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JOINT CANADA-UNITED STATES
NATIONAL STANDARD

ANSI/CAN/UL/ULC 180:2023

STANDARD FOR SAFETY

Combustible Liquid Tank Accessories

Approved American National Standard
ANSI

ANSI/UL 180-2023

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SCC FOREWORD

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UL Standard for Safety for Combustible Liquid Tank Accessories, ANSI/CAN/UL/ULC 180

Ninth Edition, Dated March 15, 2019

Summary of Topics

This revision of UL/ULC 180 dated February 24, 2023 includes the following changes in requirements:

– Revisions to requirements for vent caps with respect to openings; 8.4

– Revisions to the Fill Signal test with respect to whistle vent sound/backflow; 14.2.2

– Revisions to marking requirements with respect to smaller pipe size fittings; 21.1 and 21.1.1

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated September 23, 2022.

No Text on This Page

ANSI/UL 180-2023

MARCH 15, 2019
(Title Page Reprinted: February 24, 2023)

ANSI/CAN/UL/ULC 180:2023

Standard for Combustible Liquid Tank Accessories

First Edition – November, 1958
Second Edition – September, 1972
Third Edition – January, 1975
Fourth Edition – July, 1980
Fifth Edition – August, 1991
Sixth Edition – May, 1996
Seventh Edition – April, 2003
Eighth Edition – October, 2012

Ninth Edition

March 15, 2019

This ANSI/CAN/UL/ULC Safety Standard consists of the Ninth Edition including revisions through February 24, 2023.

The most recent designation of ANSI/UL 180 as an American National Standard (ANSI) occurred on February 24, 2023. 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 February 24, 2023.

No Text on This Page

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Preface

This is the Ninth Edition of the ANSI/CAN/UL/ULC 180, Standard for Combustible Liquid Tank Accessories.

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

Only metric SI units of measurement are used in this Standard. If a value for measurement is followed by a value in other units in parentheses, the second value may be approximate. The first stated value is the requirement.

Appendix A, identified as normative, forms a mandatory part of this Standard.

Appendices B and C, identified as informative, are for information purposes only.

This ANSI/CAN/UL/ULC 180 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.

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 Eighth Edition UL 180, Standard for Liquid-Level Gauges for Oil Burner Fuels and Other Combustible Liquids, and the First Edition of ULC/ORD-C180-97, Other Recognized Document for Liquid Level Gauges and Indicators for Fuel Oil and Lubricating Oil Tanks.

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

Requests for interpretation of this Standard should be sent to ULC Standards. The requests should be worded in such a manner as to permit a "yes" or "no" answer based on the literal text of the requirement concerned.

To purchase UL Standards, visit the UL Standards Sales Site at http://www.shopulstandards.com/HowToOrder.aspx or call tollfree 1-888-853-3503.

This Edition of the Standard has been formally approved by the Joint UL/ULC Technical Committee (TC) on Combustible Liquid Tanks and Accessories, TC 2258.

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

TC 2258 Membership

Name	Representing	Interest Category	Region
Beaulieu, Michel	Roth Industries Inc.	Producer	USA
Bourassa, Eric	Granby Industries L.P.	Non-voting	Canada
Corliss, Chuck	NH Department of Environmental Services	AHJ	USA
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International Classification for Standards (ICS): 23.040.50; 75.180.01

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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.

CETTE NORME NATIONALE DU CANADA EST DISPONIBLE EN VERSIONS FRANÇAISE ET ANGLAISE.

INTRODUCTION

1 Scope

1.1 This Standard covers construction and performance requirements for the tank accessories identified in Clause 1.2, for use on atmospheric aboveground tanks not exceeding 19,927 L (5,000 U.S. gal) which are intended for the storage and supply of heating fuels for oil burning equipment, diesel fuels for compression ignition engines, motor oils (new or used) for automotive service stations, and similar combustible liquid applications.

In addition to this Standard's traditional safety requirements for tank accessories that primarily evaluate functional operation, structural integrity, and mitigate fire and environmental hazards from loss of liquid containment under expected normal conditions; optional construction and/or performance requirements, and associated ratings, intended to address more severe conditions associated with the effects of Climate Change are included in Appendix B.

1.2 These requirements cover the following tank accessories intended for installation in, on or connected to the storage tank or supply tank in accordance with the manufacturer's instructions:

a) Liquid Level Gauges – mechanical float, low-voltage electric, or other types with integral or remote indicators;

b) Fill Signal Devices –indicating devices with audible and/or visual signals, including "whistle vent" alarms;

c) Aboveground Piping Systems – aboveground pipe and fittings for tank fill & venting and supply of utilization equipment, including flexible hose; and

d) Fill Pipe Covers & Vent Pipe Caps.

1.3 These requirements do not cover any tank accessories for products covered by the requirements of:

a) UL 565 and ULC/ORD-C565 for electrical liquid level gauges for flammable liquid tanks;

b) UL 1238 and CAN/CSA-C22.2 No. 61010-1 for electrical fill signal devices for flammable liquid tanks;

c) UL 971, UL 971A, or CAN/ULC-S679 for underground piping systems, or UL 2039 or CAN/ULC-S633 for flexible connector pipe;

d) UL 1238 and CAN/ULC-S675.1 or CAN/ULC-S675.2 for leak detection devices for flammable liquid tanks;

e) UL 2583 for fill pipe covers, pressure vacuum vents or emergency vents for flammable liquid tanks;

f) UL 2085 and CAN/ULC-S661 for spill containment devices for flammable liquid tanks;

g) UL 2085 and CAN/ULC-S663 for overfill prevention devices for flammable liquid tanks;

h) UL 331 and ULC/ORD-C331 for filters and strainers for flammable and combustible liquids; or

i) UL/ULC 1369 for requirements applicable to larger diameter piping for flammable and combustible liquids intended for motor vehicle fueling and generator supply applications.

1.4 The products covered by this Standard are intended for installation and use in accordance with the applicable Codes and Regulations as determined by the Authority Having Jurisdiction (AHJ), such as:

a) In the United States:

1) Flammable and Combustible Liquids Code, NFPA 30;

2) Code for Motor Fuel Dispensing Facilities and Garages, NFPA 30A;

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

4) Uniform Fire Code, NFPA 1;

5) International Fire Code published by the International Fire Council; and/or

6) Other applicable federal and state regulations for combustible liquid tank accessories.

b) In Canada:

1) The National Fire Code of Canada;

2) CAN/CSA-B139, Installation Code for Oil Burning Equipment;

3) CCME Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products; and/or

4) Provincial or other Regulations.

1.5 Except for optional Climate Change Adaptation requirements in Appendix B, these requirements do not cover special evaluations for resistance to, or use after, earthquakes, floods, high wind events, or other natural disasters; or resistance to vehicle impact.

NOTE 1: See the Note at the beginning of Appendix B for further information on the terms “Adaptation” and “Mitigation”, as they pertain to Climate Change.

1.6 These requirements do not cover evaluation of either resistance to, or emission of, electromagnetic interference, or compliance with Federal Communications Commission (FCC) or Industry Canada Department of Communications regulations for electrical products with local or remote signal features, or the effectiveness of optional wired or wireless signal communications to remote service providers or central station monitors.

1.7 These requirements do not cover any applications with flammable liquids, or for electric gauging or signaling, use in hazardous (classified) locations, or waste oils that may contain high levels of contaminants and/or flammable liquids.

1.8 These requirements do not cover the use of accessories with waste oils or other combustible liquids with different physical or material compatibility properties than they are evaluated for, but do cover use with bio diesel blends up to 20 %, or up to 100 % bio diesel if optionally tested.

2 Units of Measurement

2.1 When a value for measurement is followed by a value in other units in parentheses, the second unit is only approximate. The first stated value is the requirement.

3 References

3.1 Refer to Appendix C for a list of publications referenced in 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. When the latest edition of a Standard is not applicable, the appropriate edition is indicated accordingly in Appendix C.

4 Glossary

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

4.2 ABOVEGROUND – Physically located on or above the earth's surface. Aboveground location ratings include:

a) Indoor – Locations generally protected after installation from physical damage, extreme temperatures, precipitation and sunlight, which typically include inside buildings that are occupied and environmentally controlled; and

b) Outdoor – Locations generally unprotected after installation from physical damage, extreme temperatures, precipitation and sunlight, which for pipe runs can include on exterior structures, within below grade sumps, and underground where routed through chase piping (but not direct burial).

