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NATIONAL STANDARD

ANSI/CAN/UL/ULC 2152:2021

STANDARD FOR SAFETY

Special Purpose Nonmetallic Containers and Tanks for Specific Combustible or Noncombustible Liquids

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Approved American National Standard
ANSI

ANSI/UL 2152-2021

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UL Standard for Safety for Special Purpose Nonmetallic Containers and Tanks for Specific Combustible or Noncombustible Liquids, ANSI/CAN/UL/ULC 2152

First Edition, Dated January 26, 2021

Summary of Topics

This First Edition of ANSI/CAN/UL/ULC 2152, Standard for Special Purpose Nonmetallic Containers and Tanks for Specific Combustible or Noncombustible Liquids, has been issued to reflect the latest ANSI and SCC approval dates, and to incorporate the proposals dated January 17, 2020 and July 17, 2020.

The new requirements are substantially in accordance with Proposal(s) on this subject dated January 17, 2020 and July 17, 2020.

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ANSI/CAN/UL/ULC 2152:2021

Standard for Special Purpose Nonmetallic Containers and Tanks for Specific Combustible or Noncombustible Liquids

First Edition

January 26, 2021

This ANSI/CAN/UL/ULC Safety Standard consists of the First Edition.

The most recent designation of ANSI/UL 2152 as an American National Standard (ANSI) occurred on January 26, 2021. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, Preface or SCC Foreword.

This standard has been designated as a National Standard of Canada (NSC) on January 26, 2021.

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Preface

This is the First Edition of ANSI/CAN/UL/ULC 2152, Standard for Special Purpose Nonmetallic Containers and Tanks for Specific Combustible or Noncombustible Liquids.

UL is accredited by the American National Standards Institute (ANSI) and the Standards Council of Canada (SCC) as a Standards Development Organization (SDO). ULC Standards is accredited by the Standards Council of Canada (SCC) as a Standards Development Organization (SDO).

This Standard has been developed in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization.

This ANSI/CAN/UL/ULC 2152 Standard is under continuous maintenance, whereby each revision is approved in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization. In the event that no revisions are issued for a period of four years from the date of publication, action to revise, reaffirm, or withdraw the standard shall be initiated.

Annexes A and B are identified as Normative, as such, form mandatory parts of this Standard.

In Canada, there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

This joint American National Standard and National Standard of Canada is based on, and now supersedes, the second issue of the outline of investigation UL 2152 and the first edition ULC/ORD-C142.14.

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

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This Edition of the Standard has been formally approved by the UL Standards Technical Panel (STP) on Combustible Liquid Tanks and Accessories, STP 2258.

This list represents the STP 2258 membership when the final text in this standard was balloted. Since that time, changes in the membership may have occurred.

STP 2258 Membership

Name	Representing	Interest Category	Region
Beaulieu, Michel	Roth Industries Inc.	Producer	Canada
Bourassa, Eric	Granby Industries LP	Non-voting member	Canada

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STP 2258 Membership Continued

Name	Representing	Interest Category	Region
Corliss, Chuck	NH Department of Environmental Services	AHJ	USA
Deschamps, Claude	Régie du bâtiment du Québec (RBQ)	AHJ	QC, Canada
Fasel, Mark	Viega LLC	Producer	USA
Fernandes, Elson	ELFENT Ltd	Commercial / Industrial User	Canada
Juranty, Michael	NH Department of Environmental Services	AHJ	USA
Lacroix, J.	Vilco Ltd	Producer	Canada
Legault, Pierre	Integrated Review Services – Consulting	General	Canada
Levey, John	Oil Heat Associates	General	USA
Mailvaganam, Miles	M. Mailvaganam	General	Canada
Marando, Michael	National Fire Protection Association (NFPA)	Non-voting member	USA
Moulton, Peter	State of Maine	Government	USA
Olszewski, Ted	R W Beckett Corp	Producer	USA
Prusko, Jeffrey	Underwriters Laboratories Inc.	Project Manager – Non-voting member	USA
Ramert, Jason	Innovative Outdoor Solutions Inc.	Producer	USA
Riegel, Roland A.	UL LLC	Testing and Standards Org	USA
Wade, John A.	ULC Standards	Chair – Non-voting member	Canada
Werner, Laura	ULC Standards	Project Manager – Non-voting member	Canada

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This Standard is intended to be used for conformity assessment.

The intended primary application of this standard is stated in its scope. It is important to note that it remains the responsibility of the user of the standard to judge its suitability for this particular application.

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INTRODUCTION

1 Scope

1.1 These minimum requirements cover special purpose nonmetallic containers and tanks (vessels) for specific aboveground use applications for combustible or non-combustible liquids as indicated for each special purpose type. The requirements address the specific designs, features, limitations, use factors and other unique characteristics of each type. The types of different special purpose vessels covered by this Standard are:

a) Liquid Chemical Containers and Tanks designed for stationary storage of combustible or non-combustible liquids in non-residential applications, intended to be used in accordance with Table 1.1. Liquid chemical tanks are limited to the specific liquid (s) or family of similar liquids and application(s) to which they are rated;

b) Cooking Oil Tanks designed for storage of cooking oils and fats typically found in restaurant or similar commercial food preparing applications having engineered transfer systems. These tanks are intended for either delivery of fresh oil and/or collection of waste oils through piping networks by trained persons using service trucks with pressure or vacuum pumps. These tanks are limited to Class IIIB oils and fats, and are intended to be installed in cooking oil storage systems used in commercial kitchens, in accordance with Table 1.1;

c) Lube Oil Tanks designed for storage, dispensing and collection of Class IIIB motor oils (such as lubricating, transmission, cooling, etc.), working oils (such as hydraulic, brake, steering, cutting, etc.), and other petroleum or synthetic oils with similar chemical and physical properties used in equipment applications; and

d) Vehicle Fluid Tanks for storage, dispensing and collection of non-combustible fluids such as antifreeze/coolants (ethylene-glycol and water mixtures), windshield washer (alcohol, water and detergent mixtures), DEF (nominally 1/3 urea and 2/3 water, diesel exhaust solution), and other optional fluid types typically used in vehicles.

Table 1.1
Regulatory Applications

Type	Liquids stored	U.S.A. Regulatory applications	Canada Regulatory applications
Liquid Chemical Containers and Tanks	Combustible and non-combustible [1.1 (a)] Class II or III and non-combustible [4.16(a)]	NFPA 30-9.4 [1.1(a)]	NFC
	Class II and IIIA containers [6.1.2(a)]	NFPA 30-9.4.1 (4), etc. [6.1.2(a)]	NFC
	Class II and IIIA tanks [6.1.2(b)]	NFPA 30-9.4.1 (6), etc. [6.1.2(b)]	NFC
	Class IIIB [6.1.2(c)]	–	NFC
	non-combustible [6.1.2(c)]	–	NFC
Cooking Oil Tanks	Class IIIB oils and fats [1.1(b)]	NFPA 1-66.19.7 or NFPA 30-19.7 [1.1(b)]	NFC
Lube Oil Tanks	Class IIIB motor oils [1.1(c)]		
Vehicle Fluid Tanks	Non-combustible [1.1(d)]		

1.2 These requirements do not cover nonmetallic cans, containers or tanks for which there are separately published standards, such as:

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a) Bulk Shipping Containers intended for commercial transportation applications in accordance with DOT Hazardous Materials Regulations (Title 49 CFR Parts 100-1999), UN Recommendations on Transport of Dangerous Goods (Part 6), or NMFC (Items 256, 258, 294 and 296);

b) Consumer Portable Fuel Cans in accordance with ASTM F852, Standard Specification for Portable Gasoline, Kerosene, and Diesel Containers for Consumer Use;

c) Portable Containers and Tanks in accordance with UL 75, Outline of Investigation for Portable Containers and Tanks for Flammable and/or Combustible Liquids;

d) Commercial Safety Cans in accordance with UL 1313, Standard for Nonmetallic Safety Cans for Petroleum Products, or ULC/ORD-C30, Safety Containers; or

e) Oil Burner Tanks in accordance with ANSI/CAN/UL/ULC 2258, Standard for Aboveground Nonmetallic Tanks for Fuel Oil and Other Combustible Liquids.

1.3 All special purpose vessels are factory manufactured atmospheric types of primary, secondary or diked containment designs. The containment materials are formed from primarily thermoplastic or thermoset polymers with or without integrated metallic components.

1.4 In addition to requirements for the vessel's structural integrity, material compatibility, environmental exposures and fire resistance, requirements for optional accessories that may be installed in or on the tank, such as supports, pumps, heaters, gauges, filters, hoses, valves and controls are also provided in this Standard.

1.5 These tanks are intended for installation and use in accordance with applicable documents in the following list:

a) In Canada:

1) National Fire Code of Canada;

2) CCME PN1326, Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products;

3) Regulations of the authority having jurisdiction; and

b) In the United States:

1) Standard for the Installation of Oil-Burning Equipment, NFPA 31;

2) Flammable and Combustible Liquids Code, NFPA 30; and

3) Code for Motor Fuel Dispensing Facilities and Repair Garages, NFPA 30A, as applicable.

1.6 Any accessories or components not described in 1.4 that are shipped with, attached to, or added to the tanks are not included in the scope of this Standard. It is intended that the AHJ approve the use and/or installation of any such accessories or components independent of the conformance of a tank to these requirements.

1.7 These requirements do not cover resistance to hurricanes, tornadoes, earthquakes, floods, or other natural disasters; or large-scale fire and excessive damage resistance. In addition, assessment of any damage for continued use after such events, are not included in the scope of this Standard.

1.8 Any common fuel, oil and other liquid terms referenced in this Standard are intended to describe fluids which are commercially available, and which meet the requirements of a recognized industry specification, such as documents published by ASTM, SAE or SCE.

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2 Units of Measurement

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

3 Referenced Publications

3.1 The documents shown below are referenced in the text of this Standard. 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.

UL Standards

UL 79, *Standard for Power-Operated Pumps for Petroleum Dispensing Products*
UL 75, *Outline of Investigation for Portable Containers and Tanks for Flammable and/or Combustible Liquids*
UL 87B, *Standard for Power-Operated Dispensing Devices for Diesel Fuel, Biodiesel Fuel, Diesel/Biodiesel Blends with Nominal Biodiesel Concentrations Up to 20 Percent (B20), Kerosene, and Fuel Oil*
UL 124, *Outline for Hand-Operated Pumps for Flammable and Combustible Liquids*
UL 746A, *Standard for Polymeric Materials – Short Term Property Evaluations*
UL 746B, *Standard for Polymeric Materials – Long Term Property Evaluations*
UL 746C, *Standard for Polymeric Materials – Use in Electrical Equipment Evaluations*
UL 842, *Standard for Valves for Flammable Fluids*
UL 842B, *Standard for Valves for Diesel Fuel, Biodiesel Fuel, Diesel/Biodiesel Blends with Nominal Biodiesel Concentrations Up to 20 Percent (B20), Kerosene, and Fuel Oil*
UL 1313, *Standard for Nonmetallic Safety Cans for Petroleum Products*
UL 2583, *Outline of Investigation for Fuel Tank Accessories*

ULC Standards

CAN/ULC-S127, *Standard Corner Wall Method of Test for Flammability Characteristics of Non-Melting Foam*
CAN/ULC-S663, *Spill Containment Devices for Aboveground Flammable and Combustible Liquid Storage Tanks*
ULC/ORD-C30, *Safety Containers*
ULC/ORD-C842, *Guide for the Investigation of Valves for Flammable and Combustible Liquids*

UL/ULC Standards

ANSI/CAN/UL/ULC 180, *Standard for Combustible Liquid Tank Accessories*
ANSI/CAN/UL/ULC 2258, *Standard for Aboveground Nonmetallic Tanks for Fuel Oil and Other Combustible Liquids*

Other Standards

ASTM D256, *Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics*
ASTM D396, *Standard Specification for Fuel Oils*
ASTM D638, *Standard Test Method for Tensile Properties of Plastics*
ASTM D790, *Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials*
ASTM D975, *Standard Specification for Diesel Fuel Oils*
ASTM D1822, *Standard Test Method for Tensile-Impact Energy to Break Plastics and Electrical Insulating Materials*

