UL 2085

Underwriters Laboratories Inc.

Standard for Safety

Protected Aboveground Tanks for Flammable and Combustible Liquids

UL Standard for Safety for Protected Aboveground Tanks for Flammable and Combustible Liquids, UL 2085

Second Edition, Dated December 30, 1997

Summary of Topics

This revision is being made to update the title page to indicate that the standard is no longer an American National Standard.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

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UL 2085

Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids

The first edition was titled Insulated Aboveground Tanks for Flammable and Combustible Liquids.

First Edition – December, 1994

Second Edition

December 30, 1997

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at http://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover shop fabricated, aboveground atmospheric Protected Tanks intended for storage of stable flammable, or combustible liquids that have a specific gravity not greater than 1.0 and that are compatible with the material and construction of the tank.

Revised 1.1 effective December 30, 1998

1.2 These requirements do not cover Fire Resistant Tanks which are intended for installation and use in accordance with the Automotive and Marine Service Station Code, NFPA 30A. These tanks are covered in UL's Outline of Investigation for Fire Resistant Tanks for Flammable and Combustible Liquids, Subject 2080.

Revised 1.2 effective December 30, 1998

1.3 These tank constructions are intended to limit the heat transferred to the primary tank when the construction is exposed to a 2-hour hydrocarbon pool fire and are provided with protection from physical damage. Tanks appropriately identified by product markings provide additional protection for the primary tank against projectile impact and vehicle impact.

1.4 These tanks shall be provided with integral secondary containment intended to prevent any leakage from the primary tank from entering the environment.

Added 1.4 effective December 30, 1998

1.5 Protected Tanks are intended for stationary installation and use in accordance with the Uniform Fire Code, published by the International Fire Code Institute; the Flammable and Combustible Liquids Code, NFPA 30; and the Automotive and Marine Service Station Code, NFPA 30A.

1.6 Tanks covered by these requirements are fabricated, inspected, and tested for leakage before shipment from the factory as completely assembled units.

1.7 These requirements and tests are not intended to determine a tank's acceptability for use after fire exposure, vehicle impact, or projectile impact.

1.8 These requirements do not address methods of anchoring which may be required to prevent uplift from flooding or movement due to wind or seismic forces.

1.9 These requirements do not address either the construction, or attachment means of ladders, stairs, runways, guardrails, platforms, or equipment supports.

1.10 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this Standard, and that involves a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements to determine that the level of safety as originally anticipated by the intent of this Standard is maintained. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this Standard shall not be judged to comply with this Standard. Where appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this Standard.

1.10 revised May 7, 1999

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

2.1.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

2.1.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.1.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

2.1.5 Components of a Protected Tank shall be evaluated for their intended use. A component designed to perform the functions of two or more individual components is acceptable when it has been determined that it complies with the applicable requirements in this standard.

2.2 Units of measurement

2.2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

2.3 Undated references

2.3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

3 Glossary

3.1 For the purpose of this standard the following definitions apply.

3.2 ATMOSPHERIC TANK – A storage tank that has been constructed to operate at pressures between minus 1.0 psig (minus 6.8 kPa) and 1.0 psig (6.8 kPa) measured at the top of the tank.

3.3 INTERSTITIAL SPACE – (Annulus) The space between the primary tank and the secondary containment wall that is capable of being monitored for leakage. The interstitial space may be void, contain thermal insulating material, or contain other materials.

3.4 PRIMARY TANK – A single-wall atmospheric tank intended for stationary installation having a liquid capacity exceeding 60 gallons (230 l).

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3.5 PROTECTED TANK – An aboveground atmospheric tank with secondary containment and an insulation system intended to reduce the heat transferred to the primary tank when the tank is exposed to a hydrocarbon pool fire, and provided with protection from physical damage.

3.6 SECONDARY CONTAINMENT – A structure that has a permeability not more than 4×10^{-8} inches/second (10^{-7}cm/s) for the stored fluids, is external to and forms an interstitial space with the primary tank, and contains the entire contents of the primary tank in the event of a rupture or leak.

