following combinations of loads, with corresponding percentages of basic stresses to be used in design, shall be allowed:

Load Combination	Percentage of Allowable Stress
Dead load plus live load	100
Dead load plus live load plus wind load	133
Dead load plus live load plus seismic load	133

e. Determine forces and hydrodynamic effects from seismic loading in accordance with API Std 650 and NAVFAC P-355. Design tank to provide freeboard to minimize or prevent overflow and damage to the roof and upper shell that may be caused by sloshing of the liquid contents. Design columns to resist the forces caused by sloshing of the liquid contents.

f. Tank design shall be coordinated with the foundation shown on the structural drawings.

g. The usable capacity of the tank shall be not less than 10,000 (42.0 U.S. standard gallons) barrels. The tank shall be not more than 49 feet in diameter, and shall be 40 feet straight size height.

h. Specify gravity of liquid is 0.84.

i. Design tank and connected piping to accommodate external piping loads in accordance with API Std 650, Appendix P.

1.5.1 Corrosion Allowance

Make allowance of 1/16 inch in thickness of steel for corrosion loss. Corrosion allowance shall be applied to the interior of the shell, roof, and to surfaces of interior structural members.

1.5.2 Design Metal Temperature

API Std 650.

1.6 TANK CALIBRATION EXPERIENCE

Perform calibration of the tank using a qualified organization that can certify to at least 2 years of prior successful and accurate experience in calibrating tanks of comparable type and size.

1.7 ELECTRICAL WORK

Electrical equipment and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Switches and devices necessary for controlling the electrical equipment shall be provided. Wiring, equipment, and fittings shall be explosion-proof in conformance with the applicable requirements of UL 698 and UL 886 for Class I, Division 1, Group C and D hazardous locations. Electrical installations shall conform to the requirements of the NFPA 70. Underground electrical wiring shall be enclosed in PVC coated conduit which shall be isolated from steel tanks with dielectric fittings.

1.8 QUALIFICATIONS OF FML FIELD ENGINEER

The Contractor shall meet the licensing requirements of the State in which the work is to be performed. The Contractor shall provide a field engineer full time to this project. The field engineer shall have successfully completed manufacturer's training for handling and installing FML systems as well as have at least one million square feet of installation experience.

1.9 QUALITY ASSURANCE

1.9.1 Drawing Requirements

Drawings for the steel tank and floating pan shall be prepared by a registered structural engineer. Include erection diagrams and detail drawings of tank bottoms and foundations, roof, shell plates, wind girders, and openings and connections for fittings and appurtenances. The drawings shall include the following:

a. Tank erection details showing dimensions, sizes, thickness, gages, materials, finishes, and erection procedures.

b. Tank component details to include as a minimum:

(1) Sand cushion

(2) Floating pan (including details of support legs, manways, foam dams, joint attachments, anti-rotation cable, and grounding cables)

(3) Internal pipe and fittings

(4) Locations of floating pan pressure/vacuum vents, rim seals, and

foam dam

(5) Location of alarm and control switches

(6) Location of gages

c. Details of the base of any component that sets on grades; complete with attachments, anchor bolt templates, and recommended clearances for maintenance and operation.

d. Details of the electric wiring indicating applicable single line and wiring diagrams with written description of sequence of operation and the instrumentation.

e. Details showing the location, type, and description of vibration isolation devices for all applications.

f. Complete piping and wiring schematic diagrams.

1.9.2 Data Requirements

Calculations for the steel tank design and, floating pan design shall be prepared by a registered structural engineer. Include calculations that indicate the maximum and minimum operating pressures in accordance with API Std 650, Appendix F. Include calculations for the buoyancy of the floating pan and the structural stability of the floating pan when resting on the support legs.

1.9.3 Test Examiners

Submit proof of compliance of nondestructive test examiners with API Std 650. Submit certified data on tank calibration experience.

1.9.4 Qualifications of FML Field Engineer

Submit a letter providing evidence of the Contractor's and the field engineer's experience, training, and licensing. Statements of previous FML job experience shall be provided with a point of contact, a phone number, address, the type of installation, and the current status of the installation.

1.9.5 FML Manufacturer's Representative

Submit a letter, prior to placing the FML, from the FML manufacturer naming their authorized representative complete with their address, phone number, and a point of contact.

PART 2 PRODUCTS

2.1 MATERIALS

Conform to the following requirements except that materials not definitely specified shall conform to API Std 650.

2.2 STRUCTURAL STEEL

API Std 650.

2.3 PIPE, FITTINGS, AND FLANGES

Pipe, pipe fittings, flanges, gaskets, and bolting shall be provided in accordance with Section 33 52 43.13 PIPE, MANUAL VALVES, AND FITTINGS, AVIATION FUEL SYSTEM and API Std 650.

2.4 ALUMINUM PIPING FOR STILLING WELLS

2.4.1 Pipe

Aluminum pipe shall be ASTM B 241/B 241M or ASTM B 345/B 345M, alloy 6061-T6, Schedule 40 for pipe sizes 2 inches through 12 inches; Schedule 80 for pipe sizes 2 inches and smaller.