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ASTM D2880, *Standard Specification for Gas Turbine Fuel Oils*
ASTM D3699, *Standard Specification for Kerosene*
ASTM D4814, *Standard Specification for Automotive Spark-Ignition Engine Fuel*
ASTM D5798, *Standard Specification for Ethanol Fuel Blends for Flexible-Fuel Automotive Spark-Ignition Engines*
ASTM D7467, *Standard Specification for Diesel Fuel Oil, Biodiesel Blend (B6 to B20)*
ASTM G153, *Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials*
ASTM G155, *Standard Practice for Operation Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials*
CCME PN 1326-2003 (UPD 2015), *Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products*
CAN/CGSB 3.2-2017, *Heating Fuel Oil*
CAN/CGSB 3.3-2014, *Kerosene*
CAN/CGSB 3.5-2016 (AMD 1 2017), *Automotive Gasoline*
CAN/CGSB 3.6-2010, *Off-Road Diesel Fuel*
CGSB 3.11-2017, *Naval Distillate Fuel*
CAN/CGSB 3.18-2010 (R2016), *Diesel Fuel for Locomotive-Type Medium-Speed Diesel Engines*
CAN/CGSB 3.22-2012 (R2017), *Wide-Cut Type Aviation Turbine Fuel (Grade JET B)*
CAN/CGSB 3.23-2016, *Aviation Turbine Fuel (Grades JET A and Jet A-1)*
CAN/CGSB 3.24-2016, *Aviation Turbine Fuel (Military Grades F-34. F-37 and F-44)*
CAN/CGSB 3.27-2012, *Naphtha Fuel*
CAN/CGSB 3.511-2016 (AMD 1 2017), *Oxygenated Automotive Gasoline Containing Ethanol (E1 – E10)*
CAN/CGSB 3.512-2013 CORR 1, *Automotive Ethanol Fuel (E50 – E85)*
CAN/CGSB 3.516-2017, *Denatured Fuel Ethanol for Use in Automotive Spark-Ignition fuels*
CAN/CGSB 3.517-2017, *Diesel Fuel*
CAN/CGSB 3.520-2017, *Diesel Fuels Containing Low Levels of Biodiesel (B1 – B5)*
CAN/CGSB 3.522-2017, *Diesel Fuel Containing Biodiesel (B6 – B20)*
CAN/CGSB 3.524-2017, *Biodiesel (B100) for Blending in Middle Distillate Fuels*
CGSB 3-GP-531M-1982, *Methanol, Technical*
NFC, *National Fire Code of Canada, 2015*
NFPA 1, *Fire Code*
NFPA 30, *Flammable and Combustible Liquids Code*
NFPA 31-2016, *Standard for the Installation of Oil-Burning Equipment*

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Abbreviations

ANSI – American National Standards Institute
ASTM – American Society for Testing and Materials
CCME – Canadian Council of the Ministers of the Environment
CGSB – Canadian General Standards Board
CSA – CSA Group
NFPA – National Fire Protection Association

4 Glossary

4.1 Terms used in this Standard are defined as follows:

4.2 ABOVEGROUND TANK (also known as ABOVEGROUND STORAGE TANK or AST) – A storage tank that is intended for installation above grade, at grade or below grade without backfill.

4.3 ATMOSPHERIC TANK – (also known as NONPRESSURE TANK) – A storage tank that has been designed to operate at pressures from atmospheric through a gauge pressure of 6.9 kPa (1.0 psi) measured at the top of the tank; not intended to accommodate an internal vacuum greater than 300 Pa (0.0435 psi) or -2.25 mmHg (-0.0886 inHg).

4.4 AUTHORITY HAVING JURISDICTION (AHJ) – The governmental body responsible for the enforcement of any part of this Standard or the official or agency designated by that body to exercise such a function.

4.5 CLOSED SECONDARY CONTAINMENT (also known as CLOSED TOP DIKE TANK) – Construction that is external to the primary tank that is designed to prevent the entrance of precipitation and debris into the containment and where the interstitial space is capable of being monitored.

4.6 FUEL – Any flammable liquid having a flash point below 37.8°C (100°F) and a vapour pressure not exceeding 275 kPa (absolute) (40 psi) at 37.8°C (100°F), or any combustible liquid having a flash point at or above 37.8°C (100°F) and below 93.3°C (200°F), and as defined in the National Fire Code of Canada and NFPA 30. A flammable or combustible liquid which is commercially available as an energy source for spark ignition or compression ignition engines, generators, turbines, heaters, or similar equipment; and meets appropriate fuel specifications, such as:

a) GASOLINE – General description of various Flammable Class I petroleum distillates and alcohol blends compliant with ASTM D4814, Standard Specification for Automotive Spark-Ignition Engine Fuel, or ASTM D5798, Standard Specification for Ethanol Fuel Blends for Flexible-Fuel Automotive Spark-Ignition Engines, in a range of E0 to E83 or CGSB 3.5, Automotive Gasoline, typically used in spark ignition engines.

b) DIESEL – General description of various Combustible Class II petroleum distillates and biodiesel blends compliant with ASTM D975, Standard Specification for Diesel Fuel Oils, or ASTM D7467, Standard Specification for Diesel Fuel Oil, Biodiesel Blend (B6 to B20), or CAN/CGSB 3.517, Diesel Fuel, in a range of B0 to B20 typically used in compression ignition engines.

c) FUEL OIL/HEATING OIL – General description of various Combustible Class II petroleum distillates and biodiesel blends compliant with ASTM D396, Standard Specification for Fuel Oils (in a range of B0 to B20), or CAN/CGSB 3.2, Heating Fuel Oil (in a range of B0 to B5) typically used in heating equipment.

d) KEROSENE – General description of various Combustible Class II petroleum distillates compliant with ASTM D3699, Standard Specification for Kerosene, or CGSB 3.3, Kerosene, typically used in cooking, heating, lighting or similar equipment.

e) TURBINE OIL – General description of various Combustible Class II petroleum distillates compliant with ASTM D2880, Standard Specification for Gas Turbine Fuel Oils, typically used in turbine type engines or generators.

4.7 INTERSTITIAL SPACE (also known as ANNULAR SPACE or INTERSTICE) – The space between the walls that is capable of being monitored for leakage through:

a) The primary tank wall;

b) The secondary containment wall;

c) The multiple containment walls; or

d) Monitorable bulkheads.

4.8 NONMETALLIC – Synthetically produced organic materials capable of being molded into any form. For the purpose of this Standard, they typically include, but are not limited to, thermoplastic polymers, such as Polyethylene (PE), and thermoset polymers, such as Fiberglass Reinforced Plastics (FRP).

4.9 OIL – A combustible liquid which is commercially available as a lubricating oil or working fluid for engines, machines, or similar equipment; and meet appropriate SAE or similar specifications, such as:

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a) MOTOR OIL – General description of various Class III petroleum distillate or synthetic grades including lube oils, hydraulic oils or transmission oils typically used as lubricating, cooling, or working fluids in motor vehicle applications.

b) HYDRAULIC OIL / TRANSMISSION OIL – General description of various Class IIIB petroleum distillate or synthetic type lower viscosity oils typically used as working fluids in engine or machinery applications.

c) UNUSED OILS – General description of Class IIIB motor, lube, hydraulic, transmission or similar oils that have not been transferred to motor vehicles, engines or machinery, and do not adversely affect the tank.

d) USED OILS – General description of Class IIIB motor, lube, hydraulic, transmission or similar oils drained from motor vehicles, engines or machinery after use, that may contain small amounts of contaminants, but do not adversely affect the tank.

e) COOKING OILS – General description of Class IIIB fresh or waste liquids extracted from either plants (such as corn, soy, canola, palm, or vegetable oils) and/or animals (such as fats or grease), and used in cooking or food preparation processes.

4.10 OPEN SECONDARY CONTAINMENT (also known as OPEN TOP DIKE TANK) – Construction that is external to the primary tank that is open to the atmosphere and where the interstitial space is not capable of being pressurized but is capable of being monitored.

4.11 PERFORMANCE TESTS – A complete evaluation conducted on a limited quantity of representative "worst case" tanks intended to verify compliance with all applicable performance requirements in a Standard. Performance tests are typically destructive.

4.12 PRIMARY CONTAINMENT – The ability of a tank design and construction to contain a liquid while in normal use (intended storage).

4.13 PRIMARY TANK – The product storage tank or compartment.

4.14 PRODUCTION TESTS – A limited evaluation conducted by the tank manufacturer on each tank after complete assembly but prior to shipping intended to verify compliance with critical production requirements in a Standard, such as leakage. Production tests are not destructive.

4.15 SECONDARY CONTAINMENT – The ability of a design or construction to contain a liquid to a minimum of 300° (for cylindrical and obround), 95 % height (for rectangular and verticals), or 110 % primary capacity (for secondary containments) only in abnormal use (from primary tank leakage or rupture) for short periods without leakage.

4.16 SECONDARY CONTAINMENT TANK (also known as SECONDARY TANK) – A primary tank with an integral secondary containment where the inner and outer walls are in intimate contact and the interstitial space is capable of being vacuum or pressure monitored. Double wall tanks are provided with a vacuum monitor.

4.17 SPECIAL PURPOSE CONTAINER or TANK – A nonmetallic aboveground container or tank (vessel) covered by the requirements of this Standard, which are intended for specific applications and/or fuels or liquids as indicated by each special purpose type.

a) LIQUID CHEMICAL CONTAINER or TANK – A special purpose vessel with optional dispensing or collection equipment intended for storage of only Class II or III combustible liquid chemicals or non-combustible liquid chemicals for specific applications.

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b) COOKING OIL TANKS – A special purpose tank for storage of Class IIIB cooking oils and fats typically found in restaurant or similar commercial food preparing applications having engineered transfer systems, intended for either delivery of fresh oil or collection of waste oils through piping networks by trained persons using service trucks with pressure or vacuum pumps.

c) LUBE OIL TANKS – A vessel designed for storage, dispensing and collection of Class IIIB motor oils (such as lubricating, transmission, cooling, etc.), working oils (such as hydraulic, brake. steering, cutting, etc.), and other petroleum or synthetic oils with similar chemical and physical properties used in equipment applications.

d) VEHICLE FLUID TANKS – A vessel designed for storage, dispensing and collection of non-combustible fluids such as antifreeze/coolants (ethylene-glycol and water mixtures), windshield washer (alcohol, water and detergent mixtures), DEF (nominally 1/3 urea 2/3 water, diesel exhaust solution), and other optional fluid types typically used in vehicles.

4.18 STORAGE CONTAINER (also known as CONTAINER) – A vessel having a liquid capacity that does not exceed 227 L (60 US gal), that is intended for stationary installation, and is not used for processing.

4.19 STORAGE TANK (also known as TANK) – A vessel having a liquid capacity that typically exceeds 227 L (60 US gal), that is intended for stationary installation, and is not used for processing.

4.20 SUPPORT – Optional load bearing members for aboveground tanks or containers intended to provide stability and structural support without creating hazardous stresses in the tank shell. Typical support designs include saddles, beams and legs.

4.21 VENT OPENING – A tank or container top opening that is intended to provide separate or combined normal venting and/or emergency venting. The vent opening(s) shall be either a fitting on the shell or a short pipe stub attached to the fitting or shell.

a) EMERGENCY VENT (E-VENT) – A vent opening or device that automatically relieves excessive internal pressure due to an external fire exposure or blockage of the normal vent.

b) NORMAL VENT (N-VENT) – A vent opening or device that automatically relieves internal pressure or vacuum during normal storage (atmospheric pressure equalization) and during normal operations (fill or withdraw).

c) FORM-OF-CONSTRUCTION – A feature of the tank construction designed to relieve internal pressure, such as a weak top shell joint.

4.22 VESSEL – A storage container or tank.

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CONSTRUCTION

5 General Construction of All Special Purpose Containers and Tanks

5.1 Containment type, shape, dimensions, capacity and materials

5.1.1 Containers shall be primary types only. Tanks shall be of a primary, secondary or diked containment design, and are permitted to have compartments. Both are permitted to be of any shape and orientation. Any limitations in dimensions and capacity, plus required and optional features are indicated by the specific construction requirements for each special purpose container or tank in 6, Specific Construction of Special Purpose Containers and Tanks.