4.3 ABOVEGROUND PIPING SYSTEMS – Combinations of small diameter pipe, tubing, or hose and their connection or termination fittings for containment and transfer of combustible liquids in applications identified in the scope of this Standard. Aboveground piping system may be of different containment designs for different application types:

a) Fill & Vent Pipe – Intended for transfer of liquids from a delivery truck to a supply tank and venting of displaced vapors in the tank during fill operations. Vent pipe also provides combined normal and emergency venting of the tank. These pipes are typically rigid types in the 25.4 mm to 101.6 mm (1.0 in to 4.0 in) size range;

b) Flexible Hose – Special highly flexible hose connectors of short length/small diameter intended for transfer of liquids typically from a supply pipe end to the utilization equipment, where tight bending and frequent disconnection for installation and maintenance is required. Flexible hose are typically elastomeric hose with metal braid sleeves in a 1/4" to 3/8" size range;

c) Special piping/tubing – Engineered piping or tubing that does not conform to common tubing standards (i.e. Schedule or SDR) for dimension or wall thickness as part of an engineered piping system for filling and venting of above ground combustible liquid tanks; or

d) Supply Pipe – Intended for transfer of liquids from a fuel storage tank or supply tank to utilization equipment, such as an oil burner or diesel generator. These pipes are typically flexible in the 9.5 mm to 25.4 mm (3/8 in to 1.0 in) size range.

4.4 COMBUSTIBLE LIQUIDS – A wide range of Class II and III liquids that has a closed cup flash point equal to or above 37.8 °C (100 °F). Combustible Liquid types include:

a) Bio Diesel – General description of various Class II to IIIB range of long chain fatty acid ester fuels complying with the ASTM D6751, Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels, processed from vegetable oils or animal fats in pure form (B100). Bio diesel may also be blended with heating fuels or diesel fuels (B1 to B99) denoting the percent volume of bio diesel in the mix;

NOTE: "triglyceride fuels" using alternative oil sources and production processes are covered under the ASTM D6751 blendstock or ASTM D975 and ASTM D396 finished fuel specifications.

b) Diesel Fuels – General description of various Class II petroleum distillate grades complying with the Standard Specification for Diesel Fuel Oils, ASTM D975, or CGSB-3.520, including No. 1 and No. 2 Diesel Fuel (also known as on-road diesel, including low sulfur diesel, ultra-low sulfur diesel and bio diesel blends) typically intended for powering compression ignition engines;

NOTE: these fuels may contain up to 5 % biodiesel (B5) without identification of the blend percentage, and 6 % to 20 % biodiesel (B6 to B20) is covered under ASTM D7467, but also without identification of the blend percentage.

c) Heating Fuels – General description of various Class II petroleum distillate grades complying with the Standard Specification for Fuel Oils, ASTM D396, or CGSB-3.2; or the Standard Specification for Kerosene, ASTM D3699 or CGSB-3.3, including No. 1 and No. 2 Fuel Oils (also known as oil burner fuel, including low sulfur distillates and bio diesel blends); or K1 Kerosene typically intended for use in oil burning equipment;

NOTE: only ASTM D396 Grade 1 & 2 or CGSB-3.2 Heating Fuel may contain up to 5 % biodiesel without identification of the blend percentage, and ASTM D396 Grade B6 to B20 may contain between 6 % and 20 % biodiesel without identification of the blend percentage, but ASTM D3699 or CGSB-3.2 Kerosene is not permitted to have any biodiesel.

d) 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; and

e) Used Oil – General description of oils such as those drained from motor vehicles or cooking appliances after use that do not contain water, gas or other contaminants that change the oil Class or may adversely affect the storage tank or supply tank.

4.5 FILL PIPE COVER – A transition fitting with mating top cover intended to be fixed on the end of a threaded tank fill pipe to resist rain entry and vapor escape. The twist on/off cap completely covers the opening but can be removed during fill operations.

4.6 FILL SIGNAL DEVICE – A device that provides an automatic and continuous audible or visual indication to the delivery truck operator that the tank has reached the rated fill level. Whistle vent alarms are venturi type fill signal devices that are installed into the top vent opening prior to the vent pipe and produce a whistle to indicate proper venting during the fill operation.

4.7 HIGH (LINE) VOLTAGE – Any plug outlet or field wired source of electricity from the power grid, nominally 115 volts and 60 hz.

4.8 LOW (CLASS 2) VOLTAGE – An electrical potential of not more than 30 Vac (rms) or 42.4 V (dc or peak ac) supplied by:

a) An energy-limiting direct plug-in, cord connected or field wired Class 2 transformer;

b) A dry cell battery having output characteristics no greater than those of an energy-limiting Class 2 transformer;

c) The combination of an isolated transformer secondary winding and a fixed impedance or reliable regulating network which complies with the performance requirements of an energy-limiting Class 2 transformer; or

d) The combination of a rechargeable battery and a fixed impedance or reliable regulating network which complies with the performance requirements of an energy-limiting Class 2 transformer.

4.9 PIPE CONTAINMENT DESIGNS – Aboveground piping systems having different liquid containment levels and optional jacket features as follows:

a) Primary (aka Single Wall) Pipe – A single wall pipe construction intended for long term normal containment of combustible liquids. Primary pipe designs are typically of flexible tubing connected with standard flare compression fittings, or rigid pipe connected with standard threaded or welded fittings, or engineered systems (special fittings and tools/equipment); or

NOTE: Engineered Systems are products, so don't require a Professional Engineer Stamp, such as for designs.

b) Jackets – A nonmetallic coating factory-applied to the outer wall of the above pipe designs that provides external corrosion protection with, or without, optional leak detection and interstitial communication features;

c) Secondary (aka Double Wall) Pipe – A separate single wall pipe construction that surrounds the primary pipe and is intended to contain combustible liquids under abnormal conditions (such as primary pipe rupture), and provides leak monitoring and interstitial communication.

d) Coaxial – A pipe construction consisting of integral primary pipes and secondary pipes with a defined interstitial space that provides leak monitoring and interstitial communication.

4.10 QUALIFIED PERSON – A worker specifically trained by the manufacturer to perform proper assembly and installation of its products in the field in accordance with the specified instructions. The qualified person is not required to be an employee of the manufacturer.

4.11 SIZE (Pipe Size or Fitting Size) – Nominal or trade dimensions (in or mm) of connector pipe and fittings based on inside diameters or thread.

NOTE: Nominal or trade sizes may not be equivalent to the actual measurements.

4.12 SPECIAL FITTING – Connection of pipe/tube and fittings which are not common types, such as threaded, flanged or welded, and typically require manufacturer supplied components, tools and instructions or training for proper assembly.

4.13 SWING JOINT – A connection or joint design which permits occasional movement of the pipe to relieve stresses.

4.14 SWIVEL JOINT – A connection or joint design which permits frequent movement of the pipe during normal functional use.

4.15 UNION JOINT – A connection or joint design which permits pipe adjustments only during installation or maintenance.

4.16 VENT PIPE CAP – A fitting intended to be fixed on the end of a threaded tank vent pipe to resist rain and insect entry while providing adequate venting capacity during fill operations and fire events.

CONSTRUCTION

5 General Design and Materials

5.1 Tank accessories shall be designed and constructed to resist damage and/or malfunction from expected assembly, installation, environmental and other use conditions for their intended application(s) in accordance with the applicable performance tests described in this Standard.

5.2 Tank accessories are permitted to be designed for indoor or outdoor locations, or indoor use only, but shall be capable of assembly, installation and inspection by consumers, unless qualified persons are required by the marking and instruction details.

5.3 Tank accessories are permitted to be constructed from any combination of materials meeting all applicable performance requirements in this Standard for the marked use and location rating, unless otherwise indicated for the specific tank accessory construction detail. Any test exemptions for some materials are specified in the Performance Sections 12 – 19.

6 Aboveground Piping System Construction

6.1 All Piping Systems shall meet the following requirements as appropriate for the design type and general material(s). Primary pipes and fittings shall only be of metal. All piping systems containment types shall be rated at least 345 kPa (50 psig).

6.1.1 All piping systems constructed with common stock pipe & fittings shall be evaluated for each different connection method (threaded, welded or flare), but are permitted to be sold separately provided the markings & instructions identify the component combinations and minimum connection parameters evaluated.