2.5 ALUMINUM FITTINGS FOR STILLING WELLS

Aluminum to aluminum-threaded connections shall not be permitted.

2.5.1 Socket Welding Fittings

Aluminum socket welding fittings shall be ASME B16.11, except aluminum shall be alloy 5083-H112, alloy 6061-T6, or alloy 356-T6.

2.5.2 Butt-welding Fittings

Aluminum butt-welding fittings shall be ASME B16.9, except aluminum shall be ASTM B 241/B 241M, alloy 6061-T6, of the same weight as the pipe in which the fittings are installed.

2.5.3 Flanges and Bolting

Aluminum flanges shall be ASME B16.5, Class 150 or Class 300 where indicated, Flat Face Type, except aluminum shall conform to ASTM B 247, alloy 6061-T6 or alloy 356-T6. Aluminum flanges may be welding neck or slip-on type. Provide bolting in accordance with Section 33 52 43.13 AVIATION FUEL PIPING. Provide electrical isolation for separation of dissimilar metals.

2.6 WELDING FOR ALUMINUM PIPING

2.6.1 Process for Aluminum

ASME B31.3, Gas Tungsten Arc Welding (GTAW) Process or Gas Metal Arc Welding (GMAW) Process. Backing rings shall not e permitted.

2.6.2 Aluminum Welding Electrodes and Rods

AWS A5.10/A5.10M, ER5356 electrodes.

2.7 PIPE FLANGE GASKETS

ASME B16.21, spiral-wound type.

2.8 GASKETS FOR MANHOLES, CLEANOUTS, AND COVERS

2.8.1 Flanged and Bolted Connections and Covers

Provide composition asbestos-free, fire-resistant gaskets.

2.8.2 Roof Manhole Frames and Covers

Provide rubber gaskets, MIL-PRF-6855, for covers which are not bolted.

2.9 MASTIC SEAL

Mastic seal for sealing foundation ring wall shall be resistant to jet fuel and shall conform to FS SS-S-200 for cold applied sealant and FS SS-S-1614 for hot applied sealant.

2.10 INTERIOR PROTECTIVE COATING SYSTEM

Section 09 97 13.17 THREE COAT EPOXY INTERIOR COATING OF WELDED STEEL PETROLEUM FUEL TANKS.

2.11 EXTERIOR PROTECTIVE COATING SYSTEM

Section 09 97 13.27 EXTERIOR COATING OF STEEL STRUCTURES.

2.12 APPURTENANCES

2.12.1 Floating Pan

The floating pan shall be naturally buoyant by means of sealed honeycomb cells in aluminum sandwich panels, be suitable for operation with liquids having a specific gravity of 0.70, be internal to the tank, have full surface contact with the fuel, be equipped with a seal at each penetration, and meet the requirements of API Std 650 Appendix H. A rim shall be provided around the floating pan periphery and extend a minimum of 6 inches above the free liquid surface. The rim shall contain turbulence and prevent fuel from splashing up onto the top surface of the floating pan.

2.12.1.1 Pan Integrity

The floating pan shall support the following loading conditions without causing damage to the pan, sinking the pan, or allowing product to spill onto the top surface of the pan in the event the pan is punctured.

a. A uniform load of three times the weight of the pan.

b. For tanks larger than 30 feet in diameter, a point load of 500 pounds on a one square foot area anywhere on the floating pan while it is floating or resting on the legs.

2.12.1.2 Joint Connections

Aluminum sandwich panels shall be joined together by means of a gasketed joint that transmits loads without structural failure or leakage.

2.12.1.3 Aluminum Extrusions

Extrusions shall be made from alloy 6063-T6 in accordance with ASTM B209.

2.12.1.4 Aluminum Sandwich Panels

Panels shall be made from alloy 3003 H14, 3003 H16, 3105 H14, or 5010 H24 in accordance ASTM B209. The skin of the panels shall have a minimum thickness of 0.014 inches. The core of the panels shall be one inch aluminum honeycomb.

2.12.1.5 Support Legs

Floating pan shall be provided with two position self-draining legs that are designed to support a uniform load of 12.5 pounds per square foot. The legs shall be tubular structural members at least 2 inches in diameter and ride with the pan when the fuel level is above the high position. The low position shall be as shown on the construction drawings and high position 75 inches. The exact location and number of the support legs shall be as recommended by the floating pan manufacturer. The legs shall be capable of allowing a person, standing on top of the floating pan while the tank is in service, to perform the following functions:

a. Change from the high to the low position.

b. Change from the low to the high position.

c. Completely remove the legs.

d. Adjust the legs vertically a distance equal of plus or minus 3 inches.