CONSTRUCTION

4 General

4.1 All materials used in the construction of a Protected Tank shall be compatible with the product stored.

4.2 When dissimilar materials are used in the construction of a Protected Tank such that corrosion occurs, they shall be isolated from each other.

4.3 Exposed surfaces subject to atmospheric degradation shall be treated by a coating or similar means to protect the surface during storage and transit to the installation site.

4.4 For initial type testing, physical properties of construction materials, such as the tensile strength of steel or the compressive strength of concrete, shall be documented in accordance with standard test methods.

4.5 Requirements in this standard, when different from requirements found in referenced UL Standards, shall supersede those requirements.

5 Primary Tank

5.1 Primary steel tanks shall comply with the applicable requirements in the Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids, UL 142. Primary fiberglass reinforced plastic tanks shall comply with the applicable requirements in the Standard for Glass-Fiber-Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-Gasoline Mixtures, UL 1316, as indicated in Table 5.1.

5.2 The method for providing structural support for a nonmetallic primary tank shall be evaluated.

5.3 A primary tank shall have a capacity greater than 60 gallons (230 l).

5.4 All openings shall be located along the top of the tank above the maximum normal liquid level.

Table 5.1
Summary of applicable requirements for fiberglass reinforced plastic (FRP) primary and secondary containment tanks

Requirements applicable to FRP primary and secondary containment tanks from the Standard for Glass-Fiber-Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-Gasoline Mixtures, UL 1316
Section 2 – Components
Section 3 – Construction, General
Section 4 – Pipe Connections, 4.1 (fittings) only
Section 5 – Manholes, 5.2 (manhole-cover joint) only
Section 7 – Performance, General
Section 8 – Leakage Test
Section 11 – Water-Load Test
Section 12 – External Pressure Test
Section 13 – Internal Pressure Test
Section 14 – Physical Properties of Materials Tests
Section 15 – Earth-Load Test
Section 16 – Annulus Proof-Pressure Test
Section 17 – Leakage Test (Production)
Section 18 – Internal Vacuum Test (Production)
Section 19 – Surface Cure Test (Production)

6 Secondary Containment and Interstitial Space

6.1 All enclosed spaces that could contain leakage from the primary tank shall be evaluated as interstitial spaces for secondary containment.

Added 6.1 effective December 30, 1998

6.2 Secondary containment shall be constructed to catch a leak from any location of the primary tank and contain the entire contents in the event that a leak occurs.

6.3 Secondary containment surfaces shall have a permeability of not more than 4×10^{-8} inches/second (10^{-7}cm/s) with the store fluids as determined using the Standard Test Methods for Water Vapor Transmission of Materials, ASTM E96.

6.4 Secondary containment shall be constructed to prevent rain or debris from entering the interstitial space.

6.5 The interstitial space shall have provisions for monitoring leaks from the primary tank and for detecting secondary containment loss of integrity.

6.6 Secondary containment shall be constructed so that it does not interfere with emergency venting of the interstitial space.

6.7 Secondary containment shall either be provided with an emergency vent device or a form of construction that relieves excessive internal pressure.

6.8 All fittings that penetrate the secondary containment structure shall be permanent and terminate above the maximum liquid level.

7 Normal and Emergency Venting

7.1 Each primary containment tank and each compartment of a multi-compartment tank shall have provision for both normal and emergency venting. The interstitial space of the secondary containment structure shall also have provision for emergency venting. Vent devices used for emergency venting, shall be assembled to, or provided with, each tank.

Revised 7.1 effective December 30, 1998

7.2 Normal and emergency vents shall be sized in accordance with the Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids, UL 142.

7.3 A long-bolt manway shall not be used for emergency venting in lieu of an emergency vent device.

Revised 7.3 effective December 30, 1998

7.4 A weak shell to roof seam shall not be used for emergency venting of the primary tank.

8 Spill Containers

8.1 Spill containers, when provided, shall comply with applicable installation requirements. When these accessories are to be installed in the field, each fill opening shall be marked as indicated in 30.1(g).