6.1.2 All piping systems shall be capable of transitioning at the end fittings to threaded pipe connections of NPT, NPTF, BSPT, BSPP or similar common trade types. Solder shall not be used as a means to join pipes and fittings. Piping systems may have union joints or swing joints, but swivel joints are not permitted, except for flexible hose.

6.1.3 Piping systems constructed from tubing and rated for outdoor use, except for stainless steel types, shall be provided with an extruded cover with, or without, optional shrink fit end sleeves. The covers shall be of the types below, tested with the complete system assembly, and evaluated for the rated function according to:

a) Corrosion Protection (CP) only – Section 15, Assembly & Use Tests, Section 16, Exposure & Compatibility Tests;

b) Leak Transmission (LT) (transfers leaks for end detection) – The above CP tests and Subsection 17.6, Interstitial Communication Test; or

c) Secondary Containment (SC) (sec containment & leak detection) – The above CP and LT tests and Section 13 Pressure Test on Secondary.

6.2 Tubing shall be flexible, intended for flare connections using common flare tools & mating fittings, shall be within a (6.35 mm to 25.4 mm (0.25 in to 1.0-in) size range, supplied in minimum lengths of 6.1 m (20 ft), and meet one of the following construction specifications. “quick-connect” and “push-to-connect” fittings or similar types that are easily disconnected are not permitted:

a) Copper – Types “L” or “ACR” conforming to ASTM B68, B75, B88, B280, B743 or B837;

b) Brass – Types “L” or “ACR” conforming to ASTM B135; or

c) Stainless Steel – Types 304/304L or 316/316L conforming to ASTM A269, ASTM A554 or ASTM A778.

6.3 Pipes shall be rigid, intended for threaded connections using common tools/equipment & mating fittings, shall be within a 25.4 mm to 101.6 mm (1.0 in to 4.0 in) size range, supplied in minimum lengths of 1.2 m (4 ft), and meet one of the following construction specifications.

a) Carbon Steel – Minimum Sch 40 conforming to ASTM A53 & A53M, or ASME B36.10M;

b) Stainless Steel – Minimum Sch 40 Types 304/304L or 316/316L conforming to ASTM A312; or

c) Manufacturer specific pipe/tubing dimensions, wall thickness and pressure rating per engineered system requirements.

6.4 Engineered piping systems that require either special pipes/tubes, fittings, or connection methods or tools/equipment supplied by the manufacturer and/or require assembly by qualified persons, shall meet

the requirements of Clause 6.2 for flexible tube or Clause 6.3 for rigid pipe and one of the following connection methods or specifications:

a) Welded or Brazed using the appropriate fitting types for the tube or pipe;

b) ASTM F3226 Metallic Press-Connect Fittings for Piping and Tubing Systems; or

c) Manufacturer specific pipe and fitting joining and sealing system to connect special piping to special fittings per engineered system requirements.

6.5 Flexible hose shall be flexible, with a bend radius of 50.8 mm (2.0 in) or less, and dimensions of not more than 9.5 mm (3/8 in) diameter and 914 mm (36 in) length. Flexible hose shall also have at least one integral union or swivel joint.

7 Fill Signal Devices

7.1 Fill signal devices shall be designed for connection to a 25.4 mm to 1016 mm (1 ¼" – 4.0" NPT) threaded fitting and produce a continuous audible and/or visual signal to indicate the tank is nearing not more than 95 % rated capacity per Subsection 14.2, Fill Signal Test. These devices shall also have features that are capable of being checked for their intended function (fill level, vent flow, etc.) prior to fill operations. All fill signal devices shall comply with the applicable Subsection 14.2, Fill Signal Test, in addition to other appropriate tests identified in Table 12.1.

7.2 These devices are permitted to have a signal unit that is separate from the detection unit, provided the instructions identify the proper location and maximum distance of the signal unit from the fill opening for effective delivery operator signaling. They may also be combined with central station monitoring, but the fill signal function shall only be relied on by the delivery operator at the tank location. Electric powered devices shall not rely on only battery power.

7.3 Whistle Vent Alarms shall additionally be designed for direct attachment to a tank top opening and have a threaded outlet for connection to a 25.4 mm to 50.8 mm (1 1/4" or 2.0" NPT) pipe. The audible signal shall also indicate proper flow through the vent line at the start of the fill operation, with the signal ending when the tank is nearing the rated capacity. The venturi & whistle shall comply with Subsection 17.5, Endurance Test, and shall not obstruct flow more than permitted per Subsection 17.7, Flow Test.

8 Fill Pipe Covers & Vent Pipe Caps

8.1 Fill pipe covers and vent pipe caps shall be designed to resist entry of water into the connecting fill or vent pipe and shall comply with all "outdoor" rating tests.

8.2 Fill pipe covers shall consist of a body capable of connecting to NPT or other commercial threads used on steel fill pipes and a fitting capable of connecting to a commercial oil delivery hose end, and mating caps which shall be able to be opened/closed by hand.

8.3 Vent pipe caps shall be capable of connecting to NPT or other commercial threads used on steel fill pipes, and shall resist insect entry without reducing adequate venting capacity during fill operations and fire events.

8.4 Compliance with insect resistance and adequate venting shall be either by providing openings on the underside of the cap with slots, holes or a metal mesh screen with a maximum opening (excluding slot length) of 4.0 mm (0.16 in), a minimum 20 % open area, and for mesh, minimum 30 AWG wire; or determined by the Subsection 17.7, Flow Test.

8.5 Compliance with rain resistance for both fill pipe covers and vent pipe caps shall be determined by the Subsection 17.3, Rain Test.

8.6 Potential blocking of adequate venting capacity shall be determined by the Subsection 17.4, Icing Test.

9 Electrical Components

9.1 Gauges with electrical components shall be designed to interface with the tank at the following installation locations based on voltage, power and class ratings as follows:

a) Line voltage (nominal 115 vac) or high voltage components (≥30 V rms or 42.2 V peak) shall not be designed for installation on the tank, piping or other components typically attached to a tank;

b) Low voltage (<30 V rms or 42.2 V peak) components may be installed on the tank, piping or other tank components, but shall not be designed for installation inside the tank, or in contact with fuel; and

c) Low voltage (<30 V rms or 42.2 V peak) components from Class 2, SELV, or LPS circuits of limited energy (≤100 VA) shall be permitted for installation inside the tank and/or in contact with fuel.

9.2 Power Supplies are permitted to be of direct plug-in, cord connected or field wired types, but shall be in compliance with one of the following Standards, and rated for the intended location (indoor or outdoor):

a) UL 5085-1, Standard for Low Voltage Transformers – Part 1: General Requirements, and UL 5085-3, Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers;

b) C22.2 No. 66.1, Low Voltage Transformers – Part 1: General Requirements, and C22.2 No. 66.3, Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers;

c) UL 60950-1, Standard for Information Technology Equipment – Safety – Part 1: General Requirements;

d) CAN/CSA-C22.2 No. 60950-1, Information Technology Equipment – Safety – Part 1: General Requirements;

e) UL 1310, Standard for Class 2 Power Units; or

f) UL 62368-1, Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements.

9.3 Wiring and other electrical wiring components shall be enclosed or insulated and shall be suitably rated for the circuit and use applications. A means for fixing or strain relief shall be provided to resist pulling.

10 Liquid Level Gauge

10.1 The gauge's level indicating assembly may be connected to or separate from the level measuring assembly, but shall be capable of communicating the measured tank level accurately and consistently in a visible manner after installation.

10.2 The level indicating assembly shall have a readout with at least the following scale information that is readily visible from 3.0 ft (0.9 m).

a) The words "Empty" and "Full" or "0%" and "100%"; and

b) At least 3 equal intermediate levels, in fraction or percent.

11 Optional Liquid Level Gauge Signals

11.1 In addition to the required visual readout of the liquid level, optional gauge signals for specific levels are permitted to be integrated with, or separate from the measuring and indicating assemblies.

11.2 These option signals may include, but are not limited to:

a) Local audible or visual signals such as beeping or flashing when the tank is near empty or full; and/or

b) Remote wired or wireless data communications to service providers, such as to fill or empty the tank.

PERFORMANCE

12 General Performance

12.1 Test Samples

12.1.1 All performance tests shall be conducted on samples representative of production in all size and construction variations unless a “worst case” can be determined using engineering based rationale. Guidelines for determining worst case samples are identified for each tank accessory below or in the specific test if applicable. All samples shall be assembled, installed, and if applicable, adjusted for operation in accordance with the manufacturer's instructions using the components or tools/equipment as specified.