2.12.1.6 Periphery Seals

Periphery seals shall be made of flexible polyurethane foam in accordance with ASTM D3453 and be covered with a polyurethane coated polyester fabric wrap at least 0.025 inch thick. The periphery seal shall fit the space between the tank shell and the outer edge of the floating pan with two flexible seals, a primary and a secondary. The seals, primary and secondary as a unit, shall accommodate a deviation between the path of the floating pan relative to the tank shell of an additional 4 inches of compression and an additional extension of 2 inches from its normal compressed position at any fluid level. The primary seal shall be above the liquid level and be free draining without trapping any liquid. The secondary seal shall be above the primary seal. Seals shall be capable of being replaced during tank operations, be durable in the tank's environment, be abrasion resistant, and not discolor or contaminate the liquid stored in the tank.

2.12.1.7 Penetration Seals

Penetration seals shall be made of Buna-N. Vertical appurtenances such as columns, ladders, cable, etc. that penetrate the floating pan shall have seals that permit a local deviation of plus or minus 5 inches and have a rim that extends a minimum of 6 inches above the free liquid to contain product turbulence and prevent the tank product from splashing up onto the top surface of the floating pan.

2.12.1.8 Manway

A manway shall be provided for each floating pan to provide access to the tank interior when the floating pan is on its supports and the tank is empty. Manway shall have an clear inside diameter of at least 30 inches. The cover shall be bolted fuel tight to the floating pan with a Buna-N gasket. Manway shall have a rim that extends a minimum of 3 inches above the free liquid to contain product turbulence and prevent the tank product from splashing up onto the top surface of the floating pan.

2.12.1.9 Grounding Cables

Two or more 1/8 inch diameter grounding cable made of 304 stainless steel aircraft cable conforming to ASTM A492, with a maximum resistance of 8.5 ohms per 100 feet shall be provided for each tank. The exact location and number of grounding cables shall be as recommended by the floating pan manufacturer.

2.12.1.10 Anti-Rotation Cable

One 1/4 inch diameter anti-rotation cable made of 304 stainless steel conforming to ASTM A492 shall be provided for each tank. Fittings for anti-rotation cables including cable clamps, pins, sockets, turnbuckles, U-bolts and nuts, etc. shall be 304 stainless steel. Cable shall be made taut by means of the turnbuckle. The exact location of the anti-rotation cable shall be as recommended by the floating pan manufacturer.

2.12.1.11 Fire Test

The floating pan design shall be fire tested by both of the following tests being applied to a test floating pan. Float the test floating pan in aviation turbine fuel or motor gasoline with a flash point of less than 120 degrees F. Successful conclusion of each fire test shows that the design is adequate if no significant damage occurs to the pan, the pan continues to float, and the fire did not spread to the whole surface of the fuel.

a. Hole Fire: The test floating pan shall have a 12 inch or larger diameter hole cut through it. After being lit, the fuel in the hole shall burn for a minimum of 2 hours.

b. Rim Fire: After being lit, the fuel around the test rim section shall burn for a minimum of 2 hours.

2.12.2 Gage Hatch

Provide gage hatch and stilling well to within 3 inches of the bottom of the tank for manual gauging. Provide a horizontal datum plate of 1/4 inch thick stainless steel at the bottom of the stilling well with the top of the plate at the elevation at which the shell intersects the bottom. Equip hatch with a self-closing, foot-operated, lockdown cover of nonferrous metal. Provide gasket for dissimilar metal protection. Provide a thermometer holder. Locate hatch near roof manhole, readily accessible from the top platform of the stairway.

2.12.3 Mechanical Tape Level Gage

The mechanical tape gage shall be complete with all necessary incidental pipe, pulleys, fittings, supports, support brackets, tension spring, and guide wire assemblies. The gage shall automatically provide the location of the floating pan within plus or minus 1/16 inch of the actual liquid level. The head shall be made of aluminum and be mounted on the exterior of the tank shell approximately 54 inches above the tank bottom. The head shall contain a glass covered window complete with an inside wiper. The seals shall be made of teflon. The shafts, graduated tape, and tape drum assembly shall be made of stainless steel. The tape shall be of sufficient length to measure the liquid level from the bottom to the top of the storage tank. Gage measurements shall be graduated in 1/16 inch increments. The tape shall be carried over pulleys housed in elbow assemblies at each change of direction.

2.12.4 Servo Level Gage

2.12.4.1 Construction

The materials of construction of the servo level gage, excluding "O" ring gaskets, magnetics, and electronic components, shall be constructed of either ASTM A351/A351M Type 316 stainless steel or cast aluminum. "O" ring gaskets shall be constructed of Buna-N. The servo level gage shall be Underwriters Laboratory (UL) or Factory Mutual (FM) labeled for Class I, Division 1, Group D hazardous areas, and shall have maximum temperature rating of "T2D" 419 degrees F as defined by NFPA 70. The nameplate shall include the temperature rating. Unit shall be provided with a thermostatically controlled heater for prevention of condensation and freeze protection and an RTD and self compensating temperature converter. Unit shall receive 120 volts, single phase power and shall consume 60 VA, maximum.

2.12.4.2 Assembly

The automatic tank level gage assembly shall include a servo level gage, an ASTM A492 Type 316 stainless steel measuring wire, an unguided 5.7 inch diameter type 316 stainless steel displacer, an aluminum calibration chamber, local and remote level indications, and an aluminum stilling well. The measuring wire shall be of sufficient length to measure the liquid level from the bottom to the top of the storage tank.

