# UL 2080

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# Fire Resistant Tanks for Flammable and Combustible Liquids

Underwriters Laboratories Inc. (UL)
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UL Standard for Safety for Fire Resistant Tanks for Flammable and Combustible Liquids, UL 2080

First Edition, Dated March 14, 2000

The new requirements are substantially in accordance with UL's Bulletin(s) on this subject dated May 21, 1999. The bulletin(s) is now obsolete and may be discarded.

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New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing and Follow-Up Services after the effective date, and understanding of this should be signified in writing..



This Standard consists of pages dated as shown in the following checklist:

MARCH 14, 2000

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2080

# Standard for Fire Resistant Tanks for Flammable and Combustible Liquids

First Edition

March 14, 2000

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

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## MANUFACTURING AND PRODUCTION TESTS



## MARKINGS



## APPENDIX A

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## FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction which conflict with specific requirements of the Standard cannot be judged to comply with the Standard. A product employing materials or having forms of construction not addressed by this Standard may be examined and tested according to the intent of the requirements and, if found to meet the intent of this Standard, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

## INTRODUCTION

### 1 Scope

1.1 These requirements cover shop fabricated, aboveground atmospheric Fire Resistant 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.

1.2 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. Tanks appropriately identified by product markings provide protection for the primary tank against projectile impact and vehicle impact.

1.3 Fire Resistant Tanks are intended for stationary installation and use in accordance with the Flammable and Combustible Liquids Code, NFPA 30, and the Automotive and Marine Service Station Code, NFPA 30A.

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

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

1.6 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.

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

1.8 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.

### 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 needed 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 fire resistant 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 FIRE RESISTANT TANK – An aboveground atmospheric tank provided with two-hour fire-resistive protection that limits the temperature rise of the primary tank when exposed to a high intensity liquid pool fire.

3.4 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.

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

3.6 SECONDARY CONTAINMENT – A structure that has a permeability not more than $4 \times 10^{-8}$ 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 Fire Resistant Tank shall be compatible with the product stored.

4.2 When dissimilar materials are used in the construction of a Fire Resistant 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.



**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) |

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.

## 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.

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 $4 \times 10^{-8}$ 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 Venting devices for normal and emergency venting of the primary containment tank and emergency venting of the secondary containment tank (if applicable) shall be provided. If the primary containment tank has two or more compartments, each compartment shall be provided with a normal and emergency vent device.

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.

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 31.1(i).

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. Tanks that are not provided with integral supports shall be marked as specified in 31.3.

## 10 Grounding

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

10.2 Instructions as specified in 33.1 shall be provided to detail all proper grounding connections.

## 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.

11.1.2 A single tank sample as described in 11.2.1 – 11.2.8 shall be subjected to all of the following tests in Sections 12 – 15.

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 – 21, 23, and 24. If not, a new sample shall be used for the remaining tests. Tests specified in the Vehicle Impact Test, Section 19, and the Projectile Test, Section 20, 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 22.

### 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 twelve thermocouples are to be distributed uniformly on the interior surface of the primary tank with not more than 9 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.