If acceptable to the manufacturer, the same sample may be used for multiple tests.

12.1.2 For liquid level gauges, guidelines for determining worst case samples are identified in each applicable test.

12.1.3 For fill signal devices, guidelines for determining worst case samples are identified in each applicable test.

12.1.4 For aboveground piping, different combinations of pipe/tube/hose, fittings, connection methods/parameters and tools/equipment as recommended by the manufacturer shall be tested, with worst case samples permitted based on the following, or an engineering analysis, such as hoop strength.

a) For tubes, pipes and hoses, at least one of each type with the weakest material and thinnest wall variations;

b) For fittings, at least one of each connection type with the weakest material and thinnest wall variations; or

c) For different sizes with the same wall thickness, at least the largest & smallest in the range.

NOTE: Special samples combining different variations, such as end fitting, joint and gasket options, in order to reduce the total number of samples are permitted, provided they are representative of regular design, material and production methods.

12.1.5 For fill pipe covers and vent pipe caps, the worst case for a design series with different materials and sizes shall be the weakest material and largest size for Section 15, Assembly & Use Tests. Worst case samples from Section 16, Exposure & Compatibility Tests, shall be materials that are most susceptible to degradation from the fuels, fluids or exposures.

12.2 Test Conditions

12.2.1 Unless otherwise indicated in a specific test method, all tests shall be conducted with working fluids (air, water, and similar substances) at 21 ± 6 °C (70 ± 10 °F) or at normal ambient room temperatures between 10 °C and 32 °C (50 °F to 90 °F).

12.3 Test Tanks

12.3.1 If it is necessary to assemble the tank accessory on a tank for testing, a nominal 833 to 1249 L (220 to 330 U.S. gal) typical primary or secondary obround shape tank built in accordance with UL 80 or CAN/ULC-S602 shall be used unless other design types, shapes or capacities are necessary to meet worst case or special requirements.

12.4 Test Pipe

12.4.1 If necessary to assemble generic fill & vent piping to the test tank, typical schedule 40 NPT threaded steel “black” pipe and fittings shall be used in nominal sizes of 50.8 mm (2 in) (fill pipe) or 31.8 mm (1-1/4 in) (vent pipe). If generic fuel supply piping is required, Type L copper tubing with flare or compression fittings shall be used.

12.5 Pressure Tests

12.5.1 Unless otherwise indicated in a specific test method, hydrostatic tests shall be conducted with water (or similar liquids) and pneumatic tests shall be conducted with air (or similar gasses). In either case, precautions shall be used to prevent personal injury at high pressures.

12.6 Test Fluids

12.6.1 If fluids are necessary to test a tank accessory for functional operation compliance, water or similar other non-hazardous liquid shall be used unless the proper operation of the accessory is dependent upon specific properties (such as density) of combustible liquids.

12.6.2 In cases where testing with a Class II Combustible Liquid is necessary, consumer grade K1 Kerosene and No. 2 Fuel Oil or D2 Diesel Oil shall be used.

12.6.3 In cases where testing with a Class III Combustible Liquid is necessary, automotive grade 30W Lubricating Oil and 80W Transmission Oil shall be used.

12.7 Damage Assessment

12.7.1 If required for compliance assessment, damage shall be determined by visual examination with the naked eye from arms-length [approximately 91 cm (3 ft)], of any critical sample or part after testing. The following items are examples of complying and noncomplying results; however, final determination of damage characteristics and results shall be based on manufacturer input before testing or qualified by a specific test:

a) Liquid Level Gauges – unless otherwise specified by each test requirement, unacceptable damage shall include, cracking of the globe or enclosure, or breakage of the mechanical link arms;

b) Fill Signal Devices – unless otherwise specified by each test requirement, unacceptable damage shall include, cracking of the enclosure or malfunction of signal;

c) Aboveground Piping – unless otherwise specified by each test requirement, unacceptable damage shall include:

1) Metallic Piping and Fittings – discoloration or minor dimensional change are compliant, but excessive permanent deformation, crazing, cracking, splitting, braid failure, kinking, and excessive corrosion or loss of corrosion protection are noncompliant examples; and

2) Nonmetallic Flexible Piping and Fittings – discoloration or minor dimensional change are compliant, but major dimensional changes, cracking, splitting, bulging, collapse, and delamination and damage to protective braids are noncompliant examples.

d) Fill Pipe Covers & Vent Pipe Caps – unless otherwise specified by each test requirement, discoloration or minor dimensional change are compliant, but excessive permanent deformation, crazing, cracking, splitting, braid failure, threads stripping, and excessive corrosion or loss of corrosion protection are noncompliant examples unacceptable damage.

Table 12.1
Test Matrix for Combustible Liquid Tank Accessories

Performance	Combustible Liquid Tank Accessory			
12 General Performance	General Information for Performance Testing of All Combustible Liquid Tank Accessories, Including:			
12.1 Test Samples	Guidance for selection of worst case test samples for each tank accessory.			
12.2 Test Conditions	Test liquids & ambient temperatures to be used unless otherwise indicated in a specific test.			
12.3 Test Tanks	Tank types & sizes when needed for testing.			
12.4 Test Pipes	Pipe types & sizes when needed for testing.			
12.5 Test Pressures	Use of hydrostatic or pneumatic methods.			
12.6 Test Fluids	Acceptable types of fluids used during testing.			
12.7 Damage Assessment	Guidelines on determining unacceptable damage for each product type after testing.			
13 AG Pipe Pressure Test	Aboveground Pipe System Pressure Test Details applicable for All pipe types:			
13.1 General	Pipe sample number, sizes, end fittings and 3 test temperatures, plus pressurization rates & leak detection methods.			
13.2 Leakage	Leakage Test at 2X rated.			
13.3 Hydrostatic	Hydrostatic Test at 5X rated.			
14 Functional Operation	Functional Operation Test Details applicable to Tank Accessories applicable to Fill Signals and Level Gauges.			
14.1 General	General test info to determine proper function & accuracy, and if testing at high and/or low temps are necessary.			
14.2 Fill Signal Test	Evaluation methods for Signal Devices (Visual and/or Audible), and Whistle Vent Alarms.			
14.3 Level Gauge Test	Evaluation methods for Liquid Level Gauges (mechanical or electrical types).			
14.4 Fill & Vent Cap Tests	Evaluation methods for Fill & Vent Cap Tests.			
15 Assembly & Use Tests	**Liquid Level Gauges**	**Fill Signal Devices**	**AG Pipe Systems**	**Fill Pipe Cover & Vent Pipe Caps**
15.1 General	General test info to determine worst case samples, if testing at high and/or low temps are necessary & sequence.			
15.2 Drop Test	Gauge or components per 15.2.1(a)	Signal or components per 15.2.1(b)	All plastic parts or areas per 15.2.1(c)	Separate cap & body per 15.2.1(d)
15.3 Connection Test	Gauge in top opening per 15.3.1(a)	Signal in top opening per 15.3.1(b)	All joints & fittings per 15.3.1(c)	Threaded bodies only per 15.3.1(d)
15.4 Impact Test	Exposed plastics per 15.4.1(a)	Exposed plastics per 15.4.1(b)	Pipes & exposed plastic per 15.4.1(c)	Cap top & body side per 15.4.1(d)