2.12.4.3 Gage Operation

The displacer shall indicate to the servo level gage a rise or fall in the liquid level of the tank. The servo level gage shall be capable of sensing any movement of the displacer and provide both a local and a remote liquid level indication. The servo level gage shall have a measuring accuracy of plus or minus 0.01 feet.

2.12.4.4 Data Transmission

When the servo level gage senses a rise or fall in the tank liquid level, the internal processor shall be capable of providing serialized output capable of being transmitted over a two-wire bus to remote receiver/indicator units. The units of measurement shall be feet and measuring increments shall be in hundredths (0.01) of a foot. Wave integration time shall be 1 to 10 seconds, adjustable.

2.12.5 Level Alarm System

System shall be designed and installed in such a way that the system shall be continuously and automatically self-checking without manual check. Electronic level sensors shall be thermistors or optic types, and be intrinsically safe Class I, Division 1, Group D for hazardous environments, with recognized FM, CSA or UL approval. Both high electronic level sensors shall be contained in a single multi-sensor holder/junction box. The sensor holder/junction box shall be accessible from the tank top or stairway.

2.12.5.1 Electronic Level Alarms

Level alarms shall be mechanically and electrically independent and be totally isolated from the gauging system. Two electronic high level alarms

shall be provided for each tank. A High Level Alarm (HLA) shall be set at approximately 95 percent of the safe tank filling height and be arranged to actuate an audible alarm signal located at or near the normal station of the person in control of the tank filling operation. A High High Level Alarm (HHLA) shall be set at approximately 98 percent of the safe filling height. HHLA shall sound an audible and visual alarm at a control panel and close the High Liquid Level Control Valve. In addition, an electronic low level alarm shall actuate a visual and audible signal at the control panel when the tank is less than 5 percent filled and a Low-Low Level Alarm (LLLA) shall actuate a visual and audible signal at the control panel when the tank is approximately 2 percent filled. See construction drawings for location and settings of level alarms.

2.12.5.2 Level Alarm Control Panel

Panel shall be located where indicated and contain one light and one relay output for each alarm point. An audible alarm shall actuate whenever any alarm point has been reached. Panel shall further contain a green (Power ON) status light and push button controls for alarm reset and test. Panel shall consist of a NEMA 4 style water-tight housing for outdoor mounting locations. Panel shall operate with 115 VAC input power. Circuitry and cables from the panel to the electronic level sensors in the tank shall be intrinsically safe.

2.12.6 High Liquid Level Control Valve

2.12.6.1 Valve

Valve shall be hydraulically operated, single-seated, normally closed, diaphragm actuated, on/off type valve. Valve shall be field adjustable. Valve shall be provided with a position indicator, float operator and assembly, pressure-operated pilot valves and accessories, solenoid-operated pilot valve, and pressure gage quick-disconnect fittings located in the valve inlet, outlet, and cover. Valve shall also operate with a special check valve feature and close rapidly when outlet pressure exceeds inlet pressure. Service and adjustments shall be possible without removing the valve from the line. Portions of the valve coming in contact with fuel shall be compatible with the fuel and be of corrosion-resistant material. Valve shall have bodies, bonnets, and covers constructed of cast steel conforming to ASTM A216/A216M, Grade WCB internally plated with chromium, nickel, or electroless nickel. Stem and trim shall be stainless steel. Valve shall be suitable for a working pressure of 275 psig at 100 degrees F with a weatherproof housing. Valve packing shall be Viton in accordance with MIL-R-83248 or PTFE in accordance with MIL-P-24396. Valve shall be provided with flanged end connections which are constructed of the same material as the valve body.

2.12.6.2 Float Operator and Assembly

Float operator and assembly shall be Grade CF3 (Type 304L) or Grade CF8M (Type 316) stainless steel conforming to ASTM A351/A351M. Float operator shall be field adjustable. Float operator shall control the high liquid level control valve based on the indicated actuation point. The float operator and assembly shall be mounted to the storage tank's exterior where indicated. Means shall be provided to test the float operator's operation and the control system's response.

2.12.6.3 Pressure-Operated Pilot Valves and Accessories

Valves shall be the adjustable, pressure-operated type and be adjustable in the field. Valves shall be tag identified and be stainless steel conforming to ASTM A351/A351M, Grade CF3 (Type 304L) or Grade CF8M (Type 316) with stainless steel internal working parts. A 40 mesh stainless steel screen, self-cleaning strainer shall be provided in the pilot valve supply piping. Pilot system tubing shall be Type 316 stainless steel in accordance with ASTM A269. Control, supply, and return connections shall be provided with isolation valves. Tubing connections shall be made with unions and not be welded or sealed with "O" rings.