8.2 Spill containers shall have a minimum 5 gallon (20 l) capacity.

8.3 Spill containers shall be constructed of non-combustible material.

8.4 A drain valve, or other means to keep the spill container empty, shall be provided.

8.5 A lid shall be provided for each spill container. The lid shall be constructed to prevent rain and debris from entering the container.

9 Supports

9.1 When provided, tank supports shall be constructed in accordance with the applicable requirements in the Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids, UL 142.

10 Grounding

10.1 A means shall be provided for the attachment of at least two grounding conductors sized in accordance with NFPA 780, Installation of Lightning Protection Systems.

Added 10.1 effective December 30, 1998

10.2 Instructions as specified in 32.1 shall be provided to detail all proper grounding connections.

Added 10.2 effective December 30, 1998

PERFORMANCE

11 Samples and Test Selection

11.1 General

11.1.1 Unless otherwise indicated, samples subjected to the following tests shall be empty and shall include construction features, materials, and workmanship that are representative of those used in tanks produced at the manufacturer's facility. Appendix B provides a summary of performance tests and requirements.

11.1.2 A single tank sample shall be subjected to all of the following tests in Sections 12 – 16.

11.1.3 At the conclusion of the tests specified in 11.1.2, the same sample, when determined to be usable, may be subjected to the remaining tests in Sections 17 – 25. If not, a new sample shall be used for the remaining tests. Tests specified in the Vehicle Impact Test, Section 20, and the Projectile Test, Section 21, are optional.

11.1.4 The following tests are not required for tanks that use a minimum of six inches of concrete as the insulation or an external steel wall that provides protection for the insulation:

a) The Ball Impact Test, Section 15, and

b) The Environmental Exposure and Small Scale Fire Test, Section 23.

11.2 Full scale fire test samples

11.2.1 When test results are to be applied to multiple tank sizes, the size of the tank sample to be tested is to be that tank with the greatest ratio of fire exposed surface area to actual tank volume.

11.2.2 Venting devices for normal and emergency venting are to be installed as intended according to the manufacturer's recommendations. All other openings are to be capped or otherwise sealed.

11.2.3 All primary tank internal equipment required for the operation of the tank and which conducts heat into the tank (such as fill pipes, automatic fuel shutoff, and anti-siphon devices) are to be installed in the test tank.

11.2.4 All equipment external to the tank, not installed during the test, is to be represented by an uninsulated, capped Schedule 40 steel pipe nipple having a minimum exposed length of 6 inches (15 cm). The pipe diameter shall be consistent with the opening and is not to be less than 1.5 inches (38.1 mm).

11.2.5 Non-ferrous external appurtenances that are intended to be installed on the tank fittings are to be installed during the test.

11.2.6 Not less than 12 thermocouples are to be distributed uniformly on the interior surface of the primary tank with not more than nine square feet (0.84 m^2) per thermocouple and not less than two thermocouples per end. Thermocouples are not to be placed closer than 12 inches (30.5 cm) to any tank opening.

11.2.7 Not less than two thermocouples are to be installed on each structural support that holds the tank 12 inches (30.5 cm) or more above grade.

11.2.8 The thermocouples are to be fabricated from minimum 0.032 inch (0.8 mm) diameter (No. 20 B & S gauge) Type K, chromel-alumel wires or equivalent having a time constant of 2 seconds or less.