5.1.2 For all refillable vessels greater than 19 L (5 US gal), the marked nominal capacity of a primary container or tank, or each compartment of a multi-compartment tank, shall be within 95 to 100 % of the maximum capacity. The capacity and other required markings shall comply with Sections 36 through 40.

5.1.3 All containers and primary tanks shall be formed or molded from only non-metallic materials which comply with the applicable requirements in this Standard. If provided, secondary or dike tank walls are permitted to be either metallic or nonmetallic. Tanks of any form shall not have any shell penetrations below the liquid level line except for supply or drain connections.

5.1.4 Secondary tanks shall have containment of at least 300° (for cylindrical and obround), 95 % height (for rectangular and verticals), or 110 % primary capacity (for secondary containments), and the interstitial space shall be capable of being pressurized with the use of a common fitting (threaded cap/plug or rubber expansion plug).

5.1.5 Dike tanks shall have containment of at least 110 % of the primary tank volume, spill coverage of at least 25.4 mm (1 in) beyond the primary tank projected area, and a wall height to at least half the primary tank height. Dikes shall be of the open or closed top design.

5.1.6 The secondary or dike tank wall is permitted to be in direct contact with the primary tank or separated by baffles or supporting members, but shall not restrict required venting or monitoring of the interstitial space as specified for each special container or tank type in Section 6, Specific Construction of Special Purpose Containers and Tanks.

5.1.7 All materials shall meet the requirements for basic strength of materials, resistance to fire, expected environments and compatibility with rated fluids as identified for each special purpose tank type in Section 7, General Performance for All Special Purpose Containers and Tanks.

5.1.8 All material joints (such as welding, fusing, bonding, etc.) and processes (such as extruding, curing, plating, etc.), shall comply with 5.1.7.

5.2 Openings and connections

5.2.1 Containers up to 20 L (5 US gal) shall only have a top opening with resealable cap and means to provide venting while pouring. All other containers and tanks, or each compartment of a compartment tank, shall have at least fill, withdraw and vent openings, but other optional openings are permitted. All vessel openings shall be made through fittings connected to the shell with minimum or maximum sizes as required for each special purpose type in Section 6, Specific Construction of Special Purpose Containers and Tanks.

5.2.2 Fittings for tank top openings and connection to inlet/outlet pipes, or other devices, shall be threaded or flanged types, or equivalent liquid tight connections. When permitted by the special purpose tank type, fittings below the normal liquid level shall only be threaded types. All fixed tank connections shall meet the requirements of Section 25, Fitting Torque Test and Section 26, Fitting Bending Test.

5.2.3 Unless designed for a special connector that is provided with the tank, threaded fittings shall be of NPT, NPTF, BSPT, BSPP, MPSM, or similar common trade types using industry recognized specifications.

5.2.4 All tank openings and open-end fittings or connections shall be protected with wooden or plastic plugs, metal covers, or their equivalent, to protect threads and to exclude foreign matter while in storage or in transit.

5.2.5 Except if provided with vent and monitor devices, all vent and monitor opening (s), and other openings for a specific purpose shall be marked per 37.1(g) or identified in the manufacturer's instructions per 39.1.

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5.3 Functional components and accessories

5.3.1 Tanks are not prohibited from using any combination of functional components or accessories provided they are integral with or assembled to the tank, and in conformance with the applicable requirements of this Standard. Some typical functional components and accessories are identified below.

5.3.2 Thermal insulations shall not interfere with emergency venting or fluid communication of the interstitial space, and shall be subject to the applicable Material Property and Compatibility Tests, Sections 8 through 14, following all applicable performance tests.

5.3.3 Rain covers or monitor caps for outdoor rated tanks shall resist rain and debris from entering the dike or secondary containment interstitial space, in accordance per Section 28, Rain/Freeze Tests, following all applicable performance tests.

5.3.4 Pumps, if provided to transfer liquids in and out of the tank, shall comply with the applicable requirements of UL 124, Outline for Hand-Operated Pumps for Flammable and Combustible Liquids, for hand operated types, UL 79B, Power-Operated Pumps for Petroleum Dispensing Products, for battery operated types, or UL 87B, Power-Operated Dispensing Devices for Diesel Fuel, Biodiesel Fuel, Diesel/Biodiesel Blends with Nominal Biodiesel Concentrations Up to 20 Percent (B20), Kerosene, and Fuel Oil, for electrically operated types, and shall be rated for the intended liquid(s). Refer to Annex C for equivalent Canadian standards.

5.3.5 Valves, if optionally provided to control liquid flows in and out of the tank, shall comply with the applicable requirements of UL/ULC 842, Standard for Valves for Flammable Fluids, or UL 842B, Standard for Valves for Diesel Fuel, Biodiesel Fuel, Diesel/Biodiesel Blends with Nominal Biodiesel Concentrations Up to 20 Percent (B20), Kerosene, and Fuel Oil, and shall be rated for the intended liquid(s). Fill limit valves shall comply with the normal function test per Section 29, Fill Signal Device Test.

5.3.6 Tank accessories for combustible liquids provided to indicate liquid levels in the tank shall comply with the applicable requirements of ANSI/CAN/UL/ULC 180, Standard for Combustible Liquid Tank Accessories, and shall be rated for the intended liquid(s). Fill signal devices shall comply with the normal Function test per Section 29, Fill Signal Device Test.

5.3.7 Tank accessories for flammable and combustible liquids provided for e-venting (emergency venting), n-venting (normal venting), or spill containment shall comply with the applicable requirements of UL 2583, Outline of Investigation for Fuel Tank Accessories, or CAN/ULC-S663, Spill Containment Devices for Aboveground Flammable and Combustible Liquid Storage Tanks, and shall be rated for the intended liquid(s).

5.3.8 For cooking oil tanks, internal heaters, and/or filter systems, if provided, shall comply with the applicable requirements of UL 499, Standard for Electric Heating Appliances, or CSA C22.2 No. 88, Construction and Test of Industrial Heating Equipment, UL 1889, Standard for Commercial Filters for Cooking Oil, or CSA C22.2 No. 109, Commercial Cooking Appliances, and shall have a maximum set temperature limit of 60°C (140°F) and an over-temperature limit.

5.3.9 For all combustible liquid tanks, optional conformance to requirements for large scale fire exposure with fire protection, as provided by wet-pipe sprinkler systems designed and installed per NFPA 30, Flammable and Combustible Liquids Code, or the National Fire Code of Canada, shall be determined in accordance with UL 2368, Standard for Fire Exposure Testing of Rigid Nonmetallic and Composite Nonmetallic Intermediate Bulk Containers for Combustible Liquids.

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6 Specific Construction of Special Purpose Containers and Tanks

6.1 Liquid chemical containers and tanks

6.1.1 Liquid chemical vessels shall be designed for storage of the specific combustible or noncombustible liquid(s) for the non-residential application(s) identified in NFPA 30, Chapter 9 (Storage of Liquids in Containers – General Requirements), Section 9.4 (Acceptable Containers and Tanks). This shall include, but is not limited to, fire resistance, chemical resistance, temperature range, use locations, and methods of fluid transfer in and out of the vessels. The designs shall have the specific construction features identified below and shall conform to the applicable requirements of Section 7, General Performance for All Special Purpose Containers and Tanks.

6.1.2 Liquid chemical containers and tank construction parameters and limitations, as identified in NFPA 30, Flammable and Combustible Liquids Code, Section 9.4, Acceptable Containers and Tanks shall be further divided into sub-types as follows:

a) Class II and IIIA Liquid Containers – NFPA 30, Section 9.4.1 (4) designs compliant with either US DOT Hazardous Materials Regulation Title 49 CFR Parts 100-199, or UN Recommendations on the Transport of Dangerous Goods Part 6, and in compliance with NFPA 30, Table 9.4.3.

b) Class II and IIIA Liquid Tanks – NFPA 30 Section 9.4.1 (6) designs compliant with either US DOT Hazardous Materials Regulation Title 49 CFR Parts 100-199, or UN Recommendations on Transport of Dangerous Goods Part 6 Classes 31H1, 31H2 and 31 HZ1, and in compliance with NFPA 30, Table 9.4.3.

c) Class IIIB Liquid Vessels – Any design types per (a) or (b) above. Or other primary, secondary or diked containment design types up to 2500 L (660 US gal) meeting all appropriate Performance requirements of this Standard.

d) Non-Combustible Liquid Vessels – Any design types per (a) or (b) above, or other primary, secondary or diked containment design types up to 5000 L (1320 US gal) meeting all appropriate Performance requirements of this Standard.

6.1.3 Each sub-type of liquid chemical container and tank shall have the following ratings identified, as applicable

a) Liquid Rating (s) – Liquid ratings shall cover either specific liquids or families of liquids with similar chemical composition, properties and compatibility characteristics as evaluated in this Standard, and in the same Liquid Class (per NFPA 30, Section 4.3).

b) Temperature Rating – Temperature ratings shall cover the periodic maximum expected temperatures of storage in general non-residential applications, 49°C (120°F), except if the vessel is designed and tested for wider temperature ranges.

c) Use Locations and Fire Protection – Options for indoor-only or indoor/outdoor ratings, with no expectation of sprinkler protection except Class II and IIIA types per (a) or (b) above.

d) Miscellaneous – Options for vessel stacking are permitted. Options for connection to pressure or vacuum pumps are permitted.

6.1.4 Required special features for liquid chemical vessels are as follows:

a) Vessels shall have emergency venting in the primary tank or container top surface to limit internal pressures under external fire conditions as follows:

1) Class II or IIIA Liquid Vessels covered by 6.1.2 (a) or(b):

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One or more e-vent device(s) that limits tank pressures to 70 kPa (10.0 psi) or 30 % of the vessel burst strength (whichever is greater) per NFPA 30 Section 9.4.2. The vessel shall additionally comply with sub-paragraphs 9.4.2.1 to 9.4.2.3 of NFPA 30, as applicable;

2) Class IIIB Liquid Vessels covered by 6.1.2(c):

At least one e-vent device set to open at ≥ 35 kPa (5 psi) with minimum 170 m^3/h (6,000 CFH) air flow capacity and combined venting that limits tank pressures to 70 kPa (10.0 psi) or 30 % of the vessel burst strength (whichever is greater); or

3) Non-Combustible Liquid Vessels covered by 6.1.2(d):

At least one e-vent device set to open at ≥ 35 kPa (5 psi) and combined venting that limits tank pressures to 70 kPa (10.0 psi) or 30 % of the vessel burst strength (whichever is greater).

4) If applicable, the requirements of Section 16, Venting Tests, shall be used to verify vent opening and flow parameters, and the requirements of 16.5 shall be applied to verify whether a Hydrostatic Strength Test shall be used to verify tank burst strength pressures, and that any fusible link type vent opens at 150°C (300°F) or less.

b) Normal Vents – The primary vessel normal vent shall be at least equal in area to the largest fill or withdraw opening, or shall conform to the requirements of Section 16, Venting Tests, for 'reduced areas' smaller than this value.

c) Combined Venting – Combined normal and emergency vents are permitted, provided that the requirements of both (a) and (b) above are met.

6.1.5 Optional components and accessories for liquid chemical tanks covered by this Standard are:

a) Handles – If either integral handles or lift lugs for transport are provided, they shall conform to the requirements of Section 20, Handling and Lug Strength Test.

b) Supports – If supports are either molded with or assembled to the vessel, they shall conform to the requirements of Section 23, Stability Test, and Section 24, Support Load Test.

c) Other Components and Accessories – Other optional components and accessories identified in 5.3, Functional Components and Accessories, are permitted, if they comply with the referenced standard in each case.

6.1.6 Neither shelves nor their mounting points are permitted on liquid chemical vessels.

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6.2 Cooking oil tanks

6.2.1 Cooking oil tanks shall be designed to integrate with engineered transfer systems for either delivery of fresh oil or collection of waste oils through piping networks by trained persons using service trucks with pressure or vacuum pumps. The tank design shall have the specific construction features identified below, and shall be evaluated to the applicable Section 7, General Performance for All Special Purpose Containers and Tanks.