2.12.6.4 Solenoid-Operated Pilot Valve

Valve shall be used for the electronic level alarm sensor control of the high liquid level control valve. Valve shall be tag identified and be stainless steel conforming to ASTM A351/A351M, Grade CF3 (Type 304L) or Grade CF8M (Type 316) with stainless steel internal working parts. Valve shall have a manual type operator or needle valve for emergency manual bypass operation. Activation of this emergency manual bypass override, during filling operations when no electrical power is available, shall cause a visible and audible indication of override status at the Level Alarm Control Panel when electrical power is restored to the system. Solenoids shall operate on 120 volts, 60 Hz, single phase power and be housed in an UL labeled explosion-proof case for Class I, Division 1, Group D areas with maximum temperature rating of "T2D" 419 degrees F.

2.12.6.5 Control Valve Operation

The high liquid level control valve shall fully close when either the float operator or the HHLA electronic level alarm sensor are activated. Valve shall fully open when the tank's fuel is below the float operator's actuation point and the HHLA electronic level alarm sensor is not activated. Means shall be provided to test the control system's response at the activation point.

2.12.7 Venting

Provide open vent at the center or at the highest elevation of the roof. Open vent shall have a weatherhood, with galvanized steel bird screen with 1/4 inch opening and a 0.135 inch minimum wire diameter.

2.12.8 Venting

2.12.8.1 Circulation Vents

Provide open circulation vents on the roof in accordance with API Std 650, Appendix H. Open vents shall have a weatherhood, with corrosion-resistant steel bird screen with 1/4 inch opening and 0.135 inch minimum wire diameter.

2.12.9 Circumferential Stairway and Platform

OSHA 29 CFR 1910.24 and 29 CFR 1910.23. Support the stairway completely on the shell of the tank with ends of the stringers clear of the ground, and at an angle of approximately 45 degrees. Construct stairway entirely of steel with treads of grating or an approved antislip floor plate. Railing shall be continuous around the platform except for access openings. At access openings, any space wider than 6 inches between the tank and the

platform shall be floored.

2.12.10 Ladders

OSHA 29 CFR 1910.27. Provide vertical interior ladders extending from the roof manholes to the tank bottom. Provide drainage for horizontal surfaces such as stairs and floored surfaces made from steel plates.

2.12.11 Roof Manholes

Provide one manhole per tank construction drawings for access to the interior of the tank through the roof. Locate one manhole adjacent to the platform of the stairway. Provide manhole with safety handrails and located directly over the interior ladders. Provide hinged and weathertight manhole covers with a formed fit.

2.12.12 Shell Access Holes

Provide three 36 inch diameter access holes. Locate the access holes in the tank shell as shown on the tank construction drawings. Provide access holes with welded steel plate frames and covers. Secure the cover plates with corrosion-resistant bolts and nuts. Provide access holes with gaskets and smooth gasket seats.

2.12.13 Floating Pan Installation Hatch

Provide a floating pan installation hatch on the fixed roof per tank construction drawings and floating pan manufacturer's requirements.

2.12.14 Roof Perimeter Guardrail

Construction and finishing of roof perimeter handrail shall be similar to the stairway. Toe-plates shall be provided.

2.12.15 Fittings and Piping

Provide fittings and piping and other miscellaneous items as necessary to permit tank operations.

2.12.15.1 Product Inlet Connections

Product inlet connections shall consist of an external flange, a nozzle through the tank shell, supports, and an internal expanding cone, as indicated on the construction drawings. The flange shall be 150 pound, conforming to ASME B16.5 with slip-on or welded neck.

2.12.15.2 Product Outlet Connection

Product outlet connection shall consist of an external flange, a nozzle through the tank shell, internal flanges, elbows, product withdrawal line assembly, and supports, as indicated on the construction drawings.

2.12.15.3 Water Drawoff Connection

Water drawoff connection shall consist of an external flange or coupling, nozzle andpipe through the tank shell, supports, and fittings to a point 2 inches above the bottom of the center sump, as indicated on the construction drawings.

2.12.16 Scaffold Cable Support

Provide scaffold cable support on the tank roof in accordance with API Std 650. Locate the support near the center of the tank and in a manner that supported cables will have maximum range and flexibility of operation with minimum interference with other tank fittings.

2.13 FLEXIBLE MEMBRANE LINER (FML)

The FML shall demonstrate the acceptable limits of the properties listed under Table 1. The FML shall be factory produced from a base fabric that is completely covered with a polymer. The base fabric shall weigh no less than 13 ounces per square yard and be made of aramid (kevlar), polyester, or nylon. The FML shall have an overall finished weight no less than 30 ounces per square yard. Factory seams shall be made with a 2 inch overlap plus or minus 1/4 inch by an automatic thermal high-pressure welding process. The FML shall retard the growth of mildew and be capable of containing the liquid stored, withstanding temperatures up to 180 degrees F, withstanding humidity up to 99 percent relative humidity, and withstanding direct exposure to sunlight.

2.13.1 Job Lot of FML

A job lot of FML is defined by this specification as the amount of FML product that can be produced from a singular mixture of chemicals. Any FML material created from a new or altered mixture of chemicals shall be considered a new job lot.