11.3 Environmental exposure and small scale fire test samples

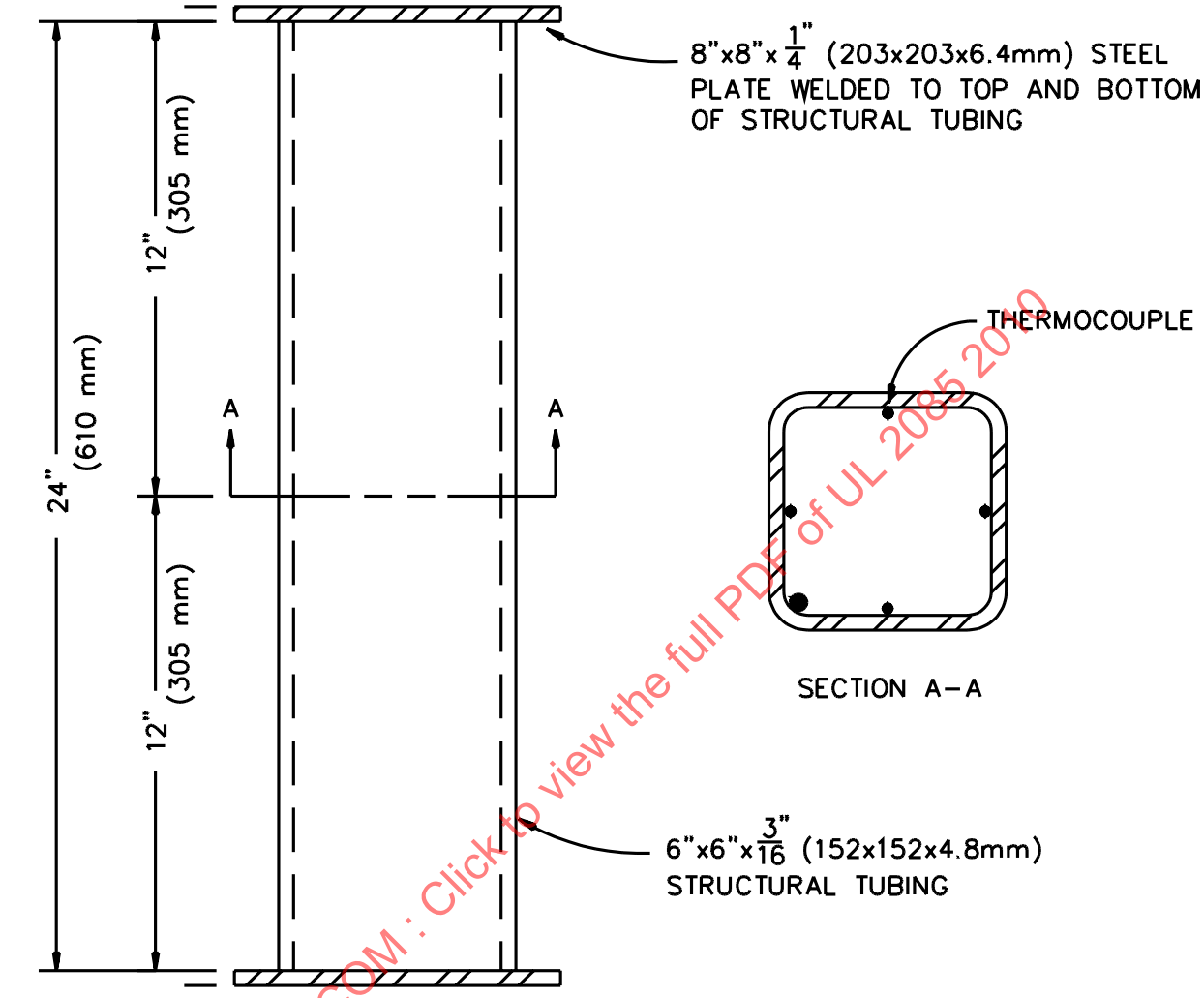
11.3.1 Test samples are to consist of 2-foot by 6-inch by 6-inch (610- by 152- by 152-mm) structural steel tubes with 3/16-inch (4.8-mm) wall thickness. The steel tubes are to be provided with steel caps and covered with the insulation material in the minimum thickness being investigated. Figure 11.1 shows the details of a test sample prior to application of the insulation material.