Table 12.1 Continued on Next Page

Table 12.1 Continued

15.5 Puncture Test	Exposed plastics per 15.5.1(a)	Exposed plastics per 15.5.1(b)	Some pipes & parts per 15.5.1(c)	Exposed plastics per 15.5.1(d)
15.6 Pipe Torque Test	N/A for traditional types per 15.6.1(a)	N/A for traditional types per 15.6.1(b)	Some pipes & parts per 15.6.1(c)	N/A
15.7 Pull Test	N/A for traditional types per 15.7.1(a)	N/A for traditional types per 15.7.1(b)	Some pipes & parts per 15.7.1(c)	N/A
15.8 Crush Test	N/A for traditional types per 15.8.1(a)	N/A for traditional types per 15.8.1(b)	Some pipes & parts per 15.8.1(c)	N/A
15.9 Bend Test	N/A for traditional types per 15.9.1(a)	Vent pipe connections per 15.9.1(b)	Most pipes & parts per 15.9.1(c)	N/A
16 Exposure/ Compatibility	**Liquid Level Gauges**	**Fill Signal Devices**	**AG Pipe Systems**	**Fill Pipe Cover & Vent Pipe Caps**
16.1 General	General test info to determine worst case test samples, damage re-creation & post test evaluation.			
16.2 Thermal Aging	Plastics, electronics, etc., per 16.2.1(a)	Plastics, electronics, etc., per 16.2.1(b)	Plastics or parts per 16.2.1(c)	Plastics or parts per 16.2.1(d)
16.3 UV Light Exposure	External plastics per 16.3.1(a)	External plastics per 16.3.1(b)	External plastics per 16.3.1(c)	External plastics per 16.3.1(d)
16.4 Salt Fog	Outdoor rated functional parts per 16.4.1(a)	Outdoor rated functional parts per 16.4.1(b)	Outdoor rated functional parts per 16.4.1(c)	Outdoor rated functional parts per 16.4.1(d)
16.5 Fuels & Fluids	Parts in contact with fuels/fluids per 16.5.1(a)	Parts in contact with fuels/fluids per 16.5.1(b)	Parts in contact with fuels/fluids per 16.5.1(c)	Only Nonmetallic types per 16.5.1(d)
16.6 Repeat Function	Repeat Subsection 14 Functional Operation Test at room temperature only if material changes or damage after exposures were observed per 16.6.1.			
16.7 Metal Stress Crack	For any metal tank accessory with threaded fittings, enclosures or other functional components if constructed with ≥ 15 % Zn, per 16.7.1.			
16.8 Plastic Stress Crack	For any plastic tank accessory with threaded fittings, enclosures or other functional components if constructed with polyethylene (PE) per 16.8.1.			
17 Special Tests	**Liquid Level Gauges**	**Fill Signal Devices**	**AG Pipe Systems**	**Fill Pipe Cover & Vent Pipe Caps**
17.1 General	General test info to determine worst case test samples and identify the appropriate post-test evaluations.			
17.2 P/V Strength	Liquid containing parts per 17.2.1	Liquid containing parts per 17.2.1	Only flexible hose (1) per 17.2.1	N/A
17.3 Rain	Outdoor rated tank top parts per 17.3.1	Outdoor rated tank top parts per 17.3.1	N/A	Outdoor rated caps per 17.3.1
17.4 Icing	Outdoor rated functional parts per 17.4.1	Outdoor rated functional parts per 17.4.1	N/A	Outdoor rated caps per 17.3.1
17.5 Endurance	Parts that frequently move per 17.5.1	Parts that frequently move per 17.5.1	Frequently flexed pipes (2) per 17.5.1	N/A
17.6 Leak Communication	N/A	N/A	Interstitial spaces per 17.6.1	N/A
17.7 Flow Test	NA	Alt flow test for 14.2 per 17.7.1	N/A	Alt flow test for 14.2 per 17.7.1
18 Pipe Cyclic Use Tests	N/A	N/A	Vibe, Surge or Flex (3) per 18.1	N/A
19 Fire Tests	N/A	N/A	All pipe systems per 19.1	N/A

(1) Exempt for pipe & tubing with metal walls. The Leakage & Hydrostatic tests exceed P/V Strength requirements.

(2) Pipe systems or flexible hose intended for frequent flexing shall be tested. See other applicable tests in 17.7.

(3) See 18.2 Vibration, 18.3 Surge & 18.4 Flex Tests for details on which pipe systems are applicable.

13 Aboveground Pipe System Pressure Tests

13.1 General

13.1.1 Sets of 3 pipe system samples of different pipe/tube/hose, fitting and connection combinations in each type, construction and size, or worst case representatives as defined in Clause 12.1.4, shall be tested in a continuous sequence on the same sample according to Sections 13.2, Leakage Test, and 13.3, Hydrostatic Test, while at the temperatures indicated below. Samples shall be at least 91 cm (3 ft) long, or the longest size for flex hose, and consist of joined pipes with end fittings assembled according to the manufacturer's instructions.

a) Room Temperature @ 18 °C to 30 °C (64 °F to 86 °F) for all pipe types and materials, and if applicable;

b) Low Temperature @ -30 °C (-22 °F) for "Outdoor" rated pipes with materials or connections affected by cold; and/or

c) High Temperature @ 50 °C (122 °F) for "Outdoor" rated pipes with materials or connections affected by heat

NOTE: Both flexible tube/hose type conforming to Clause 6.2 and rigid pipe type conforming to Clause 6.3 and common fittings are not affected by heat or cold. Nonmetallic pipes and gaskets shall be evaluated for heat and cold. If testing at high and/or low temperatures are required, testing at room temperature is not necessary.

13.1.2 All pipe systems evaluated shall be filled with water (with or without antifreeze as required) before applying the test pressures hydrostatically. Filling and sealing the primary pipe of a coaxial pipe is permitted when testing the secondary to prevent implosion.

Alternatively, an aerostatic method or combined hydrostatic/aerostatic method is permitted if found superior to the hydrostatic method to accurately determine leakage in complex piping systems.

13.1.3 The test sequence shall start at 0 kPa (0 psig) and be gradually increased at a rate no greater than 689 ± 138 kPa/min (100 ± 20 psig/min) with at least a 1 min pause between tests to visually examine samples for damage and leakage.

13.1.4 Leakage shall be detected by visual examination with or without the aid of dyes, leak solution, blotting paper, bubble submersion, or any other accurate and repeatable method. Noncomplying damage shall be determined in accordance with Clause 12.7.1.

13.2 Leakage Test

13.2.1 The leakage test pressure shall be at least twice the rated pressure, and there shall be no leakage or any noncomplying damage while the samples are pressurized.

13.3 Hydrostatic Test

13.3.1 The hydrostatic test pressure shall be at least five times the rated pressure. There shall be no leakage (but damage is acceptable) while the samples are pressurized.

14 Functional Operation Tests

14.1 Functional Operation Tests, General

14.1.1 Representative sample(s) in accordance with 12.1.2 shall be evaluated for functional operation and accuracy with Class II and Class III liquids under the following conditions:

a) Room temperature, and if applicable to affected products (in accordance with 14.1.2 and 14.1.3);

b) High temperature of 50 ± 2 °C (122 ± 3.6 °F) using the same sample; and/or

c) Low temperature of minus 30 ± 2 °C (minus 22 ± 3.6 °F) using the same sample.

The results shall be used for initial compliance, and shall also establish a baseline to which any repeat tests, after other test conditions, are judged for comparison.

14.1.2 To determine if tests at high/low temperatures are needed, assessment of the design and shall use engineering principles including, but not limited to thermal expansion/contraction and changes in flexibility, hardness, and similar material properties. The effect of thermal changes of the intended liquids, such as density and viscosity shall also be considered with respect to the product's proper operation.

14.1.3 If the high/low temperature effect on performance cannot be determined, the test shall be repeated on one sample for comparison, and if found to have different results than at room temp, additional test on other samples in the model group shall be conducted.

14.2 Fill Signal Test

14.2.1 The fill signal device shall be installed on a test tank with any remote indicators placed at the maximum distance from the fill pipe per the manufacturers instructions. The outlet of Whistle Vent Alarms shall be connected to a minimum 3.05 m (10 ft) vent pipe run consisting of at least of 0.3 m (1 ft) vertical to 2.44 m (8 ft) horizontal to 0.3 m (1 ft) vertical sections using Sch 40 steel pipe & elbows, and shall terminate with a vent pipe cap between 0.61 to 1.23 m (2 to 4 ft) above grade. Water shall be used as the test liquid.

14.2.2 A dBA pressure level meter shall be placed at a 4 m (13.1 ft) distance from the audible alarm device, and the device actuated. The sound level reading shall be ≥ 60 dBA at 10 – 20 gpm and ≥ 70 dBA at more than 20 gpm. The measurements shall be taken at every 38 Lpm (10 US gpm) interval in a 38 – 303 Lpm (10 – 80 US gpm) operating range with a general purpose sound pressure level meter on the A scale with a slow dynamics setting.

14.2.3 Visual signal devices shall emit a continuous or flashing light that is visible in a radius of at least 15 m (50 ft) approximately 1.83 m (6.0 ft) above grade in daylight conditions. The visual signal device shall be installed in accordance with the manufacturer's instructions and actuated. An observer shall stand at a distance of 15 m from the device and view it from a height of 1.5 m, the observer shall move around the device through a 120° arc that is centred on the device. The visual signal shall be detectable by the observer from all points around the arc.