2.13.2 FML Samples

Twenty four samples shall be cut from every job lot of FML. Each sample shall be approximately 8 1/2 by 11 inches in size. Eight of the samples shall be cut across factory seams.

2.13.3 FML Factory Test

Each manufacturer's job lot of FML shall have each of the FML properties verified by the factory test procedures and methods listed below. No substitute methods shall be allowed for verification of any property. Each separate verification of a property shall be made on a separate sample. The FML shall demonstrate through factory testing the acceptable limits of the following properties listed in Table 1. The properties shall be verified by each of the test standards listed.

TABLE 1. Standards and Limits for FML Properties

Property	Acceptable Limits	Test Standard	Notes
Minimum Overall Finished Thickness	32 mils	ASTM D751	
Minimum Tear Strength	40 pounds (ibd)	ASTM D751 Tongue Method	(Warp & Fill)
Minimum Adhesion Strength	20 pounds per inch	ASTM D751	

TABLE 1. Standards and Limits for FML Properties

Property	Acceptable Limits	Test Standard	Notes
Minimum FML (MTS)	1000 pounds (ibd)	ASTM D751 Grab Method	(Warp & Fill)
Minimum FML (MTS)	600 pounds (ibd)	ASTM D751 Cut Strip Method	(Warp & Fill)
Minimum FML Seam Shear Strength	See Note 1	ASTM D751 Section 53	
Minimum Abrasion Resistance	5,000 cycles	ASTM D3389	See Note 2
Minimum Withstanding of Accelerated Weathering	1,000 hours	ASTM D2565	See Note 3
Minimum Bursting Strength	1,500 pounds	ASTM D751 Ball Tip Method	
Maximum Stiffness	30,000 pounds (ibd)	ASTM D747	
Hydrostatic Resistance	500 pounds per square inch	ASTM D751	
Maximum Permeability	0.10 ounces per square foot per 24 hours	ASTM E96/E96M Procedure BW	See Note 4
Fuel Compatibility	No Delamination, No Bubbles, No Discoloration	See Note 5	
Maximum Volume Swell (Coating Compound Only)	15 percent of original	See Note 6	
Maximum Weight Gain or Loss	10 percent of original	See Note 5	

Table Abbreviations:
(ibd) in both direction
(MTS) Material Tensile Strength

Notes:

1. The acceptable limit for the seam shear strength shall be 95 percent of the minimum (MTS) property using the Strip Method.
2. Test until fabric exposure with a H-22 wheel loaded to 1,000 grams.
3. Manufacturer's certification of the FML, instead of actual factory testing, may be considered acceptable for the Minimum Withstanding of Accelerated Weathering if the certification verifies that the acceptable limits listed were previously achieved using the test standard listed. Data from either a manufacturer's certification or an actual factory test

shall verify that no visible cracking or appreciable changes resulted as a result of the testing.
4. The test shall be performed using the Inverted Water Method with ASTM Fuel B.
5. Testing shall be performed in accordance with ASTM D543 by immersion in ASTM Fuel B for 14 continuous days at room temperature.
6. Testing shall be performed in accordance with ASTM D471.

2.13.4 FML Ring Wall Sealant

The FML ring wall sealant shall be compatible with the FML, concrete, and the fuel being stored.

2.13.5 FML Components

Components such as sleeves, boots, etc., shall be factory prefabricated from the FML material and have the same fabrication characteristics.

2.13.6 Fuels for Testing FML

Materials, other than the FML, shall be resistant to the fuel being stored. Fuels as required or mentioned by this specification shall be in accordance with the following:

2.13.6.1 JP-8

Fuel shall be in accordance with MIL-DTL-83133.

2.14 NONWOVEN GEOTECHNICAL FABRIC

Nonwoven geotechnical fabric shall be placed just beneath the FML liner underneath the tank bottom on top of the sand. See Specification Section 33 56 63 FUEL IMPERMEABLE LINER SYSTEM, FOR NONWOVEN GEOTEXTILE FABRIC.

2.15 ANTISEIZE COMPOUND

Provide antiseize compound for fasteners on tank exterior flanges and bolted connections and covers. Provide MIL-PRF-907 compound on steel fasteners. Provide an approved antiseize compound for stainless steel fasteners. Do not use MIL-PRF-907 compound on stainless steel. On tank interior fasteners, use oil only.

2.16 SAND CUSHION

Cushion shall be located on top of the flexible membrane liner (FML) and beneath the tank bottom plates. Cushion shall be a minimum of 8 inches thick and be fine sand aggregate in accordance with ASTM C33/C33M. Cushion shall contain no more than 25 parts per million (ppm) chlorides, no more than 30 ppm sulfates, and have a pH greater than 7. Magnesium sulfate shall be used in the ASTM C88 soundness test.

PART 3 EXECUTION

3.1 SAFETY PRECAUTIONS

API RP 2009 for fire and explosion hazard areas.

2.2.1.3 Epoxy Topcoat

Epoxy polyamide, MIL-DTL-24441/31 (Formula 152, Type IV, White).