11.3.2 The temperatures of the test sample are to be measured by five Type K thermocouples having a time constant not greater than 2 seconds and located within the steel tube as shown in Figure 11.1. The thermocouples are to be fabricated by fusion-welding the twisted ends of 0.064-inch (1.6-mm) diameter (No. 14 B & S gauge) chromel-alumel wires having a time constant of 2 minutes or less, and mounting the wires in porcelain insulators. The thermocouple assembly is to be inserted through a standard weight, nominal 1/2-inch (12.7-mm) iron, steel, or inconel pipe. The end of the pipe from which the welded junction protrudes is to be open. The thermocouple junction is to protrude 1/2 inch (12.7 mm) from the open end of the pipe.

11.3.3 Three as received samples are to be subjected to the furnace environment as described in 17.2. The thickness of the insulating material shall be such that the time at which the test sample reaches an average temperature rise of 260°F (144°C), and no individual temperature rise greater than 400°F (204°C), is not less than 50 minutes nor greater than 90 minutes after the beginning of the test. This time is to be defined as the control period. If necessary, the thickness of the protective material is to be varied from one test sample to another to determine the thickness necessary for compliance with this requirement. This thickness, once determined, is to be the thickness applied to subsequent test samples.

Figure 11.1
Test sample and thermocouple location

Figure 11.1 revised May 7, 1999



12 Pipe Fitting Torque Strength Test

12.1 Where fittings and their method of attachment differ from those described in the applicable standard specified in 5.1, each fitting construction shall be subjected to this test. The fitting shall not crack or split, the threads shall not strip, and the tank and insulation system shall show no signs of damage.

12.2 A length of Schedule 40 pipe is to be threaded into a fitting for the pipe connection and tightened to the torque specified in Table 12.1.

Table 12.1
Torques on pipe fittings

Nominal pipe size, inches[a]	Torque, lb-inches
3/4	2000
1	2400
1-1/4	2900
1-1/2	3100
2	3300
2-1/2	3500
3	3600
3-1/2	3700
4	3800
6	4200
8	4600

[a] Nominal pipe size specifications are in accordance with the Standard for Welded and Seamless Wrought Steel Pipe, ANSI/ASME B36.10M.

13 Pipe Fitting Bending Moment Strength Test

13.1 Where fittings and their method of attachment differ from those described in the applicable standard specified in 5.1, each fitting construction shall be subjected to this test. The fitting shall not crack or split, and the tank and insulation system shall show no signs of damage.

13.2 A 4-foot (1.2-m) length of Schedule 40 steel pipe is to be threaded into the fitting. A force is then to be applied to the top of the pipe. The force is to be first applied parallel to the longitudinal axis of the tank and then transverse to the longitudinal axis of the tank. The applied force is to be increased so that the bending moment is increased from zero to 2000 lb-ft (2712 N·m) in 250 lb-ft (339 N·m) increments. Whenever the Schedule 40 pipe bends before the required bending moment is reached, the test is to be stopped and the fitting examined for compliance with the requirements in 13.1.

14 Lift Fitting Strength Test

14.1 Each fitting or device intended to be used to lift and move a tank shall be subjected to this test. The fitting or device shall withstand a load equal to twice that imposed by lifting the empty tank for one minute. When more than one fitting is provided on a tank, the load is to be divided between the fittings in proportion to the load to which they are subjected by lifting the tank as intended. Neither the fitting nor the tank shall be damaged.

15 Ball Impact Test

15.1 The tank is to be subjected to six impacts from a 4-inch (102-mm) diameter steel ball having an impact energy of 72 ft-lbs (97.9 N·m). The top, sides, corners, and fittings of the tank are to be tested with no two impacts on the same point. The tank and the insulation system shall not show signs of damage as a result of this test.

16 Load Test

16.1 For flat-top tank constructions, a 1,000-lb (454-kg) load is to be applied over a 12- by 12-inch (30.5- by 30.5-cm) surface at various places on the top surface of the tank near the center of the longest unsupported span to determine the worst case condition. The load is to be sustained for 1 minute at each location. The tank surface shall not show signs of permanent deformation as a result of this test.