6.2.2 Primary tanks with covered open tops are permitted, where:

a) For transfer of waste oil;

1) The process shall be visibly controlled and the applicable Markings and Instructions shall be required; or

2) Fill limit valves shall comply with UL 2583, Outline of Investigation for Fuel Tank Accessories, and CAN/ULC-S661, Standard for Overfill Protection Devices for Flammable and Combustible Liquid Storage Tanks; or

3) Fill signal devices shall comply with either UL/ULC 180 or Section 29; and

b) A cover shall extend over the entire top opening and provides access (readily removable or hinge connected).

6.2.3 The cover is permitted to have fittings (per 5.2.2).

6.2.4 The unsealed space between the tank and the cover may be designed to achieve adequate venting [per 6.2.7 (a) and (b)].

6.2.5 Primary tanks with uncovered open tops are not permitted.

6.2.6 Cooking oil tank construction parameters and limitations are as follows:

a) Stored Liquids – Class IIIB Cooking Oils Only, such as fresh or waste liquids extracted from either plants (such as corn, soy, canola, palm, or vegetable oils) and/or animals (such as fats or grease) used in cooking or food preparation processes.

b) Containment Types and Sizes – Primary, Secondary or Diked containment types with or without compartments, with a total capacity range of 227 to 757 L (60 to 200 US gal).

c) Liquid Temperatures – Maximum temperatures of liquids entering the tank or from internal heaters are 60°C (140°F) continuous and 113°C (235°F) intermittent.

d) Use Location and Fire Protection – The tanks may be rated for either indoor-only or indoor/outdoor use, with no requirement for sprinkler/extinguishing protection.

e) Stacking – Specification by the manufacturer that the tank may be stacked is not permitted.

NOTE: Specification by the manufacturer of options for connection to pressure or vacuum pumps is expected.

6.2.7 Required special features for cooking oil tanks are as follows:

a) Emergency Vents – The primary tank emergency vent and interstitial space emergency vent shall each have an equivalent vent area to that of a pipe diameter of at least 19 mm (0.75 in) for tanks ≤ 379 L (100 US gal) or 25.4 mm (1.00 in) for tanks > 379 L (100 US gal). Vents that do not meet this area requirement ('reduced area' e-vents), thermally actuated or pressure relief devices, or form-of-construction designs shall conform to the requirements of Section 16, Venting Tests;

b) Normal Vents – The primary tank normal vent area shall be at least equal to that of the largest fill or withdraw opening, or shall conform to the requirements of Section 16, Venting Tests, to verify effective venting for reduced areas;

c) Combined Venting – Combined normal and emergency vents are permitted, provided that the requirements of both (a) and (b) above are met; and

d) Tank Anchors – A means to secure the tank shall be provided, such as wall brackets or floor support, and shall be evaluated to Section 23, Stability Test, for stability.

6.2.8 Optional components and accessories for cooking oil tanks covered by this Standard are:

a) Tank Supports – If supports to elevate or stabilize the tank are either molded with or assembled to it, they shall be evaluated to Section 23, Stability Test, and Section 24, Support Load Test;

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b) Tank Handles – If either integral handles or lift lugs for transport are provided, they shall be evaluated to Section 20, Handling and Lug Strength Test, at 2 times the empty assembled tank weight;

c) Oil Heaters – If provided, heaters shall comply with 5.3.8 and shall have a maximum set temperature limit of < 60°C (140°F); and

d) Optional Accessories – Refer to Table 6.1

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Table 6.1
Reference Table for Construction Requirements

Vessel	Liquid ratings[1]	Vessel type and size L (US gal)	Temperature rating[1] C (F)	Use locations	Fire protection	Stacking	Connection to pressure or vacuum pumps	Venting	Tank anchors	Optional components and accessories	Specific markings
Liquid Chemical Containers, 6.1	– Class II and IIIA Liquid Containers, 6.1.2(a) – Class II and IIIA Liquid Tanks, 6.1.2(b) – Class IIIB Liquid Vessels, 6.1.2(c) – Non-Combustible Liquid Vessels, 6.1.2(d)	– As per 6.1.2 (a), Compliant with Codes – As per 6.1.2 (b), Compliant with Codes – (a) or (b) above. Or other primary, secondary or diked containment design types up to 2500 L (660 US gal) – (a) or (b) above. Or other primary, secondary or diked containment design types up to 5000 L (1320 US gal)	As per 6.1.3(b), Max 49°C (120° F)[2]	indoor-only or indoor/outdoor rating, as per 6.1.3(c)	no expectation of sprinkler protection except Class II and IIIA types per (a) or (b) above, as per 6.1.3(c)	Permitted, as per 6.1.3(d)	Permitted, as per 6.1.3(d)	Emergency venting required, as per 6.1.4(a); Normal venting Required as per 6.1.4(b); Combined Venting permitted as per 6.1.4(c)	N/A?	As per 6.1.5, Handles, Supports, and Other[3]	As per 38.1
Cooking Oil Tanks, 6.2	As per 6.2.6(a), Class IIIB Cooking Oils Only	As per 6.2.6(b), Primary, Secondary or Diked containment types with or without compartments, with a total capacity range of 227 to 757 L (60 to 200 US gal); As per 6.2.2, Primary tanks with covered open tops are permitted	As per 6.2.6(c), max 60°C (140° F) continuous and 113°C (235° F) intermittent	As per 6.2.6(d), indoor-only or indoor/outdoor rating	As per 6.2.6(d), no requirement for sprinkler/extinguishing protection	As per 6.2.6(e), Not permitted	As per 6.2.6(e), Specification by the manufacturer expected	Emergency Venting required as per 6.2.7(a); Normal Venting required as per 6.2.7(b); Combined venting permitted as per 6.2.7(c)	Required as per 6.2.7(d)	As per 6.2.8, Handles, and Supports, oil heaters, Racks/Shelves[4], Fill Limit Valves[5], Fill Signal Devices[6], and Other[3]	As per 38.2
Lube Oil Tanks, 6.3	As per 6.3.2(a), Class IIIB motor oils, working oils, or similar oils	As per 6.3.2(b), primary, secondary or diked containment types with or without compartments, with a total capacity range of 227 to 3000 L	As per 6.3.2(c), max 49°C (120° F)[2]	As per 6.3.2(d), indoor only or indoor/outdoor rating	As per 6.3.2(d), no expectation of sprinkler protection, except if additionally evaluated per 5.3.9	As per 6.3.2(e), is permitted	As per 6.3.2(e), is permitted	Emergency Venting required as per 6.3.3(a); Normal Venting required as per 6.3.3(b); Combined Venting permitted as per 6.3.3(c)	Required as per 6.3.3(d)	As per 6.3.4, Handles, and Supports, oil heaters, Collection Funnels, Racks/Shelves[4], Fill Limit Valves[5], Fill Signal Devices[6], and Other[3]	As per 38.3

Table 6.1 Continued on Next Page

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Table 6.1 Continued

Vessel	Liquid ratings[1]	Vessel type and size L (US gal)	Temperature rating[1] C (F)	Use locations	Fire protection	Stacking	Connection to pressure or vacuum pumps	Venting	Tank anchors	Optional components and accessories	Specific markings
		(60 to 793 US gal). Smaller tanks are permitted if intended for stacking with total aggregate capacity ≥ 227 L (60 US gal)									
Vehicle Fluid Tanks, 6.4	As per 6.4.2(a), Only non-combustible fluids such as antifreeze/coolants, windshield washer, DEF or other fluid types typically used in vehicles	As per 6.4.2(b), Primary, secondary or diked containment types with or without compartments, with a total capacity range of 227 to 5000 L (60 to 1325 US gal). Smaller tanks are permitted if they are designed for stacking with a total aggregate capacity ≥ 227 L (60 US gal)	As per 6.4.2(c), max 49°C (120° F)[2]	As per 6.4.2(d), indoor only or indoor/outdoor ratings	As per 6.4.2(d), no expectation of sprinkler protection, except if additionally evaluated per 5.3.9	As per 6.4.2(e), is permitted	As per 6.3.4(e), is permitted	Emergency Venting[7] not required as per 6.4.3(a); Normal Venting required as per 6.4.3(b); Combined Venting permitted as per 6.4.3(c)	Required as per 6.4.3(d)	As per 6.4.4, Handles, and Supports, DEF heaters, Racks/Shelves[4], Fill Limit Valves[5], Fill Signal Devices[6], and Other[3]	As per 38.4

[1] Each sub-type of liquid chemical container and tank shall have the following ratings identified, as applicable

[2] Periodic maximum expected temperature of storage in general non-residential applications, except if the vessel is designed and tested for wider temperature ranges

[3] Other Components and Accessories – Other optional components and accessories identified in 5.3, Functional Components and Accessories, are permitted, if they comply with the referenced standard in each case.

[4] Racks and Shelves – If provided, equipment racks, storage shelves or similar loading devices integral to the tank shall conform to the requirements of Section 22, Top, Side and Shelf Loads Test, and Section 23, Stability Test

[5] Fill Limit Valves – If provided, fill limit valves shall be designed to greatly reduce oil flow into, and eliminate pressurizing of, the tank after reaching the rated capacity, and shall conform to the requirements of Section 29, Fill Signal Device Test

[6] Fill Signal Devices – If provided, fill signal devices shall be low voltage float and switch types, designed to visually signal when a tank reaches rated capacity, and shall conform to the requirements of Section 29, Fill Signal Device Test.

[7] For high alcohol windshield washer blends rated Class IIIB combustible liquids, emergency vent shall be sized in accordance with 6.3.3(a).

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6.3 Lube oil tanks

6.3.1 Lube oil tanks intended for Class IIIB motor oils, working oils, or similar oils shall be designed for general storage of, and integration with, equipment to transfer them in and out of the tank by trained persons using pressure or vacuum pumps through hoses, or manual dispensing and collection. The tank design shall have specific construction features below, and shall be evaluated to the applicable Section 7, General Performance for All Special Purpose Containers and Tanks, in this Standard.

6.3.2 Lube oil tank construction parameters and limitations are as follows:

a) Liquid Ratings – only class IIIB motor oils (such as lubricating, transmission, cooling, etc.), working oils (such as hydraulic, brake, cutting, etc.) or other petroleum and synthetic oils with similar chemical and physical properties;

b) Containment Types and Sizes – primary, secondary or diked containment types with or without compartments, with a total capacity range of 227 to 3000 L (60 to 793 US gal). Smaller tanks are permitted if intended for stacking with total aggregate capacity ≥ 227 L (60 US gal);

c) Temperature Rating – periodic maximum expected temperatures of storage in general non-residential applications are 49°C (120°F), except if specially evaluated for wider ranges;

d) Use Locations and Fire Protection – options for indoor only or indoor/outdoor ratings, with no expectation of sprinkler protection, except if additionally evaluated per 5.3.9; and

e) Miscellaneous – options for vessel stacking is permitted, options for connection to pressure or vacuum pumps is permitted.

6.3.3 Required special features for lube oil tanks are as follows:

a) Emergency Vents – The primary tank and interstitial space emergency vent shall each have an equivalent vent area to at least the nominal pipe sizes for tank capacities as follows. Vents that do not meet this area requirement, thermally actuated or pressure relief devices, or form-of-construction designs shall conform to the requirements of Section 16, Venting Tests:

Tank Cap L (US gal)	Up to 227 (60)	228 – 379 (61 – 100)	380 – 606 (101 – 160)	607 – 946 (161 – 250)	947 – 1363 (251 – 360)	1364 – 2498 (361 – 660)	2499 – 3002 (661-793)
Nominal Pipe Size mm (in)	19.1 (0.75)	25.4 (1.00)	31.8 (1.25)	38.1 (1.50)	50.8 (2.00)	63.5 (2.50)	76.2 (3.00)

b) Normal Vents – The primary tank normal vent area shall be at least equal to that of the largest fill or withdraw opening, or shall conform to the requirements of Section 16, Venting Tests, to verify effective venting for reduced areas;

c) Combined Venting – Combined normal and emergency vents are permitted, provided both (a) and (b) are met; and

d) Tank Anchors – A means to secure the tank shall be provided, such as wall brackets or floor support, and shall be evaluated to Section 23, Stability Test, for tank stability.