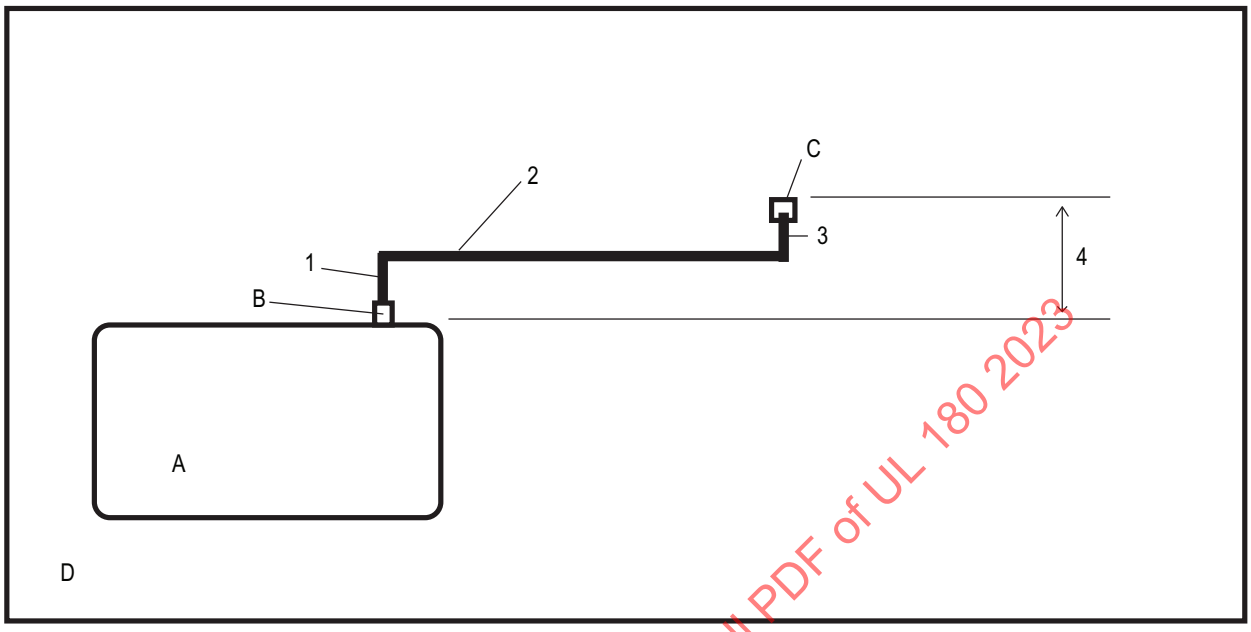
NOTE: Daylight is considered at least two 100 Watt light bulbs when tested indoors.

14.2.4 The fill signal device shall indicate the tank is nearing rated fill levels (full alarm) at no more that 90 % of the rated tank capacity by a different signal than when the fill operation starts. These may include, but are not limited to different sounds & colors or frequency & intensity. Secondary signals (overfill alarm) starting at 95 % of the rated tank capacity shall also be permitted if different from the full alarm and compliant with other applicable tests in this Subsection.

14.2.5 Compliance with Subsection 17.7, Flow Test, if required to show the device does not restrict adequate venting capacity, the alternate water method may be used in the above test sequence.

Figure 14.1

Fill signal test set up



su3435

A –Tank,
B – Whistle Vent,
C – Vent Cap,
D – The Total Pipe run from outlet of Vent Whistle is 3.05 m (10 ft) minimum

1– minimum 0.3 m (1 ft),
2 – minimum 2.44 m (8 ft),
3 – minimum 0.3 m (1 ft),
4 – 0.61 m to 1.23 m (2 ft to 4 ft)

14.3 Liquid Level Gauge Test

14.3.1 A gauge shall be installed on a level test tank or simulated tank apparatus, initially calibrated in accordance with the manufacturer's instructions, then evaluated for intended operation and level accuracy by filling the tank with the test liquids, and measuring the actual capacity at each required level interval (in accordance with Section 10, Liquid Level Gauge), and any optional signal levels (in accordance with Section 11, Optional Liquid Level Gauge Signals).

14.3.2 A gauge shall indicate the liquid level as intended without excessive delay or fluctuation, and each measured value shall be visible from 3.0 feet (0.9 m) and accurate to within ±10 % of the actual tank capacity.

14.4 Fill & Vent Cap Tests

14.4.1 For fill pipe covers, Subsection 17.3, Rain Test, shall apply.

14.4.2 For vent pipe caps, Subsection 17.3, Rain Test, Subsection 17.4, Icing Test, and Subsection 17.7, Flow Test, shall apply.

15 Assembly and Use Tests

15.1 General

15.1.1 Representative tank accessory sample(s) in accordance with Subsection 12.1, Test Samples, shall be evaluated for resistance to assembly and use in accordance with the test sequence for each tank accessory in Table 12.1 under each of the following conditions, as applicable:

a) Room temperature (for indoor ratings), or for outdoor ratings if applicable to affected products (in accordance with Clauses 15.1.2 to 15.1.4);

b) High temperature of 50 ± 2 °C (122 ± 3.6 °F) using the same sample; and/or

c) Low temperature of -30 ± 2 °C (-22 ± 3.6 °F) using the same sample.

Following completion of all tests, samples shall be assessed for damage, and then subjected to repeat Functional Operation Tests (in accordance with Section 14), Leakage Test (in accordance with Subsection 13.2), and other tests if applicable for the tank accessory at only room temperature.

NOTE: Guidance provided in Clauses 15.1.2 to 15.1.4 is provided to determine if high or low temperatures are applicable to each tank accessory and/or material in addition to details in Table 12.1 and each test method.

15.1.2 Samples with worst case damage from the Assembly and Use Tests shall also be used or re-created on new samples to conduct additional tests as applicable for the tank accessory, as described in Section 16, Exposure and Compatibility Tests, Section 17, Special Tests, Section 18, Pipe Cyclic Use Tests, or Section 19, Fire Test.

15.1.3 To determine if tests at high/low temperatures are needed, assessment of the design and materials with respect to increased damage causing reduced function from all Assembly and Use Tests at each temperature shall use engineering principles including, but not limited to thermal changes in material strength, impact resistance, flexibility, and similar properties.

15.1.4 If the worst case sample size for reduced performance after each Assembly and Use Test at each temperature can’t be determined, the test shall be repeated on one sample for comparison, and if found to have different results than at room temperature, additional test on other samples in the model group shall be conducted.

15.2 Drop Test

15.2.1 At least one sample of each tank accessory or their components as indicated below shall be dropped once from a height of 91 cm (3 ft) onto a flat concrete surface while at the temperatures as applicable for the rating and materials in accordance with Subsection 15.1, Assembly and Use Tests – General:

a) Liquid Level Gauges – Pre-assembled gauge or gauge components (measuring unit, indicating unit, etc.) as packaged by the manufacturer shall be dropped;

b) Fill Signal Devices – Pre-assembled signal or signal components (signal tube, device body, etc.) as packaged by the manufacturer shall be dropped;

c) Aboveground Piping Systems – Pipe/tube/hose (minimum 914 mm (3.0 ft) long) and fittings on areas with nonmetallic components shall be dropped as packaged by the manufacturer; or

d) Fill Pipe Cover & Vent Pipe Cap – Components (body and cap) shall be separately dropped as packaged by the manufacturer.

15.2.2 The drop location(s) shall be selected to evaluate the area(s) most likely to cause damage or malfunction. The sample is permitted to be guided to achieve this means.

15.2.3 Following the test, samples shall be visually examined for damage before being subjected to other applicable Assembly and Use Tests in the sequence prior to Repeat Tests according to Clause 15.1.1.

15.3 Torque and Connection Test

15.3.1 The same samples from the previous test which have threaded, crimp, press or other mechanical connection or requiring special tools intended to be assembled together or installed in a tank opening shall then be subjected to connection forces while at the temperatures as applicable for the rating and materials in accordance with Subsection 15.1, Assembly and Use Tests – General;

a) Liquid Level Gauges – Shall be installed in fittings simulating tank top openings;

b) Fill Signal Devices – Shall be installed in fittings simulating tank top openings;

c) Aboveground Piping Systems – Shall be assembled to mating connection fittings or steel pipe for end fittings; or

d) Fill Pipe Cover & Vent Pipe Cap – Bodies shall be connected to a threaded NPT Sch 40 steel pipe.