17 Full Scale Fire Test

17.1 Performance criteria

17.1.1 The temperatures recorded on the primary tank any time during the two-hour fire exposure shall not exceed an average maximum temperature rise of 260°F (144°C) and a maximum temperature of any single thermocouple of 400°F (204°C).

17.1.2 Temperatures recorded on structural supports which hold the Protected Tank 12 inches (30.5 cm) or more above grade shall not exceed a temperature of 1000°F (540°C). The supports shall not collapse.

17.1.3 The emergency venting shall not be impaired as a result of the fire exposure. This shall be determined by visual examination after the test.

17.1.4 Immediately following the fire test, the tank is to be subjected to the Hose Stream Test, Section 18, followed by the Leakage Test, Section 22. The primary containment tank shall not leak.

17.2 Furnace details

17.2.1 The two hour furnace control, calibration, and temperature curve shall be in accordance with requirements from the Standard for Rapid Rise Fire Tests of Protection Materials for Structural Steel, UL 1709.

17.3 Test method

17.3.1 Within 72 hours prior to the fire test, information on the actual moisture content and distribution within the sample is to be recorded.

17.3.2 The ambient air temperature at the beginning of the test is to be within the range of 50 – 90°F (10 – 32°C).

17.3.3 The temperature of the primary tank and structural supports is to be measured by the thermocouples installed as detailed in Samples and Test Selection, Section 11. Thermocouple readings are to be recorded at the beginning of the test and at intervals not to exceed five minutes during the two-hour test.

17.3.4 The test sample is to be subjected to the fire environment for two hours, and maximum temperatures are to be recorded during the fire exposure.

18 Hose Stream Test

18.1 Immediately after the Full Scale Fire Test, Section 17, the tank is to be removed from the furnace and subjected to a hose stream impact. The hose stream is to be applied for 2-1/2 minutes for every 100 square feet (10.8 square meters) of surface area. The minimum test duration is to be 2-1/2 minutes for samples with surface areas less than 100 square feet.

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18.2 The stream is to be delivered at a pressure of 30 psig (207 kPa) through a 2-1/2 inch (63.5 mm) diameter hose and discharged through play pipe constructed in accordance with the Standard for Play Pipes for Water Supply Testing in Fire-Protection Service, UL 385. The play pipe is to be equipped with a 1-1/8-inch (28.6-mm) discharge tip of the standard-taper, smooth-bore pattern without a shoulder at the orifice. The water temperature is to be within the range of 50 – 70°F (10 – 21°C).

18.3 The nozzle orifice is to be located 20 feet (6.1 m) from the center of the nearest exposed surface.

18.4 The hose stream is first to be directed at the center of the test specimen located closest to the nozzle, and then to all parts of the exposed surface accessible from the nozzle location, with changes in direction being made slowly.

18.5 Following this test, the primary tank shall show no signs of leakage when subjected to the leakage test for primary tanks in 22.2.

19 Tank Support Load Test

19.1 A tank provided with integral supports shall show no evidence of permanent deformation to the tank or damage to the supports when tested as described in 19.2.

19.2 The tank is to be completely filled with water. An evenly distributed load equal to the weight of the filled tank is to be placed across the top of the filled tank on a line parallel to the longitudinal axis of the tank. The tank and supports shall withstand this load for 2 minutes.

20 Vehicle Impact Test

20.1 The primary tank is to be empty and subjected to the test described in 20.2. Structural information provided by the tank manufacturer is to be used to determine the worst case tank to test in a series of tanks.

20.2 For the test, the tank is to be installed and anchored in accordance with the manufacturer's instructions. The portion determined to be most vulnerable to vehicle impact is to be subjected to a single impact of 12,000-lb (5455-kg) force applied at 10 mph (14.7 ft/s) or equivalent impact energy. The impact is to be applied using a minimum 1/2-inch (12.5-cm) thick steel plate having a frontal surface area 12 inches by 12 inches (0.093 m^2) at a height of 18 inches (457.2 mm) centered above grade level.