6.3.4 Optional components and accessories for lube oil tanks covered by this Standard are:

a) Tank Supports – If supports to elevate or stabilize the tank are either molded with or assembled to it, they shall be evaluated to Section 23, Stability Test, and Section 24, Support Load Test;

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b) Tank Handles – If either integral handles or lift lugs for transport are provided, they shall be evaluated to Section 20, Handling and Lug Strength Test, at 2 times the empty assembled tank weight;

c) Oil Heaters – If provided, heaters shall comply with 5.3.8 and shall have a maximum set temperature limit of < 60°C (140°F);

d) Collection Funnels – If provided, collection funnels shall be secured to the top opening and have a mesh screen with a compartment at least 203 mm (8 in) diameter x 102 mm (4 in) high above it; and

e) Optional Accessories – Refer to Table 6.1.

6.4 Vehicle fluid tanks

6.4.1 Vehicle fluid tanks intended for non-combustible vehicle fluids shall be designed for general storage of, and integration with, equipment to transfer the liquids in and out of the tank using pressure or vacuum pumps through hoses, or by manual dispensing and collection, by trained persons. The tank design shall have the specific construction features below and shall conform to the applicable requirements of Section 7, General Performance for All Special Purpose Containers and Tanks.

6.4.2 Vehicle fluid tank construction parameters and limitations are as follows:

a) Liquid Ratings – Only non-combustible fluids such as antifreeze/coolants (ethylene-glycol and water mixtures), windshield washer (alcohol, water and detergent mixtures), DEF (nominal 1/3 urea 2/3 water, diesel exhaust solution) or other fluid types typically used in vehicles;

b) Containment Types and Sizes – Primary, secondary or diked containment types with or without compartments, with a total capacity range of 227 to 5000 L (60 to 1325 US gal). Smaller tanks are permitted if they are designed for stacking with a total aggregate capacity ≥ 227 L (60 US gal);

c) Temperature Rating – Periodic maximum expected temperatures of storage in general non-residential applications are 49°C (120°F), except if specially evaluated for wider ranges;

d) Use Locations and Fire Protection – Options for indoor only or indoor/outdoor ratings, with no expectation of sprinkler protection, except if additionally evaluated per 5.3.9; and

e) Miscellaneous – Options for vessel stacking are permitted. Options for connection to pressure or vacuum pumps are permitted.

6.4.3 Required special features for vehicle fluid tanks are as follows:

a) Emergency Vents – Not required for non-combustible liquids;

Exception: For high alcohol windshield washer blends rated Class IIIB combustible liquids, emergency vent shall be sized in accordance with 6.3.3(a).

b) Normal Vents – The primary tank normal vent shall be at least equal to the largest fill or withdraw opening, or shall be evaluated to Section 16, Venting Tests, to verify effective venting for reduced areas;

c) Combined Venting – Combined normal and emergency vents are permitted, provided both (a) and (b) are met; and

d) Tank Anchors – A means to secure the tank shall be provided, such as wall brackets or floor support, and shall be evaluated to Section 23, Stability Test, for tank stability.

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6.4.4 Optional components and accessories for vehicle fluid tanks covered by this Standard are:

a) Tank Supports – If supports to elevate or stabilize the tank are either molded with or assembled to it, they shall be evaluated to Section 23, Stability Test, and Section 24, Support Load Test;

b) Tank Handles – If either integral handles or lift lugs for transport are provided, they shall be evaluated to Section 20, Handling and Lug Strength Test, at 2 times the empty assembled tank weight;

c) DEF Heaters – If provided, heaters shall comply with 5.3.8 and shall have a maximum set temperature limit of < 60°C (140°F); and

d) Optional Accessories – Refer to Table 6.1.

PERFORMANCE TESTS

7 General Performance for All Special Purpose Containers and Tanks

7.1 All applicable tests for the specific special purpose vessel in a design series shall be conducted on coupons cut from representative production samples of completely assembled vessels, accessories, components or materials, or on the complete item, as applicable, unless special samples are made from the same materials and processes. Unless otherwise indicated, all tests shall be conducted at 10 to 32°C (50 to 90°F). All pressures shall be measured with respect to gauge (psig).

7.2 Table 7.1 identifies the general matrix of different performance test sections and tables which provide details of applicable tests for each special purpose vessel type.

Table 7.1
Special Purpose Vessel Tests

General test matrix	Liquid chemical vessels	Cooking oil tanks	Lube oil tanks	Vehicle fluid tanks
Material Property and Compatibility	Sections 8 – 14, Table 8.1	Sections 8 – 14, Table 8.1	Sections 8 – 14, Table 8.1	Sections 8 – 14, Table 8.1
Design Strength	Sections 15 – 18, Table 15.1	Sections 15 – 18, Table 15.1	Sections 15 – 18, Table 15.1	Sections 15 – 18, Table 15.1
Assembly and Installation	Sections 19 – 29, Table 19.1	Sections 19 – 29, Table 19.1	Sections 19 – 29, Table 19.1	Sections 19 – 29, Table 19.1
Fire Resistance	Sections 30 – 34, Table 30.1	Sections 30 – 34, Table 30.1	Sections 30 – 34, Table 30.1	Sections 30 – 34, Table 30.1

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7.3 A “worst case” material sample is permitted to be selected to represent alternate grades and components within a polymer type, based on measured properties (such as strength, density, hardness, etc.), analytical data (such as IR, DSC, TGA, etc.), or other comparative information.

7.4 Any analytical and/or property tests as appropriate for the generic nonmetallic material type are permitted to be used in order to determine the “worst case” material (s), but if conducted, shall be in accordance with the following test methods.

a) UL 746A – Standard for Polymeric Materials – Short Term Property Evaluations for identification tests such as IR, DSC, TGA or others basic measures, such as Density or Ash Content;

b) UL 746B – Standard for Polymeric Materials – Long Term Property Evaluations for material changes after thermal aging;

c) UL 746C – Standard for Polymeric Materials – Use in Electrical Equipment Evaluations for small scale flame tests.

7.5 A “worst case” vessel, accessory or component sample is permitted to be selected to represent construction variations within a design series, based on shape, capacity, dimensions, thickness, ratings, options, materials, and other factors with respect to the specific test(s) to be conducted.

7.6 Assessment of damage to the tank, accessories and options, if required, shall be conducted after each physical test. Unless specific types of damage are identified as non-compliant, the manufacturer shall identify what type and degree of damage is not acceptable to judge compliance against, provided all of the following conditions are met:

a) The unacceptable damage is obviously visible to the installer prior to use, or the user after installation; and

b) Markings per 37.2(b) require the tank not to be placed in service, or to be taken out of service, if unacceptable damage is found; and

c) Instructions per 39.1 shall provide details of the type and degree of unacceptable damage.

MATERIAL PROPERTY AND COMPATIBILITY TESTS

8 General

8.1 Representative seamed and/or un-seamed samples as applicable, of the “worst case” polymer grade (s) for each generic vessel material type shall be subjected to the appropriate material property tests in the “as-received” (AR) condition, and following each long term or other exposures as indicated in Table 8.1. A minimum of 3 samples are required for each test set to obtain an average property value for comparison, and the same sample types shall be used for the sequence of tests defined by the table columns.

Table 8.1
Material Property and Compatibility Test Exposure Conditions

Clause	Liquid chemical vessels	Cooking oil tanks	Lube oil tanks	Vehicle fluid tanks
Thermal Aging	9.1(a)	9.1(b)	9.1(c)	9.1(d)
Stored Liquids Compatibility	10.1(a)	10.1(b)	10.1(c)	10.1(d)
Chemical Resistance	11.1(a)	11.1(b)	11.1(c)	11.1(d)
Sunlight Resistance	12.1(a)	12.1(b)	12.1(c)	12.1(d)
Small Flame Resistance	13.1(a)	13.1(b)	13.1(c)	13.1(d)
Section 14 Special Compatibility	Thermal cycling for heater option	Thermal cycling required	Thermal cycling for heater option	Thermal cycling for heater option
NOTE: Table 8.1 defines the exposure conditions for each test and vessel type. Refer to the relevant sections for pass/fail criteria, etc.				

8.2 The thickness of all test samples shall be within ±10 % of the average tank wall thickness as measured in the center of each test plaque or bar. If the average as-received seamed and unseamed sample material property results vary by more than 10 %, both sample types shall be evaluated in additional material property tests, otherwise, unseamed samples shall be used and compared to unseamed samples for the calculation of percentage physical property retention.

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8.3 All samples shall be conditioned for 8 to 48 h at 20 ±3°C (68 ±3°F) and 50 ±5 % RH prior to testing to any of the described methods.

8.4 The average of the measured values of the samples in each test set shall be used to determine compliance with the requirements of this Standard, but standard deviation, precision and bias, and other statistical calculations that may be identified in a referenced ASTM Method are not required.

a) Thermosets – Flexural Strength and Impact Strength tests shall be used to assess the polymer strength. Flexural Strength testing shall be in accordance with the Sections for Apparatus, Specimens, Procedure A or B and Calculations in ASTM D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials. Impact testing shall be in accordance with the Sections for Apparatus, Specimens, Notching and Procedure A or C in ASTM, D256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.

b) Thermoplastic – Tensile Strength and Tensile-Impact tests shall be used to assess the polymer strength. Tensile Strength testing shall be in accordance with the Sections for Apparatus, Specimens, Procedure, Speed and Calculations in ASTM D638, Standard Test Method for Tensile Properties of Plastics, except only for break values. Tensile Impact testing shall be in accordance with the Sections for Apparatus, Specimens, Procedure and Calculations in ASTM D1822, Standard Test Method for Tensile-Impact Energy to Break Plastics and Electrical Insulating Materials.

c) Composite type materials (non-metallic integral with metallic) shall be subjected to a 6.78 J (5.0 ft-lb) impact with a 50.8 mm (2.0 in) steel ball dropped onto the center outside surface of the material clamped in a 152 mm (6.0 in) diameter steel ring. There shall be no cracking, disbonding or delamination or other damage that would reduce the composite's critical mechanical strength or material compatibility properties.

8.5 As an alternative to the percentage physical property value retention criteria of Sections 9 to 10, samples for small tank components with different materials, such as fittings, are permitted to be evaluated using pass/fail tests results, such as the Section 21, Drop Test, Section 27, Puncture Impact Test, and Section 25, Fitting Torque Test, and Section 26, Fitting Bending Test, followed by Section 17, Leakage Test.

9 Thermal Aging Tests

9.1 The appropriate physical property tests for each material per Section 8, General, shall be repeated after thermally aging the samples in an air circulating oven for the temperature and time(s) below for each vessel type.

a) Liquid Chemical Vessels – 60 days at 87°C (189°F);

b) Cooking Oil Tanks – 90 days at 87°C (189°F);

c) Lube Oil Tanks – 90 days at 87°C (189°F); or

d) Vehicle Fluid Tanks – 90 days at 87°C (189°F).

9.2 The average physical property results after thermal aging shall be at least 70 % of the as-received values, or for composite materials shall meet the requirements of 8.5.

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10 Stored Liquids Compatibility Tests

10.1 The appropriate physical property tests for each material per Section 8, General, shall be repeated after immersing samples in representative liquids at the temperature and time(s) below for each vessel type.

a) Liquid Chemical Vessels – 60 days at 60°C (140°F) in test liquid(s) that chemically represent the:

1) Rated liquid(s), or

2) Rated family(ies) of liquid(s)

b) Cooking Oil Tanks – 90 days at 60°C (140°F) test liquids representative of cooking oils and fats:

1) Soybean oil (food grade), and

2) CriscoTM shortening (food grade).

c) Lube Oil Tanks – 90 days at 60°C (140°F) in test liquids representative of;

1) Motor Oils – 50/50 mix of SAE 10W-30 grade conventional and synthetic oils, and

2) Working Oils – 50/50 mix of ATF+4 Transmission Fluid and DOT 3 Brake Fluid.

d) Vehicle Fluid Tanks – 90 days at 60°C (140°F) test liquid representative of;

1) Antifreeze – 50/50 mix of ethylene-glycol and water;

2) Washer Fluid – 75/25 mix of water and methanol;

3) DEF – Nominal 1/3 urea 2/3 deionized water solution; and

4) Other optional vehicle fluids not represented by the above.