15.3.2 The samples shall be assembled or installed to fittings, pipe and/or other components as intended in accordance with the manufacturer's instructions, except at 1.5 times the recommended torque or other connection parameter for common tools; or for special tools, at worst case setting variations allowed.

15.3.3 Following the test, samples shall be visually examined for damage before being subjected to other applicable Assembly and Use Tests in the sequence prior to Repeat Tests according to Clause 15.1.1.

15.4 Impact Test

15.4.1 The same samples from the previous test shall then be subjected to impacts after complete assembly and installation while at the temperatures as applicable for the rating and materials according to Subsection 15.1, Assembly and Use Tests – General, as follows:

a) Liquid Level Gauges – Exposed nonmetallic areas shall be inspected after they are installed in tank tops;

b) Fill Signal Devices – Exposed nonmetallic areas shall be inspected after they are installed in tank tops;

c) Aboveground Piping Systems – Flexible tubing/hose shall be tested 2.54 mm (1.0 in) from end fittings, engineered systems on connecting fittings (*), and any exposed nonmetallic component; or

d) Fill Pipe Cover & Vent Pipe Cap – Components shall be separately impacted (body on side & cap on top).

(*) Engineered systems with gaskets fixed in place between metal pipe & metal fitting are exempt from this test.

15.4.2 The samples shall be impacted at 6.8 J (5.0 ftlbf) with a 50.8 mm x 0.535 kg (2.0 in x 1.18 lbm) diameter steel ball on area(s) most likely to cause damage or malfunction. The ball shall be guided from a drop height of 1.291 m (4.237 ft) to achieve this.

15.4.3 Following the test, samples shall be visually examined for damage prior to before being subjected to other applicable Assembly and Use Tests in the sequence prior to Repeat Tests according to Clause 15.1.1.

15.5 Puncture Test

15.5.1 The same samples from the previous test shall then be subjected to point loads on exposed nonmetallic parts after complete assembly and installation while at the temperatures as applicable for the rating and materials according to Subsection 15.1, Assembly and Use Tests – General, as follows:

a) Liquid Level Gauges – Exposed nonmetallic areas, such as gauge globes, shall be tested;

b) Fill Signal Devices – Not applicable for traditional “whistle” devices in a metal body;

c) Aboveground Piping Systems – Extruded covers, end sleeves or other exposed nonmetallic components, and external braids of any material, shall be tested; or

d) Fill Pipe Cover & Vent Pipe Cap - Nonmetallic constructions shall be tested at the thinnest area.

15.5.2 The samples shall be subjected to a 6.8 kg (15 lbm) point load applied for 1 h through a 5.0 mm (0.20 in) steel shaft with a 1.0 mm (0.04 in) diameter tip and 30° edge perpendicular to area(s) most likely to cause damage or malfunction.

15.5.3 Following the test, samples shall be visually examined for damage before being subjected to other applicable Assembly and Use Tests in the sequence prior to Repeat Tests according to Clause 15.1.1.

15.6 Pipe Torque Test

15.6.1 The same samples from the previous test shall then be subjected to twisting forces translated from connecting pipes after complete assembly and installation while at the temperatures as applicable for the rating and materials in accordance with Subsection 15.1, Assembly and Use Tests – General.

a) Liquid Level Gauges – Not applicable for traditional float gauges installed in tank top openings;

b) Fill Signal Devices – Not applicable for traditional “whistle” devices in a cast metal body; or

c) Aboveground Piping Systems – Connections on flexible tubing/hose and engineered systems shall be tested.

15.6.2 The samples shall be connected to a mating Schedule 40 steel pipe or bushing and twisted (clockwise to tighten) along the longitudinal pipe axis to 67.8 N·m (50 ftlb) or 45°, whichever is reached first, and then held for 1 min. For flexible hose, the test values shall be 33.9 N·m (25 ftlb) or 90°.

15.6.3 Following the test, samples shall be visually examined for damage before being subjected to other applicable Assembly and Use Tests in the sequence prior to Repeat Tests according to Clause 15.1.1.

15.7 Pull Test

15.7.1 The same samples from the previous test shall then be subjected to tension forces translated from connecting pipes or equipment after complete assembly and installation while at the temperatures as applicable for the rating and materials in accordance with Subsection 15.1, Assembly and Use Tests – General.

a) Liquid Level Gauges – Not applicable for traditional float gauges installed in tank top openings;

b) Fill Signal Devices – Not applicable for traditional “whistle” devices in a cast metal body; or

c) Aboveground Piping Systems – Connections on flexible tubing/hose and engineered systems shall be tested.

15.7.2 The samples shall be connected to a mating pipe or fittings and pulled along the longitudinal pipe axis at a 444.8 N (100 lbf) force for supply pipe or a 1112 N (250 lbf) force for fill or vent pipe and held for 1 min. For flexible hose, the test values shall be 222.4 N (50 lbf).

15.7.3 Following the test, samples shall be visually examined for damage before being subjected to other applicable Assembly and Use Tests in the sequence prior to Repeat Tests according to Clause 15.1.1.

15.8 Crush Test

15.8.1 The same samples from the previous test shall then be subjected to compression forces translated from static loads after complete assembly and installation while at the temperatures as applicable for the rating and materials in accordance with Subsection 15.1, Assembly and Use Tests – General.

a) Liquid Level Gauges – Not applicable for traditional float gauges installed in tank top openings;

b) Fill Signal Devices – Not applicable for traditional “whistle” devices in a metal body; or

c) Aboveground Piping Systems – Flexible tubing/hose and engineered systems 25.4 mm (1.0 in) from end fittings, and any exposed nonmetallic fitting or other component shall be tested.

15.8.2 The samples shall be compressed between 7.6 cm (3.0 in) thick flat metal plates at a 113.4 kg (250 lbm) load for supply pipe or a 226.8 kg (500 lbm) load for vent pipe and held for 1 min. For flexible hose, the test value shall be 45.5 kg (100 lbm).

15.8.3 Following the test, samples shall be visually examined for damage before being subjected to other applicable Assembly and Use Tests in the sequence prior to Repeat Tests according to Clause 15.1.1.

15.9 Bend Test

15.9.1 The same samples from the previous test shall then be subjected to bending forces, to simulate those translated from connecting pipes or equipment after complete assembly and installation, while at the temperatures as applicable for the rating and materials in accordance with Subsection 15.1, Assembly and Use Tests – General.

a) Liquid Level Gauges – Not applicable for traditional float gauges installed in tank top openings;

b) Fill Signal Devices – Rigid vent pipe connected to traditional “whistle” devices in a metal body shall be tested; or

c) Aboveground Piping Systems – Flexible tubing/hose, rigid pipe, engineered systems shall be tested.

15.9.2 Where the manufacturer’s instructions specify that the aboveground piping system may only be connected to flexible tubing, the samples shall be connected to a 0.91 cm (3 ft) length of the intended flexible tubing at one end fitting. Where the manufacturer’s instructions specify that the aboveground piping system may be connected to rigid or flexible tubing, the samples shall be connected to a 0.91 cm (3 ft) length of sch 40 steel pipe at one end fitting. The other end of the sample shall be fixed by attachment to a metal pipe. The load shall be applied to the sample as follows:

a) Flexible tubing shall be bent 1.5 times below the rated bend radius around a mandrel for 1 min;