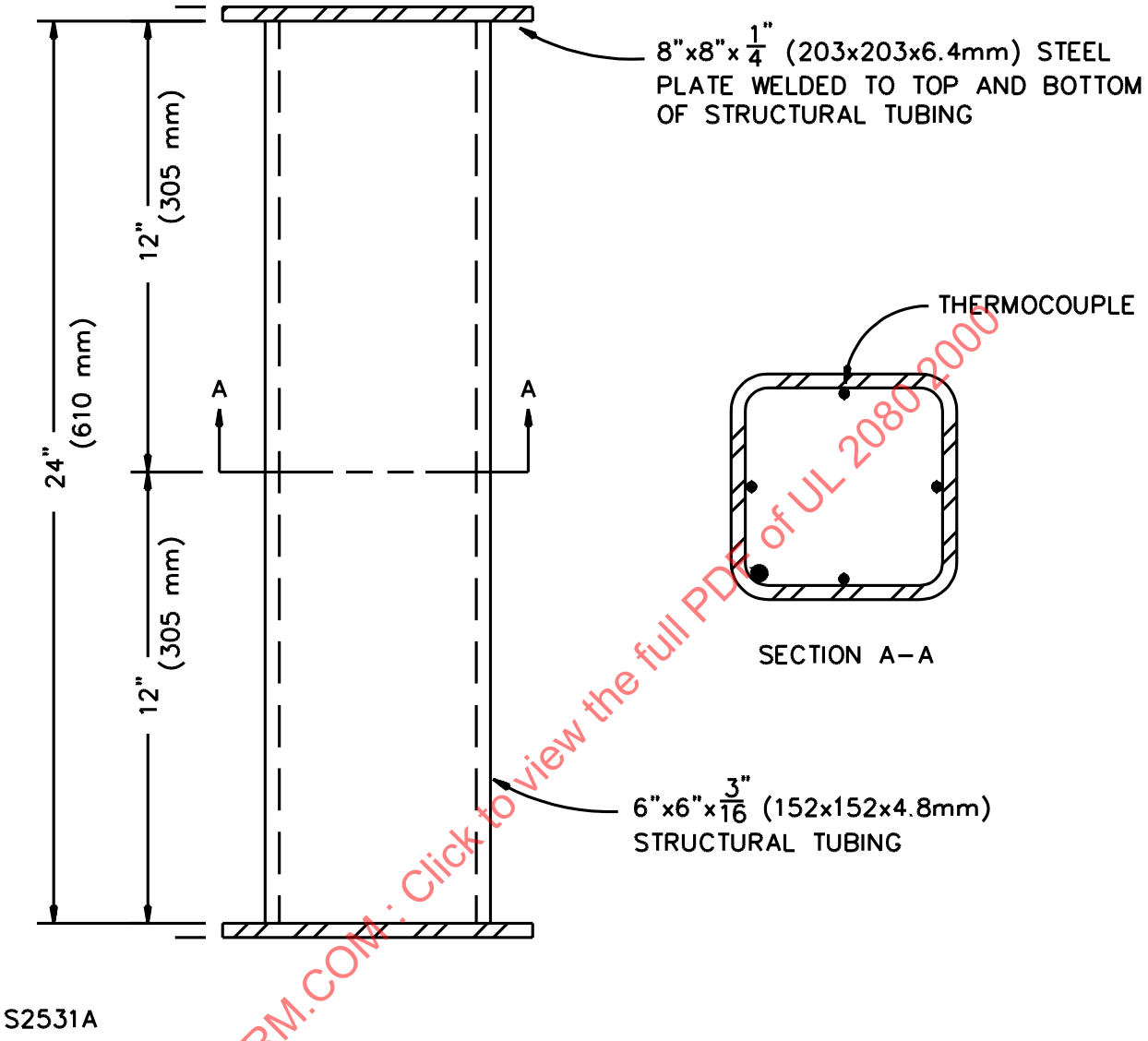
### 11.3 Environmental exposure and small scale fire test samples

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 17.2.1. The thickness of the insulating material shall be such that the time at which the test sample reaches an average temperature rise of 800°F (430°C), and no individual temperature rise greater than 1000°F (540°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**



## 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 B36.10-M.



## 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 1000-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 800°F (430°C) and a maximum temperature of any single thermocouple of 1000°F (540°C).

171.2 Temperatures recorded on structural supports which hold the 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 Leakage Test, Section 21. 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 Tank Support Load Test

18.1 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 18.2.

18.2 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.

## 19 Vehicle Impact Test

19.1 The primary tank is to be empty and subjected to the test described in 19.2. Structural information provided by the tank manufacturer is to be used to determine the worst case tank to test in a series of tanks.

19.2 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.

19.3 Following this test, the primary tank shall show no signs of leakage when subjected to the leakage test for primary tanks in 21.2.1 – 21.2.2.

## 20 Projectile Test

20.1 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.

20.2 Following the projectile test, the primary tank shall show no signs of leakage when subjected to the leakage test for primary tanks in 21.2.1 – 21.2.2.

## 21 Leakage Test

### 21.1 General

21.1.1 The leakage test is to be conducted on the primary tank in accordance with 21.2 and the secondary containment in accordance with 21.3.1 – 21.3.2. There shall be no evidence of leakage.

### 21.2 Primary tank

21.2.1 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.