20.3 Following this test, the primary tank shall show no signs of leakage when subjected to the leakage test for primary tanks in 22.2.

21 Projectile Test

21.1 An empty tank is to be subjected to five shots of 150-grain M-2 ball ammunition, having a muzzle velocity of 2700 feet per second (823 m/s), fired from a .30 caliber rifle at a distance of 100 feet (30.4 m). The bullet is to be fired perpendicular to the point of impact on the tank wall determined to be most vulnerable. The shots are to be placed independently of each other and within a 3-foot by 3-foot (0.9-m by 0.9-m) area on the tank surface.

21.2 Following the projectile test, the primary tank shall show no signs of leakage when subjected to the leakage test for primary tanks in 22.2.

22 Leakage Test

22.1 General

22.1.1 The leakage test is to be conducted on the primary tank in accordance with 22.2 and the secondary containment in accordance with 22.3. There shall be no evidence of leakage.

22.2 Primary tank

22.2.1 The one-hour leakage test is to be conducted by either of the methods described in (a) or (b) below. There shall be no evidence of leakage following this test.

a) Applying internal air pressure for a minimum of one hour. For a horizontal or rectangular tank, the test pressure is not to be less than 3 psig (21 kPa) nor more than 5 psig (35 kPa). For a vertical tank, the test pressure is not to be less than 1-1/2 psig (10 kPa) nor more than 2-1/2 psig (17 kPa) or that pressure above 1-1/2 psig which first causes visible deformation to the tank. The pressure is not to decrease during the one-hour period; or

b) Completely filling the tank with water and applying a 5 psig (35 kPa) hydrostatic pressure for one hour. The tank is to be tested in the position in which it will be installed. The pressure is not to decrease during the one-hour period.

22.2.2 Each compartment of a compartment tank shall be tested in accordance with 22.2.1 and determined to be tight against leakage.

22.3 Secondary containment

22.3.1 While maintaining pressure on the primary tank, the interstitial space is to be pressurized to the pressure indicated in 22.2.1. There shall be no evidence of leakage following this test.

22.3.2 As an option to the leakage test described in 22.3.1, the interstitial space is to be vacuum tested for 12 hours. A vacuum of at least 13 inches of mercury (43.9 kPa) is to be applied, or another method determined to be equivalent and in accordance with the manufacturer's instructions is to be used to perform the test. There shall be no evidence of leakage (loss of vacuum) as a result of this test.

23 Environmental Exposure and Small Scale Fire Test

23.1 Performance criteria

23.1.1 A separate set of three samples shall be subjected to each of the exposures described in 23.2.1 – 23.2.7. Each shall be provided with the insulation thickness established in 11.3.3. The samples shall then be subjected to the furnace environment described in 17.2.1. If requested by the manufacturer, it is acceptable for the same set of samples to be subjected to multiple environmental exposures prior to the furnace exposure.

23.1.2 The average temperature of the test samples shall not exceed 260°F (144°C), and the maximum temperature measured shall not exceed 400°F (204°C) within a time equal to three quarters of the control period (see 11.3.1 – 11.3.3).

23.1.3 Samples shall show no visible signs of cracking or damage of the insulation system.

23.2 Simulated environmental exposures

23.2.1 Cold Exposure – Samples are to be conditioned for a minimum of 16 hours in a cold box maintained at minus 40°F (minus 40°C). Immediately upon removal from the cold chamber, these samples and three additional unconditioned samples are to be subjected to a 7.08 ft lb (9.6 N·m) impact from a 2-inch (50.8-mm) diameter steel ball on the surface of the sample.

23.2.2 UV Light and Water – This condition is to be simulated by subjecting three samples each to 180 hours and 360 hours of light and water exposure in accordance with Method I of the Standard Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With or Without Water for Exposure of Nonmetallic Materials, ASTM G23-81, using apparatus designated Type D or DH in ASTM G23-81. During each operating cycle of 120 minutes, the samples are to be exposed to light alone for 102 minutes and to light and water for 18 minutes.