10.2 All test liquids shall be commercial types – see Annex B.

10.3 The average physical property results after stored liquid immersions shall be at least 70 % of the as-received values, or for composite materials shall meet the requirements of 8.5.

11 Chemical Resistance Tests

11.1 The appropriate physical property tests for each material per Section 8, General, shall be repeated after immersing samples in representative liquids at the temperature and time(s) below for each vessel type.

a) Liquid Chemical Vessels – 60 days at 60°C (140°F) in test liquid(s) of;

1) pH 3 Sulfuric Acid and pH 10 Sodium Carbonate/Bicarbonate, and

2) For outdoor ratings, Saturated Sodium Chloride and Distilled Water.

b) Cooking Oil Tanks – 90 days at 60°C (140°F) test liquids of

1) pH 3 Sulfuric Acid and pH 10 Sodium Carbonate/Bicarbonate, and

2) For outdoor ratings, Saturated Sodium Chloride and Distilled Water.

c) Lube Oil Tanks – 60 days at 60°C (140°F) in test liquid(s) of;

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1) pH 3 Sulfuric Acid and pH 10 Sodium Carbonate/Bicarbonate, and

2) For outdoor ratings, Saturated Sodium Chloride and Distilled Water.

d) Vehicle Fluid Tanks – 60 days at 60°C (140°F) in test liquid(s) of;

1) Antifreeze – 50/50 mix of ethylene-glycol and water;

2) Washer Fluid – 75/25 mix of water and methanol;

3) DEF – Nominal 1/3 urea 2/3 deionized water solution; and

4) Other optional vehicle fluids not represented by the above.

11.2 The average physical property results after liquid chemical immersions shall be at least 70 % of the as-received values, or for composite materials shall meet the requirements of 8.5.

12 Sunlight Resistance Tests

12.1 The appropriate physical property tests for each material per Section 8, General, shall be repeated after exposing samples to either ASTM simulated UV light test methods, ASTM G153, Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials, or ASTM G155, Standard Practice for Operation Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials, with a cycle rate of 17 min light followed by 3 min light + water, at the equivalent time(s) below for each vessel type.

a) Liquid Chemical Vessels:

1) 360 h ASTM G153 Carbon Arc, or

2) 720 h ASTM G155 Xenon Arc.

b) Cooking Oil Tanks:

1) 500 h ASTM G153 Carbon Arc, or

2) 1000 h ASTM G155 Xenon Arc.

c) Lube Oil Tanks;

1) 500 h ASTM G153 Carbon Arc, or

2) 1000 h ASTM G155 Xenon Arc.

d) Vehicle Fluid Tanks;

1) 500 h ASTM G153 Carbon Arc, or

2) 1000 h ASTM G155 Xenon Arc.

12.2 The average physical property results after sunlight exposures shall be at least 70 % of the as-received values, or for composite materials shall meet the requirements of 8.5.

13 Small Flame Resistance Tests

13.1 The appropriate small scale flame tests for one sample of each material tested per UL 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, or CAN/ULC-S127, Standard Corner Wall Method of Test for Flammability Characteristics on Non-Melting Foam Plastic Building

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Materials, shall be used for comparison of burn rates before and after the exposures defined in Sections 9 to 12.

a) Liquid Chemical Vessels – HB;

b) Cooking Oil Tanks – HB;

c) Lube Oil Tanks – HB;

d) Vehicle Fluid Tanks – HB.

13.2 The burn rate after the sequence of exposures shall not exceed the average of at least 3 as-received samples by 20 % or more.

14 Special Compatibility Tests

14.1 Thermal Cycling – For vessels subject to frequent normal temperature changes, the appropriate physical property tests for each material per Section 8, General, shall be repeated after subjecting the samples to thermal cycling as described below for each vessel type:

a) Liquid Chemical Tanks – Not Applicable;

b) Cooking Oil Tanks – 400 cycles at 85°C to 40°C (185°F to 104°F), in 50/50 mix of liquids per 10.1(b);

c) Lube Oil Tanks – If heated, 500 cycles at X°C to 20°C (X°F to 68°F) in oils per 10.1(c)(1);

d) Vehicle Fluid Tanks – If heated, 500 cycles at X°C to 20°C (X°F to 68°F) in fluids per 10.1(d)(3).

Exception: If optional heaters are provided, the high test temperature X in the cycle range shall be 10°C (18°F) above the high temperature set limit.

14.2 At least 6 cycles/day shall be completed, with the high and low temperatures maintained for at least 1 h within a ±2°C (±4°F) range.

14.3 The average physical property results after stored liquid immersions shall be at least 70 % of the as-received values, or for composite materials shall meet the requirements of 8.5.

DESIGN STRENGTH TESTS

15 General

15.1 Representative sample(s) of the “worst case” size, shape, thickness and polymer grade variation(s) for each special purpose vessel type and design series shall be subjected to the appropriate Design Strength Tests as indicated in Table 15.1. The tests are permitted to be conducted on the same sample, and/or in a sequence that reduces the number of samples.

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Table 15.1
Design Strength Test Exposure Conditions

Clause	Liquid chemical vessels	Cooking oil tanks	Lube oil tanks	Vehicle fluid tanks
Venting	16.1(a)	16.1(b)	16.1(c)	16.1(d)
Leakage	17.1(a)	17.1(b)	17.1(c)	17.1(d)
Strength	18.1(a)	18.1(b)	18.1(c)	18.1(d)
NOTE: Table 15.1 defines the exposure conditions for each test and vessel type. Refer to the relevant sections for pass/fail criteria, etc.				

16 Venting Tests

16.1 Vessels with normal, emergency or combined venting for each special purpose type described in Sections 5 and 6 shall be subject to verification of device functional operation at specific parameters and/or measurement of flow characteristics for permitted exceptions to the minimum construction requirements, according to the test methods in 16.2 through 16.5 as applicable and as follows:

a) Liquid Chemical Vessels – For DOT or UN types allowed per NFPA 30 Section 9.4.1 (4) and (6) that are not 3rd party tested:

1) Class II or IIIA Liquid Vessels covered by 6.1.2 (a) or (b) – Verify that individual and/or combined e-venting complies with the requirements in 6.1.4(a)(1).

2) Class IIIB Liquid Vessels covered by 6.1.2(c) – Verify that individual and/or combined e-venting complies with the requirements in 6.1.4(a)(2).

3) Non-Combustible Liquid Vessels covered by 6.1.2 (d) – Verify that individual and/or combined e-venting complies with the requirements in 6.1.4(a)(3).

b) Cooking Oil Tanks – For cooking oil tank vents not meeting the minimum emergency and normal venting size requirements in 6.2.7 (a) and (b):

1) Reduced E-Vents – Verify that emergency venting has a minimum 170 m^3/h (6,000 CFH) air flow capacity for tank volumes less than 379 L (100 US gal) or 285 m^3/h (10,000 CFH) air flow capacity for tank volumes 379 to 757 L (100 – 200 US gal), or limits tank pressures to the lesser of 70 kPa (10 psi) or 1/3 of the vessel burst strength at these flow rates; or has adequate venting via thermally actuated or pressure relief devices evaluated per UL 2583, Outline of Investigation for Fuel Tank Accessories, or has a form-of-construction design shall comply with Section 34, Comparative Fire Test for Cooking Oil Tanks.

2) Reduced N-Vents – Verify that normal venting limits tank pressures to 70 kPa (10 psi) or 1/3 of the vessel burst strength at the maximum rated inlet flow.

3) Primary tanks with covered open tops shall comply with 6.2.2.

c) Lube Oil Tanks – For lube oil tanks not meeting the minimum emergency and normal venting sizes in 6.3.3 (a) and (b):

1) Reduced E-Vents – Verify that emergency venting limits tank pressures to the lesser of 70 kPa (10 psi) or 1/3 of the vessel burst strength at the flow rates; or has adequate venting of thermally actuated or pressure relief devices evaluated per UL 2583, Outline of Investigation for Fuel Tank Accessories, or has a form-of-construction design shall comply with Section 34, Comparative Fire Test for Cooking Oil Tanks.

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2) Reduced N-Vents – Verify that normal venting limits tank pressures to 35 kPa (5 psi) or 1/5 of the vessel burst strength at the maximum rated inlet flow.

d) Vehicle Fluid Tanks – For lube oil tanks not meeting the minimum emergency and normal venting sizes in 6.4.3 (a) and (b):

1) Reduced E-Vents – Verify that emergency venting limits tank pressures to the lesser of 70 kPa (10 psi) or 1/3 of the vessel burst strength at the flow rates for the standard vent size.

2) Reduced N-Vents – Verify that normal venting limits tank pressures to 35 kPa (5 psi) or 1/5 of the vessel burst strength at the maximum rated inlet flow.

16.2 All tests shall be conducted on vessels with vent openings, vent pipes or venting devices attached, or other equipment that simulates the vessels venting means. Vessel openings other than for venting shall be plugged, except to facilitate air input from a source capable of the maximum flow rates to be evaluated.

16.3 Pressure shall be measured at any point on the vessel at least 152 mm (6 in) from the vents or inlet opening, or if a piping network is used at least 5 times the pipe ID from the end. If used, pipes shall be the same size as the outlet or device. Pressure gauges shall have a range suitable for the expected results with increments no larger than 3.4 kPa (0.5 psi), and at least 1 % accuracy.

16.4 The flow rate shall be measured on a pipe connected to the vessel outlet or vent device at a point that is at least 10 times the pipe ID from the end. The pipe shall be the same size as the outlet or device. Flow meters shall have a range suitable for the expected results with increments no larger than 0.7 m^3/h (25 CFH), and at least 2 % accuracy.

16.5 For thermally actuated vents, the temperature at which the device operates (opens) shall be measured by placing it in an oven at least 5°C (9°F) below the required actuation temperature. The oven temperature shall then be increased at a rate of 1°C (1.8°F) every 10 min until the device actuates. The actuation temperature shall be within the requirements in 16.1.

17 Leakage Test

17.1 Primary vessels shall not leak or permanently deform when evaluated in accordance with one of the test methods in 17.2 through 17.4 for compliance with the pressure and/or vacuum values below for each special purpose vessel type. Primary tanks with covered open tops allowed per 6.2.2 shall comply with 17.6. Secondary tanks shall conform to the requirements of 17.5. Dike tanks shall comply with 17.6:

a) Liquid Chemical Vessels – The greater value of:

1) 34.5 kPa (5.0 psi), or

2) 1/5 of the vessel burst strength.

b) Cooking Oil Tanks – The greater value of:

1) Plus 20.7 kPa (3.0 psi) pressure and minus 20.7 kPa (3.0 psi) vacuum, or

2) 1.5 times the manufacturer's pressure and vacuum rating.

c) Lube Oil Tanks – The greater value of:

1) Plus 20.7 kPa (3.0 psi) pressure and minus 20.7 kPa (3.0 psi) vacuum, or

2) 1.5 times the manufacturer's pressure and vacuum rating.

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d) Vehicle Fluid Tanks The greater value of:

1) Plus 20.7 kPa (3.0 psi) pressure and minus 20.7 kPa (3.0 psi) vacuum, or

2) 1.5 times the manufacturer's pressure and vacuum rating.

17.2 All openings shall be plugged or capped, with vent devices or accessories removed or disabled, and gauges or meters added to facilitate testing under the pressure and/or vacuum conditions above. The vacuum or pressure shall then be slowly applied, and if deformation occurs, is permitted to be stabilized before testing for leakage.

17.3 When air is used to pressure test the vessel, sustained bubbles found on the exterior surface after spraying with a soap/water solution is evidence of leakage. When water is used to pressurize the vessel, water is found on the exterior surface by visual exam or blotting paper is evidence of leakage. The test time shall be at least 1 min.