21.2.2 Each compartment of a compartment tank shall be tested in accordance with 21.2.1 and determined to be tight against leakage.

### 21.3 Secondary containment

21.3.1 While maintaining pressure on the primary tank, the interstitial space is to be pressurized to the pressure indicated in 21.2.1. There shall be no evidence of leakage following this test.

21.3.2 As an option to the leakage test described in 21.3.1, the interstitial space is to be vacuum tested for 12 hours with a vacuum of at least 13 inches of mercury (43.9 kPa). Another method that is determined to be equivalent and is specified in the manufacturer's instructions is not prohibited. There shall be no evidence of leakage (loss of vacuum) as a result of this test.

## 22 Environmental Exposure and Small-Scale Fire Test

### 22.1 Performance criteria

22.1.1 A separate set of three samples shall be subjected to each of the exposures described in 22.2.1 – 22.2.7. 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.

22.1.2 The average temperature of the test samples shall not exceed 800°F (430°C), and the maximum temperature measured shall not exceed 1000°F (540°C) within a time equal to three quarters of the control period as mentioned in 11.3.3.

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

### 22.2 Simulated environmental exposures

22.2.1 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.

22.2.2 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.

22.2.3 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.

22.2.4 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.

22.2.5 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.

22.2.6 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 B117-73 (1979).

22.2.7 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.

## 23 Interstitial Communication Test

23.1 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 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*

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

## 24 Fire Test of Interstitial Space

24.1 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.

24.2 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*

**25 Hydrostatic Strength Test of Secondary Containment**

25.1 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.

*Exception: In cases where the secondary containment provides venting by a form of construction, the Pressure Surge Test (Venting by Form of Construction) Section 26 shall be conducted.*

25.2 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.

25.3 The primary tank and the interstitial space are to be filled with water. The primary is to be capped. The pressure is to be applied gradually to the interstitial space in increments of 5 psig (35 kPa) at a rate not exceeding 2 psig (14 kPa) per minute. The pressure is to be held for 2 minutes after each increment of 5 psig (35 kPa) until the test pressure of 25 psig (172 kPa) is attained. Once the pressure is attained, it is to be held for 2 minutes and the overall structure examined for visible signs of leakage or damage.

*Exception: A test pressure of 15 psig (103 kPa) is to be used for tanks with a specified maximum production leakage test pressure of 3 psig (21 kPa).*

**26 Pressure Surge Test (Venting by Form of Construction)**

26.1 Secondary containment structures that provide emergency venting by a form-of-construction, such as a frangible joint where the top is designed to be weaker than the walls, shall be subjected to this test.

26.2 The primary tank is to be filled to 95 percent capacity with water and vent openings are to be provided with the intended venting devices. The interstitial space is to be completely filled with water. The interstitial space is to be subjected to surge pressure at a rate that results in the emergency venting construction to function as intended. Measurements of the liquid level in the primary tank are to be made before and after the test. Observations are to be made for any loss of liquid from the primary tank.

26.3 There shall be no loss of liquid from the primary tank following the test. Venting shall be such that only seams above the maximum normal liquid level fail. The internal pressure shall be directed upward at the moment of release, and there shall be no resulting projectiles.

**MANUFACTURING AND PRODUCTION TESTS**

**27 Leakage Test**

**27.1 Caution**

27.1.1 Caution – Testing with air pressure presents a risk of injury to persons. Personnel should be instructed in safety precautions to be taken during such testing. The precautions shall include the use of a pressure-relief device that reduces the risk of the tank becoming pressurized in excess of the specified test pressure.

**27.2 General**

27.2.1 Leakage tests shall be performed on both the primary tank and secondary containment as specified in the Leakage Test, Section 21.

27.2.2 Each compartment of a compartment tank shall be tested by the manufacturer and determined to be tight against leakage.

**28 Insulation Thickness**

28.1 The thickness of the insulation system is to be measured or otherwise verified as a production-line test on each tank construction.

**29 Density or Compressive Strength**

29.1 When concrete is used as part of the tank assembly, the density or compressive strength of a test cylinder of the concrete is to be determined in accordance with the Standard Test Method for Compressive Strength of Lightweight Insulating Concrete, ASTM C495 Rev A, or the Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens, ASTM C39. The test is to be conducted once per each production shift.