2.3 COATING SAMPLE COLLECTION AND SHIPPING KIT

Provide a kit that contains one quart can for the base of each coating material, an appropriately sized can for each activator, dipping cups for each component to be sampled, a shipping box sized for the samples to to be shipped, and packing material. Mark cans for the appropriate component. Provide shipping documents, including either pre-paid shipping or a shipper number that can be used by the QC Manager to arrange pickup, addressed to the approved coating testing laboratory.

2.4 ABRASIVE SAMPLE COLLECTION AND SHIPPING KIT

Provide a kit that contains one suitable plastic bag or container for each sample to be collected. Mark containers for the appropriate component. Provide shipping documents, including either pre-paid shipping or a shipper number that can be used by the QC Manager to arrange pickup, addressed to the approved coating testing laboratory.

2.5 TEST KITS

2.5.1 Test Kit for Measuring Chloride, Sulfate and Nitrate Ions on Steel and Coated Surfaces

Provide test kits called CHLOR*TEST CSN Salts, as manufactured by CHLOR*RID International Inc. of Chandler, Arizona (www.chlor-rid.com) or equal. An "equal" test kit shall meet the following requirements:

a. Kit contains all materials,supplies, tools and instructions for field testing and on-site quantitative evaluation of chloride, sulfate and nitrate ions;

b. Kit extract solution is acidic, factory pre-measured, pre-packaged, and of uniform concentration;

c. Kit components and solutions are mercury free and environmentally friendly;

d. Kit contains new materials and solutions for each test extraction;

e. Extraction test container (vessel, sleeve, cell. etc.) creates a sealed, encapsulated environment during salt ion extraction;

f. Test extract container is suitable for testing the following steel surfaces: horizontal (up/down configuration), vertical, flat, curved, smooth, pitted, and rough;

g. All salt ion concentrations are directly measured in micrograms per square centimeter.

2.5.2 Test Kit for Identifying Amine Blush on Epoxy Surfaces

After coating and/or primer has hardened and prior to applying the next coat, test for unreacted amines using the AMINE BLUSH CHECK, manufactured by Elcometer, Rochester Hills, Michigan, or equal. To be considered for approval as an "equal" test kit it shall meet the following requirements:

	Removal Operations
SSPC PA 1	(2000; E 2004) Shop, Field, and Maintenance Painting of Steel
SSPC PA 2	(2004) Measurement of Dry Coating Thickness With Magnetic Gages
SSPC QP 1	(1998; E 2004) Standard Procedure for Evaluating Painting Contractors (Field Application to Complex Industrial Structures)
SSPC QP 5	(1999; E 2004) Standard Procedure for Evaluating the Qualifications of Coating and Lining Inspection Companies
SSPC QS 1	(2004) Standard Procedure for Evaluating a Contractor's Advanced Quality Management System
SSPC SP 1	(1982; E 2004) Solvent Cleaning
SSPC SP 10/NACE No. 2	(2007) Near-White Blast Cleaning
SSPC SP 7/NACE No.4	(2007) Brush-Off Blast Cleaning
SSPC SP COM	(2004) Surface Preparation Commentary for Steel and Concrete Substrates
SSPC VIS 1	(2002; e 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-22262	(1993; Rev B; Am 2 1996) Abrasive Blasting Media Ship Hull Blast Cleaning
MIL-DTL-24441	(2009; Rev D) Paint, Epoxy-Polyamide, General Specification for
MIL-DTL-24441/19	(2009; Rev C) Paint, Epoxy-Polyamide, Zinc Primer, Formula 159, Type III
MIL-DTL-24441/31	(2009; Rev B) Paint, Epoxy-Polyamide, White, Formula 152, Type IV
MIL-PRF-85285	(2012; Rev E) Coating: Polyurethane Aircraft and Support Equipment
MIL-STD-161	(2005; Rev G; Notice 1 2010) Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev C; Notice 1) Colors Used in

Contractor representatives, including at a minimum, project superintendent and QC manager, paint foreman, coating inspector, and PCS shall have a pre-application coating preparatory meeting. This meeting shall be in addition to the pre-construction conference. Specific items addressed shall include: corrective action requirements and procedures, coating work plan, safety plan, coordination with other Sections, inspection standards, inspection requirements and tools, test procedures, environmental control system, safety plan, and test logs. Notify Contracting Officer at least ten days prior to meeting.

1.5 PRODUCT DATA

1.5.1 Joint Sealant Instructions

Submit manufacturer's printed instructions including detailed application procedures, minimum and maximum application temperatures, and curing procedures. Include materials safety data sheets (MSDS) for materials to be used at the job site in accordance with 29 CFR 1926.59.

1.5.2 Coating System Instructions

Submit manufacturer's printed instructions including detailed mixing and application procedures, number and types of coats required, minimum and maximum application temperatures, and curing procedures. Include materials safety data sheets (MSDS) for materials to be used at the job site in accordance with 29 CFR 1926.59.