17.4 When vacuum is applied to test the vessel, leakage occurs if there is an increase in the gauge pressure after initial stabilization due to deformation. The minimum test time shall be 1 h, and Ideal Gas Law corrections to pressure are permitted if the start and end temperature of the vessel deviates significantly.

17.5 The secondary containment of a secondary tank shall only be tested for leakage under the positive pressure conditions of 17.1 using either air or water methods in 17.3, but with the primary tank filled with water to resist implosion.

17.6 The dike of a diked containment tank shall be tested for leakage by filling it with water to the maximum wall height and determining leakage per 17.3, except that the test time shall be at least 10 min after maximum deformation occurs.

18 Hydrostatic Strength Test

18.1 Primary vessels shall not leak at the hydrostatic strength test values, and if necessary, shall be pressurized until failure in accordance with the appropriate test methods in 17.2 through 17.4 for compliance with the minimum hydrostatic pressure and vacuum values below, and to determine the ultimate design strength for each special purpose type. Primary tanks with covered open tops allowed per 6.2.2 shall be evaluated to 18.6.

a) Liquid Chemical Vessels:

1) 70 kPa (10.0 psi) minimum hydrostatic strength, and if necessary;

2) Until failure to determine the vessel burst strength.

b) Cooking Oil Tanks – The greater value of:

1) Plus 35 kPa (5.0 psi) pressure and minus 35 kPa (5.0 psi) vacuum; or

2) 2.0 times the manufacturer's pressure and vacuum rating.

c) Lube Oil Tanks – The greater value of:

1) Plus 35 kPa (5.0 psi) pressure and minus 35 kPa (5.0 psi) vacuum; or

2) 2.0 times the manufacturer's pressure and vacuum rating.

d) Vehicle Fluid Tanks – The greater value of:

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1) Plus 35 kPa (5.0 psi) pressure and minus 35 kPa (5.0 psi) vacuum; or

2) 2.0 times the manufacturer's pressure and vacuum rating.

18.2 For hydrostatic strength testing, it is recommended to apply additional pressure or vacuum on the same leakage test sample, after compliance with Section 17, Leakage Test. However, new samples are permitted to be used with test preparations and leak assessment done in accordance with 17.3 and 17.4.

18.3 For failure testing, it is recommended to fill the tank with water prior to applying additional pressure on the same leakage test sample, after compliance with Section 17, Leakage Test. However, new samples are permitted to be used with test preparations done in accordance with 17.2.

18.4 These tests are recommended to be conducted with water, but if air is used to conduct either hydrostatic or burst strength testing at these higher pressures, precautions are recommended to mitigate all potential hazards.

18.5 The secondary containment of a secondary tank, with the primary tank filled with water to resist implosion, shall only be evaluated for hydrostatic strength under the positive pressure conditions of 18.1 using the methods in 18.2 or 18.3.

18.6 The dike of a diked containment tank, with the primary tank empty, shall be evaluated for hydrostatic strength by filling it with water to the maximum wall height for at least 10 min after maximum deformation occurs. The primary tank shall not float and the dike shall not lose containment.

TANK ASSEMBLY AND INSTALLATION TESTS

19 General

19.1 Representative sample(s) of the “worst case” size, shape, thickness and polymer grade variation(s) for each special purpose vessel type and design series shall be subjected to the appropriate Assembly and Installation Tests as indicated in Table 19.1. The tests shall be conducted on the same sample, and in the recommended sequence below to simulate assembly and installation prior to use, unless otherwise indicated in the manufacturer's instructions.

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Table 19.1
Assembly and Installation Test Exposure conditions

Section	Liquid chemical vessels	Cooking oil tanks	Lube oil tanks	Vehicle fluid tanks
Handle and Lug Strength Test	20.1(a)	20.1(b)	20.1(c)	20.1(d)
Drop Test	21.1(a)	21.1(b)	21.1(c)	21.1(d)
Top, Side and Shelf Loads Test	22.1(a)	22.1(b)	22.1(c)	22.1(d)
Stability Test	23.1(a)	23.1(b)	23.1(c)	23.1(d)
Support Load Test	24.1(a)	24.1(b)	24.1(c)	24.1(d)
Fitting Torque Test	Section 25[1]	Section 25[1]	Section 25[1]	Section 25[1]
Fitting Bending Test	Section 26[1]	Section 26[1]	Section 26[1]	Section 26[1]
Puncture Impact Test	Section 27	Section 27	Section 27	Section 27
Rain/Freeze Test	Section 28[2]	Section 28[2]	Section 28[2]	Section 28[2]

Table 19.1 Continued on Next Page

Table 19.1 Continued

Section	Liquid chemical vessels	Cooking oil tanks	Lube oil tanks	Vehicle fluid tanks
Fill Signal Device Test	N/A	Section 29[3]	N/A	N/A
NOTE: Table 19.1 defines the exposure conditions for each test and vessel type. Refer to the relevant sections for pass/fail criteria, etc.				
[1] For vessels with threaded, flanged or similar fitting connections to piping. [2] For outdoor rated tanks. [3] For tanks with fill limiting devices.				

19.2 Following each test, a visual examination of the tested area and/or components shall be conducted to assess the damage, for use in determining compliance with the manufacturer's acceptable type and degree of damage (such as a surface crack), see 7.6. Refer to 37.2(b) markings and 39.2 instructions to prevent the tank from being put in service or require taking it out of service, or continue testing with damage.

19.3 Failure within the assembly test sequence is defined as any test damage that immediately results in a hazard, such as collapse, tip-over, or leakage.

19.4 Leakage within the assembly test sequence is defined as a non-compliance in accordance with Section 17, Leakage Test, using any of the test and detection methods.

20 Handling and Lug Strength Test

20.1 Vessels shall not leak, rupture or have unacceptable damage after any handles or lift lugs are evaluated for strength at the static loads indicated below for each special purpose type in accordance with the test details in 20.2 through 20.4:

a) Liquid Chemical Vessels – 1.5 times full tank weight for 5 min;

b) Cooking Oil Tanks – 2.0 times empty tank weight for 1 min;

c) Lube Oil Tanks – 2.0 times empty tank weight for 1 min;

d) Vehicle Fluid Tanks – 2.0 times empty tank weight for 1 min.

20.2 The total test load shall include any factory assembled accessories or components, and the full vessel at rated capacity. Materials such as water, sand or stacked vessels are permitted to achieve the weights or to facilitate testing.

20.3 For handles, the test load shall be applied with a rope over a maximum 76.2 mm (3.0 in) width at either the full load evenly distributed over two handles, or half the load applied to one handle.

20.4 For lugs, the test load shall be applied with metal lift hooks of maximum 12.7 mm (0.5 in) connection point width distributed between the number of lugs as marked per 6.1.6.

21 Drop Test

21.1 Vessels shall not leak, rupture or have unacceptable damage after the empty vessel is dropped once from the height indicated below for each special purpose type in accordance with the test details in 21.2 and 21.3:

a) Liquid Chemical Vessels – 0.91 m (3.0 ft);

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b) Cooking Oil Tanks – 1.22 (4.0 ft);

c) Lube Oil Tanks – 0.91 m (3.0 ft); and

d) Vehicle Fluid Tanks – 0.91 m (3.0 ft).

21.2 The drop surface shall be standard reinforced concrete at least 102 mm (4 in) thick. The drop shall target the vessels most unfavorable bottom area (typically a corner or edge). Any factory assembled accessories or components shall be included in the test.

21.3 If a vessel is supplied with protective packaging which is marked per 37.2(d) and is thus not to be removed until assembly, the test shall be conducted with the packaging in place.

22 Top, Side and Shelf Loads Test

22.1 Vessels with flat tops, mounting points for top or side loads, and/or shelves designed for equipment or other loads shall not collapse or tip over during testing, nor leak, rupture, or have unacceptable damage after the loading conditions as indicated below for each special purpose type in accordance with the test details in 22.2 through 22.4. General storage shelves or unspecified equipment shall be tested based on the marked rating:

a) Liquid Chemical Vessels – Top load 113 kg (250 lb) on 0.3 m (1 ft) x 0.3 m (1 ft) area;

b) Cooking Oil Tanks – Top and/or side load 113 kg (250 lb) on 1 ft x1 ft area, plus 2 times equipment and other rated loads on each shelf;

c) Lube Oil Tanks – Top and/or side load 113 kg (250 lb) on 0.3 m (1 ft) x 0.3 m (1 ft) area, plus 2 times equipment and other rated loads on each shelf;

d) Vehicle Fluid Tanks – Top and/or side load 113 kg (250 lb) on 0.3 m (1 ft) x 0.3 m (1 ft) area, plus 2 times equipment and other rated loads on each shelf.

Note: As specified in 6.1, neither mounting points nor shelves are permitted on liquid chemical vessels.

22.2 Top loads for specific areas shall be applied through a rigid steel plate with rounded edges in the most unfavorable top area before the installation of any piping. The vessel shall be empty, and any materials are permitted to achieve the weights or facilitate testing. The loads shall be applied for at least 1 min, or if deformation occurs, until ultimate results are determined.

22.3 Top or side loads for equipment, such a heaters, pumps and hose reels or shelves for general storage, shall be applied to the mounting points or evenly distributed on shelves provided on the vessel. The vessel shall be empty, and any materials are permitted to achieve the weights or facilitate testing. The loads shall be applied for at least 1 min, or if deformation occurs, until ultimate results are determined.

22.4 During testing, the vessel(s) shall not be fixed, but if necessary to facilitate testing, the applied loads defined in 22.1 are permitted to be stabilized if deformation occurs. Vessels rated for stacking shall be tested in accordance with Section 23, Stability Test, and Section 24, Support Load Test.

22.5 The load ratings applied per 22.1, shall be marked in accordance with 37.1(i).

23 Stability Test

23.1 Vessels with integral supports, or supplied supports or brackets assembled, and vessels rated for stacking with or without supports, shall not tip over during testing, nor leak, rupture, or have unacceptable

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damage after applying the instability conditions as indicated below for each special purpose type in accordance with the test details in 23.2 through 23.5:

a) Liquid Chemical Vessels – 222.4 N (50 lbf) push/pull, 15° tilt and stacking;

b) Cooking Oil Tanks – 222.4 N (50 lbf) push/pull and 15° tilt;

c) Lube Oil Tanks – 222.4 N (50 lbf) push/pull,15° tilt and stacking;

d) Vehicle Fluid Tanks – 222.4 N (50 lbf) push/pull, 15° tilt and stacking.

23.2 For unsymmetrical shapes, both pushing and tilting shall be done with the vessel oriented in the most unfavorable condition on a concrete floor. Each instability condition shall be applied for at least 1 min, or if deformation occurs, until ultimate results are determined. Optional equipment and shelf load combinations shall be included in the test at their rated loads, if this reduces stability of the vessel.

23.3 The push or pull force shall be applied horizontally to the highest part of the empty vessel side wall and along a direction calculated to create the greatest tipping moment. Attachments are permitted to translate the push or pull force. If the vessel slides prior to the applied force reaching the specified value, this result is acceptable.

NOTE: For horizontal cylindrical tanks, the force should be applied at the tank top in a horizontal direction, perpendicular to the tank axis.

23.4 The tilt test shall be conducted by placing the vessel on an inclined plane at the required angle, then filling it to rated capacity with water, or alternatively, filling the vessel to rated capacity with water, then slowly tilting it to the required angle.

23.5 If permitted, vessel stacking shall be conducted with the maximum number of vessels identified in the manufacturer's instructions, as marked per 38.1 (c). Each vessel shall be filled with water to rated capacity, then placed on the other vessels with loading equipment as identified in the manufacturer's instructions.

24 Support Load Test

24.1 Vessels with either integral or supplied supports, and vessels rated for stacking with or without supports, shall not collapse or tip over during testing, nor leak, rupture, or have unacceptable damage after applying the loading conditions as indicated below for each special purpose type in accordance with the test details in 24.2 through 24.5:

a) Liquid Chemical Vessels – 2.0 times filled vessel weight, or the load with a safety factor (SF) identified in 24.4;

b) Cooking Oil Tanks – 2.0 times filled vessel weight;

c) Lube Oil Tanks – 2.0 times filled vessel weight, or the load with a SF identified in 24.4;

d) Vehicle Fluid Tanks – 2.0 times filled vessel weight, or the load with a SF identified in 24.4.