23.2.3 Aging – Accelerated aging of the protective material is to be simulated by placing samples in a circulating air-oven at 150 ±5°F (66 ±2.8°C) for 270 days.

23.2.4 High Humidity – A high humidity condition is to be simulated by placing samples in a controlled humidity of 97 – 100 percent at 95 ±3°F (35 ±1.7°C) for 180 days.

23.2.5 Industrial Atmosphere – The sulfur dioxide (SO_2) content and carbon dioxide (CO_2) content of an industrial atmosphere is to be simulated by exposing the samples for 30 days to an amount of SO_2 equivalent to 1 percent of the volume of the test chamber, and an equal volume of CO_2. The test chamber is to be maintained at 95 ±3°F (35 ±1.7°C) and a small amount of water is to be maintained at the bottom of the chamber.

23.2.6 Salt Spray – A corrosive atmosphere is to be simulated by exposing samples to a salt spray for 90 days as described in Method of Salt Spray (Fog) Testing, ASTM B117.

23.2.7 Combination Wet, Freeze, and Dry Cycling – The freeze-thaw action is to be simulated by exposing samples to a cycle consisting of the equivalent of rainfall at the rate of 0.7 inch per hour (0.005 mm/s) of water for 72 hours, followed by a temperature of minus 40 ±5°F (minus 40 ±2.8°C) for 24 hours, and then a dry atmosphere of 140 ±5°F (60 ±2.8°C) for 72 hours. This cycle is to be repeated twelve times.

24 Interstitial Communication Test

24.1 The primary tank is to be filled to capacity with water. At a point farthest from the interstitial monitoring point, liquid, rated vacuum, or rated pressure is to be added to the interstitial space.

Exception: The maxinum recorded pressure shall not be greater thatn 5.0 psig (35kPa) for tanks with a specified maximum production leakage test pressure of 3 psig (21kPa).

$$S \geq \frac{D}{4}$$

in which:

S is the interstitial gap in inches

D is the nominal pipe size of the emergency vent in inches

24.2 The communication of the liquid, vacuum, or pressure to the monitoring point shall be detected in less than 24 hours.

25 Fire Test of Interstitial Space

25.1 The interstitial space of the sample tank is to be filled to saturation with unleaded gasoline. Six pressure taps are to be distributed and uniformly installed in the outer wall of the interstitial space with at least one pressure tap at each end. The primary tank is to be empty. The tank is then to be placed in a non combustible tray and subjected to a hydrocarbon pool fire for not less than 15 minutes. Pressures are to be recorded continuously throughout the test.

25.2 The maximum pressure recorded during the test shall not be greater than 8.3 psig (58 kPa). Emergency vent devices shall remain operational, venting shall not be impaired, and the primary tank capacity shall not be reduced by more than 5 percent as a result of this test.

Exception No. 1: The maximum recorded pressure shall not be greater than 5.0 psig (35 kPa) for tanks with a specified maximum production leakage test pressure of 3 psig (21 kPa).

Exception No. 2: The test is not required for tanks where the interstitial gap is void throughout the tank and is never less than:

$$S \geq \frac{D}{4}$$

in which:

S is the interstitial gap in inches

D is the nominal pipe size of the emergency vent in inches

26 Hydrostatic Strength Test of Secondary Containment

26.1 Secondary containment structures shall be subjected to this test when they do not comply with:

a) The Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids, UL 142, or

b) The Standard for Glass Fiber-Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-Gasoline Mixtures, UL 1316.

Both the primary tank and the secondary containment shall remain leak tight following the test.

26.2 The source of water pressure shall be capable of maintaining a pressure of at least 30 psig (207 kPa) for a period of not less than 2 minutes. The pressure gauges are to be calibrated and have a dial range of 0 – 50 psig (0 – 345 kPa) or 0 – 60 psig (0 – 415 kPa), a face size of at least 3-1/2 inches (89 mm) in diameter, graduations of 1 psig or 10 kPa maximum, and an accuracy of ±1 percent of the full scale reading.