1.6 DELIVERY AND STORAGE

Ship, store, and handle materials in accordance with SSPC PA 1, and as modified in this Section. Maintain temperature in storage spaces between 40 and 85 degrees F, and air temperature more than 5 degrees F above the dew-point at all times. Inspect materials for damage prior to use and return non-compliant materials to manufacturer. Remove materials with expired shelf life from government property immediately and notify the Contracting Officer.

If materials are approaching shelf life expiration and an extension is desired, samples may be sent to the manufacturer, along with complete records of storage conditions, with a request for shelf life extension. If the manufacturer finds the samples and storage data suitable for shelf life extension, the manufacturer may issue an extension, referencing the product evaluation and the review of storage records. Products may not be extended longer than allowed in the product specification.

1.7 COATING HAZARDS

Ensure that employees are trained in all aspects of the safety plan. Specified coatings may have potential health hazards if ingested or improperly handled. The coating manufacturer's written safety precautions shall be followed throughout mixing, application, and curing of the coatings. During all cleaning, cleanup, surface preparation, and paint application phases, ensure that employees are protected from toxic and hazardous chemical agents which exceed concentrations in 29 CFR 1910.1000. Comply with respiratory protection requirements in 29 CFR 1910.134. The CIH shall approve work procedures and personal protective equipment.

1.8 JOB SITE REFERENCES

Make available to the Contracting Officer at least one copy each of ASTM D3276, ASTM D3925, ASTM D4285, ASTM D7127, SSPC SP COM, SSPC SP 1, SSPC SP 7/NACE No.4, SSPC SP 10/NACE No. 2, SSPC PA 1, SSPC PA 2, SSPC Guide 6, SSPC VIS 1, SSPC QP 1, SSPC QS 1, and an SSPC Certified Contractor Evaluation Form at the job site.

PART 2 PRODUCTS

2.1 JOINT SEALANT

TT-S-00230, Type II, Class B

2.2 COATING SYSTEM

Alternate systems or products will not be considered. All primer, intermediate coat and topcoat materials shall be supplied by one supplier. The entire coating system is intended to be applied in the field. Alternatively, surface preparation may be accomplished in the shop, following all temperature, humidity, and testing requirements listed herein, followed by an application of a hold-primer. Remove all shop-applied primer prior to final field surface preparation and coating system application. Adjust all shop preparation to avoid conflicts with final surface preparation requirements.

The Military specification epoxy and polyurethane products specified in this Section do not require approval for listing on the QPL prior to contract award, as indicated in paragraph 3.2 of MIL-DTL-24441 and paragraph 3.1 of MIL-PRF-85285. Testing of products by an independent laboratory to the QUALIFICATION INSPECTION requirements of MIL-DTL-24441 and MIL-PRF-85285prior to contract award is required. See specific submittal requirements in paragraph QUALITY ASSURANCE.

2.2.1 Zinc-Rich Epoxy Primer Coat

Epoxy polyamide, MIL-DTL-24441/19 (Formula 159, Type III).

2.2.2 Epoxy Intermediate Coat

Epoxy polyamide, MIL-DTL-24441/31 (Formula 152, Type IV, White (Tinted)). Tint to approximately FED-STD-595 color number 27778 parchment using pigment dispersions prepared for epoxy paint tinting. Manufacturer shall tint material and appropriately label. All other requirements of this Military Specification apply.

2.2.3 Polyurethane Topcoat

Polyurethane coating topcoat of MIL-PRF-85285, Type II Beige FED-STD-595 color number 27769 in gloss.

Modify paragraph 3.6.4 of MIL-PRF-85285, Viscosity and Pot Life, as follows:

The viscosity of the admixed coating, when tested in accordance with ASTM D1200 through a No. 4 Ford cup, shall be as follows:

Time from mix (minimum)	Maximum time through a No. 4 Ford cup
Initially	30 seconds
2 hours	60 seconds
4 hours	No gel

Modify paragraph 3.7.1 of MIL-PRF-85285, Drying Time, as follows:

When applied by spray techniques and when tested in accordance with ASTM D1640, the coating shall be set-to-touch within four hours and dry-hard within eight hours (see 4.6 and table I).

2.3 COLOR IDENTIFICATION OF FUEL HANDLING AND STORAGE FACILITIES

Piping, conduit, and tank identification shall be in accordance with MIL-STD-161. Mark direction of fluids in accordance with MIL-STD-161. The NATO symbol for JP-8 is F-34.

2.4 COATING SAMPLE COLLECTION AND SHIPPING KIT

Provide a kit that contains one quart can for the base of each coating material, an appropriately sized can for each activator, dipping cups for each component to be sampled, a shipping box sized for the samples to to be shipped, and packing material. Mark cans for the appropriate component. Provide shipping documents, including either pre-paid shipping or a shipper number that can be used by the QC Manager to arrange pickup, addressed to the approved coating testing laboratory.

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2.6 TEST KITS

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a. Kit contains all materials,supplies, tools and instructions for field testing and on-site quantitative evaluation of chloride, sulfate and nitrate ions;

b. Kit extract solution is acidic, factory pre-measured, pre-packaged, and of uniform concentration;

c. Kit components and solutions are mercury free and environmentally friendly;