24.2 The vessel weight shall include the empty vessel weight with all factory assembled components plus the liquid weight at rated capacity, based on the highest density of the rated liquid (s). If shipped separately, all supports shall be assembled to the vessel in accordance with the manufacturer's instructions.

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24.3 Total test loads are permitted to consist of stacked vessels filled with water, sand or other materials necessary to achieve the weights, and be stabilized to facilitate testing. All loads shall be applied for at least 1 min, or if deformation occurs, until ultimate results are determined.

24.4 For vessels rated for stacking as marked per 23.2 – 38.1(c). The total stacked weight test load shall be the sum of the rated number of filled vessel weights times a safety factor (SFX) of 1.8 for 2-high ratings, times 1.6 for 3-high ratings, or 1.5 for 4-high ratings, and the bottom vessel shall be half filled during testing.

24.5 As an alternative to physical testing, calculations are permitted provided they reflect the minimum construction features and maximum loading in 23.1 and 24.1. The analysis shall be conducted at a 2 times SF by a licensed Professional Engineer.

25 Fitting Torque Test

25.1 All vessels with openings designed for field assembly to threaded type pipes and fittings or bolted flanges shall be subjected to the applicable torque test(s) below, and in preparation for the subsequent bending test in Section 26. During testing, the threads shall not strip. Following testing, the sample shall be visually examined, and there shall be no leakage, failure or unacceptable damage.

25.2 For unique pipe and fittings which are supplied with the vessel, 1.5 times the manufacturer's rated torque with the supplied or specified lubrication, tool or method as identified in the manufacturer's instructions, shall be applied to the pipe, fitting or bolt. If the instructions limit connections to flexible hose with a hose barb and clamp, the test shall apply to the fitting, but not the clamp screw.

25.3 For standard pipe or fittings which are compatible with commonly available trade sizes, torque values in accordance with Table 25.1 with Schedule 40 steel pipe or fittings lubricated with pipe thread sealants or tapes shall be applied to the pipe, fitting or bolt. If the instructions limit connections to rigid plastic pipe, the torque values are permitted to be half the values in Table 25.1.

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Table 25.1
Torque Test Values

Nominal size		Torque		Nominal pipe size		Torque	
mm	(in)	N·m	(in-lbs)	mm	(in)	N·m	(in-lbs)
12.7	(0.50)	181	(1600)	50.8	(2.00)	373	(3300)
19.1	(0.75)	226	(2000)	63.5	(2.50)	396	(3500)
25.4	(1.00)	271	(2400)	76.2	(3.00)	407	(3600)
31.8	(1.25)	316	(2800)	88.9	(3.50)	418	(3700)
38.1	(1.50)	350	(3100)	101.6	(4.00)	429	(3800)

26 Fitting Bending Test

26.1 All vessels with openings assembled with a pipe, fitting or flange and tested per Section 25, Fitting Torque Test, shall be subjected to the applicable bending test(s) below, from a 113 kg (250 lb) load applied perpendicular to a 914 mm (36 in) long pipe per the instructions directly connected to the tank opening, or indirectly through the fitting or flange. During testing, the fittings and pipe shall not disconnect. Following testing, the sample shall be visually examined, and there shall be no leakage, failure or unacceptable damage. If the instructions limit use of only plastic pipe, the test is either exempt for flexible pipe (hose), or for rigid pipe, the test is reduced to a 45 kg (100 lb) load and 15° maximum bend angle in 26.2 and 26.3.

26.2 For unique pipe and fittings which are supplied with the vessel, the load shall be gradually applied to the supplied pipe until the maximum value is reached or shall be discontinued when the pipe and vessel exhibits deformation or bending (> 30°) from the starting plane.

26.3 For standard pipe or fittings which are compatible with commonly available trade sizes, the load shall be gradually applied to a schedule 40 steel pipe until the maximum value is reached or shall be discontinued when the pipe and vessel exhibits deformation or bending (> 30°) from the starting plane.

27 Puncture Impact Test

27.1 After assembly of the vessel and all components identified in the manufacturer's instructions, exposed vessel surfaces shall be selected as worst case representatives of different vessel sections, such as flat, curved or corner areas, and shall each be subjected to a 6.78 J (5 ft·lb) impact applied perpendicular to the surface using a 50.8 mm (2.0 in) diameter steel dart having 30° tip point.

27.2 Following the impact(s), each target area shall be visually examined, and there shall be no leakage, failure or unacceptable damage.

27.3 For vessels rated for outdoor locations, the above impact test shall be repeated while the tank (or representative parts of the tank) is at -20°C (-4°F) for at least 8 h. Lower test temperatures are permitted, and the marking may indicate the specific rated temperature as per 36.5.

28 Rain/Freeze Tests

28.1 General

28.1.1 For secondary containment or dike tanks rated for outdoor use, all interstitial space caps or covers shall be evaluated for resistance to water entry from rain, and if found to admit water, further evaluated for resistance to freeze damage. The tests shall be conducted on vessel designs that are most likely to allow water entry and result in freeze damage.

28.2 Rain test

28.2.1 All tank systems rated for "Outdoor Use" shall be evaluated for resistance to rain as described in 28.2.2. Tanks provided with supplied covers shall be evaluated after their assembly in accordance with the manufacturer's instructions, and in the normally closed position. Following the simulated rain exposure, there shall be no water entering the inside of the primary tank, secondary or interstitial containment.

28.2.2 The test tanks shall be positioned on a level surface and subjected to a 30 min. simulated rain exposure, emitted from a Rain Test Spray Head (Figure 28.1) focused on the tank area(s) most likely to allow entry of water. The nozzle shall operate at 34.5 kPa (5.0 psig) within 914 mm to 1524 mm (3.0 to 5.0 ft) of the test area:

a) For 15 min at a 45° angle with respect to the tank top; then

b) Followed by 15 min parallel to the tank top.

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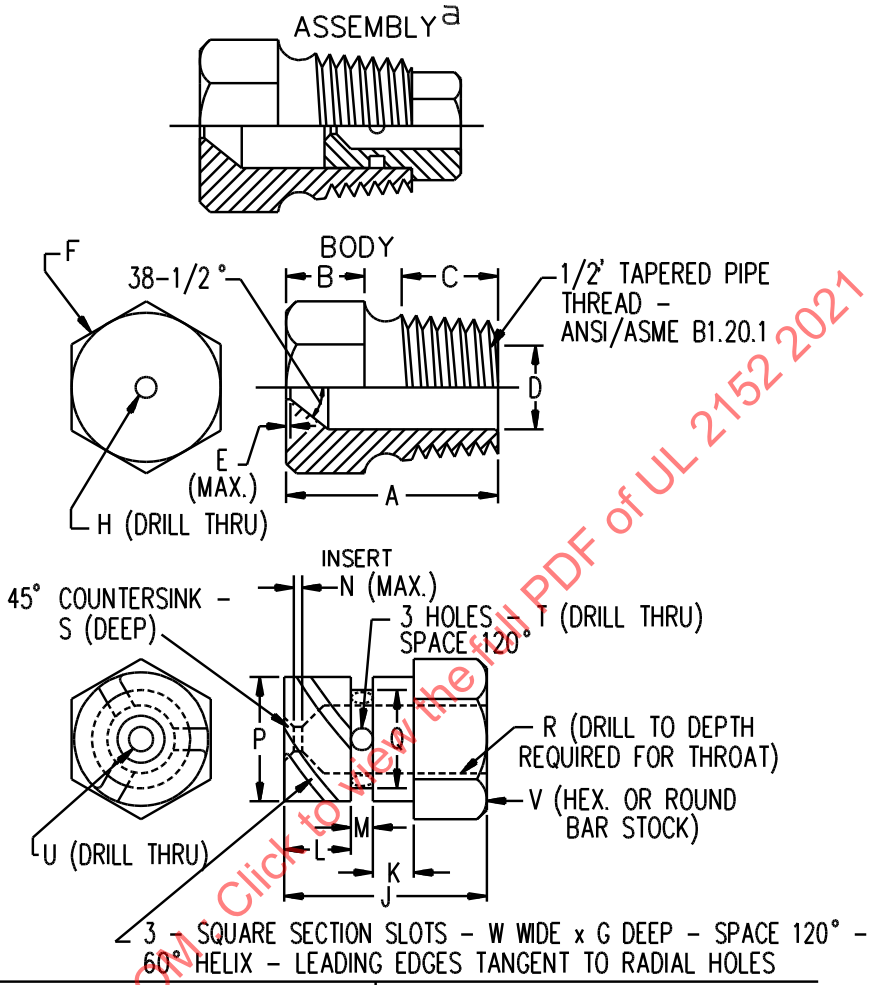
Figure 28.1

Rain Test Spray Head



Item	inch	mm	Item	inch	mm
A	1 7/32	31.0	N	1/32	0.80
B	7/16	11.0	P	.575	14.61
C	9/16	14.0		.576	14.63
D	.578	14.68	Q	.453	11.51
	.580	14.73		.454	11.53
E	1/64	0.40	R	1/4	6.35
F	c	c	S	1/32	0.80
G	.06	1.52	T	(No. 35) [b]	2.80
H	(No.9) [b]	5.0	U	(No. 40) [b]	2.50
J	23/32	18.3	V	5/8	16.0
K	5/32	3.97	W	0.06	1.52
L	1/4	6.35			
M	3/32	2.38			

[a] Nylon Rain-Test Spray Heads are available from Underwriters Laboratories

[b] ANSI B94.11M Drill Size

[c] Optional - To serve as a wrench grip.

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28.3 Freeze/thaw cycle test

28.3.1 All tank systems with an interstitial space rated for "Outdoor Use" shall not crack, leak or have other damage which could cause a hazard after being subjected to the freeze/thaw cycle described in 28.3.2. The tank system shall be visually examined for damage (including interior components) before conducting the leakage test.

28.3.2 The interstitial space of the sample shall be filled with water to 2 % of the rated primary tank capacity or a depth of at least 50.8 mm (2.0 in) from the bottom of the interstitial space, then subjected to a temperature cycle of 24 h at -20 ±2°C (-4 ±4°F) followed by 24 h at 20 ±2°C (68 ±4°F) followed by 24 h at -20 ±2°C (-4 ±4°F).

28.3.3 The vessels shall either not allow any water to enter the interstitial space, or if found to admit water, not result in leakage, as determined by testing per Section 17, Leakage Test, after the freeze/thaw cycles.

29 Fill Signal Device Test

29.1 Cooking oil tanks that include a float and switch operated fill signal device designed to provide a “full” tank signal to truck operators or restaurant employees to prevent overfills shall be subjected to the tests in 29.2 through 29.4, as applicable.

29.2 Operation of the float and switch shall be tested for normal function by verifying that the fill signal device actuates within ±2.0 cm (0.79 in) or ±1 % of the high fill level. This shall be done by filling the tank with water and measuring the volume when the switch actuates, or an equivalent means.

29.3 Abnormal operation of the fill signal device to simulate oil accumulation on the float or connecting links shall be done by adding a 100 gm weight to the float and repeating the 29.2 test except that the fill signal device shall activate within ±4.0 cm (1.57 in) or ±2 % of the designed fill level.

Exception: Tanks provided with inlet drop tubes extending at least 30.5 cm (12 in) below the float are exempt from this test.

29.4 Switches shall be subjected to 6,000 cycles of endurance in a manner that simulates normal use through the physical operating range with electrical power. The mechanical and electrical components shall not degrade to a point where they do not operate as designed as determined by repeating the test described in 29.2 except that the fill signal device shall activate within ±4.0 cm (1.57 in) or ±2 % of the designed fill level.

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FIRE RESISTANCE TESTS

30 General

30.1 Representative sample(s) of the “worst case” size, shape, thickness and polymer grade variation(s) for each special purpose vessel type and design series shall be subjected to the appropriate Fire Resistance Tests as indicated in Table 30.1.