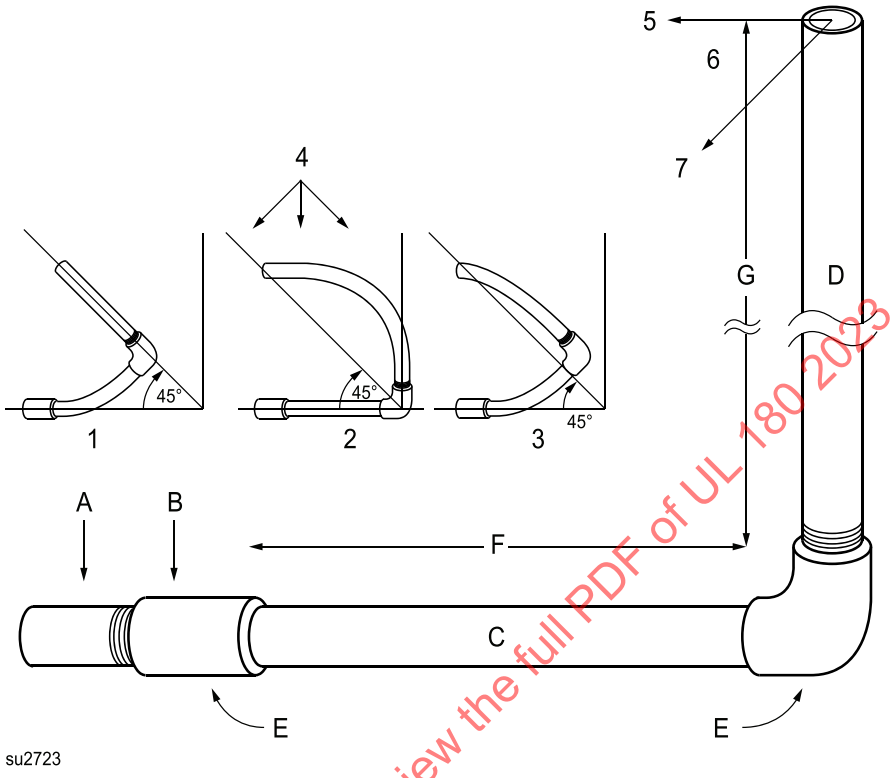
b) Rigid pipe shall apply a 222.4 N (50 lbf) force for supply pipe, or a 444.8 N (100 lbf) force for vent pipe, at the steel pipe end for 1 min.

15.9.3 The bending moments shall be applied both parallel and perpendicular to the sample pipe axis within 1 min of each other, refer to Figure 15.1. If the pipe bends more than 45° from the original axis before reaching the maximum value, the bending moment shall be stopped.

15.9.4 Following the test, samples shall be visually examined for damage before being subjected to other applicable Assembly and Use Tests in the sequence prior to Repeat Tests according to Clause 15.1.1.

Figure 15.1

Bending Moments



A – Metal Pipe;
B – Fixed Ends;
C – Sample under test;
D – Flexible tubing or SCH 40 Steel Pipe, as applicable;
E – Fittings specified in the manufacturer's instructions;
F – 0.91 m (3 ft) minimum;
G – 0.91 m (3 ft)

1 – Sample Bends 45°;
2 – Loaded pipe Bends 45°;
3 – Both Pipes Bend 45°;
4 – Stop application of Bending Force, and record value, at 45° Bending of 1, 2, or 3;
5 – Parallel;
6 – Refer to Clause 15.9.2 Applied Bending Force;
7 – Perpendicular

16 Exposure and Compatibility Tests

16.1 General

16.1.1 Representative tank accessory sample(s) in accordance with Subsection 12.1, Test Samples, with any damage from the Assembly and Use Tests re-created according to Clause 15.1.2 shall be evaluated for resistance to expected exposure and for material compatibility per Subsections 16.2 to 16.8 as applicable, followed by repeat Tests as specified. Metallic fill pipe covers and vent pipe caps are exempt from Subsection 16.5, Fuels & Fluids Compatibility Test.

16.1.2 Following completion of each test, samples shall be visually examined for material changes, then assessed for damage and proper function to determine if, repeat Functional Operation Tests (in accordance with Subsection 16.6) are applicable.

16.1.3 Samples with worst case damage from the Exposure and Compatibility Tests shall also be used or re-created on new samples to conduct the tests described in Section 17, Special Tests, as applicable.

16.1.4 To determine the worst case sample, assessment of design and materials with respect to changes or damage causing reduced function from each condition shall use engineering principles including, but not limited to material changes or reduced impact resistance from metal corrosion and polymer or elastomer changes in dimensions, flexibility, hardness, or other key characteristics. The worst case sample size shall be consistent for comparison purposes.

16.2 Thermal Aging Test

16.2.1 Samples with functional polymers, electronics or other components that may be affected by long term exposure to heat, shall be subjected to accelerated aging in an air circulating oven for 90 days at 70 ± 2 °C (158 ± 3.6 °F):

a) Liquid Level Gauges – One sample is permitted to be installed in fittings simulating tank top openings during the test if necessary. Repeat tests according to Subsections 15.4, Impact Test, and 16.6, Repeat Functional Operation after Exposure and Compatibility Tests, shall then be conducted on the same sample;

b) Fill Signal Devices – One sample is permitted to be installed in fittings simulating tank top openings during the test if necessary. Repeat tests according to Subsections 15.4, Impact Test, and 16.6, Repeat Functional Operation after Exposure and Compatibility Tests, shall then be conducted on the same sample;

c) Aboveground Piping Systems – Tests shall be conducted on nonmetallic parts as applicable:

1) Pipes – 3 samples at least 30 cm (12 in) long shall be assembled to mating connection fittings or steel pipe for end fittings during the test. Repeat Tests (*) shall be conducted according to the requirements of Subsections 15.4 Impact Test, 15.5 Puncture Test, and 15.8, Crush Test, (one test per sample), followed by those of Subsection 13.2, Leakage Test, (all samples); or

2) Sleeves – 3 samples at least 30 cm (12 in) long shall be aged according to Subsection 16.2, Thermal Aging Test, while on the pipe. Repeat Tests shall be conducted according to the requirements of Subsections 15.4 Impact Test, 15.5 Puncture Test, and 15.9 Bend Test (one test per sample), followed by a visual exam for damage. There shall be no holes, tears, cracks or other damage that exposes the pipe.

(*) Engineered systems with ring gaskets fixed in place between metal pipe & metal fitting are exempt from the repeat Impact, Puncture & Crush Tests prior to Leak Testing.

d) Fill Pipe Cover & Vent Pipe Cap – One sample shall be assembled to a Sch 40 steel pipe with the cap on hand tight. Repeat tests per Subsection 15.4 Impact Test, and Subsection 16.6, Repeat Functional Operation after Exposure and Compatibility Tests, shall then be conducted on the same sample.

16.3 UV Light Exposure Test

16.3.1 Samples with functional external polymers or other components that may be affected by long term exposure to sunlight after installation, shall be subjected to cycles of 102 min light and 18 min light/water in accordance with either Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials, ASTM G153, (Carbon Arc) for 720 h or Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials, ASTM G155 (Xenon Arc) for 1000 h. For flexible hose with external braids of any material, the test shall be conducted after the sample is flexed to the minimum bend radius for 10 cycles to expose potential gaps. The test shall be conducted with the sample flexed to the minimum rated bend radius.

a) Liquid Level Gauges – One sample is permitted to be installed in fittings simulating tank top openings during the test if necessary. Repeat Tests according to the requirements of Subsections

15.4, Impact Test, and 16.6, Repeat Functional Operation after Exposure and Compatibility Tests, shall then be conducted on the same sample;

b) Fill Signal Devices – One sample is permitted to be installed in fittings simulating tank top openings during the test if necessary. Repeat Tests according to Subsections 15.4, Impact Test, and 16.6, Repeat Functional Operation after Exposure and Compatibility Tests, shall then be conducted on the same sample;

c) Aboveground Piping Systems – Tests shall be conducted on nonmetallic parts as applicable:

1) Pipes – 3 samples at least 30 cm (12 in) long shall be assembled to mating connection fittings or steel pipe for end fittings during the test. Repeat Tests (*) shall be conducted according to the requirements of Subsections 15.4, Impact Test, 15.5, Puncture Test, and 15.8, Crush Test (one test per sample), followed by those of Subsection 13.2, Leakage Test, (all samples); or

2) Sleeves – 3 samples at least 30 cm (12 in) long shall be aged according to Subsection 16.2, Thermal Aging Test, while on the pipe. Repeat Tests shall be conducted according to the requirements of Subsections 15.4, Impact Test, 15.5, Puncture Test, and 15.9, Bend Test (one test per sample), followed by a visual exam for damage. There shall be no holes, tears, cracks or other damage that exposes the pipe.

(*) Engineered systems with ring gaskets fixed in place between metal pipe & metal fitting are exempt from the repeat Impact, Puncture & Crush Tests prior to Leak Testing.

d) Fill Pipe Cover & Vent Pipe Cap – One sample shall be assembled to a Sch 40 steel pipe with the cap on hand tight. Repeat tests per Subsection 15.4 Impact Test, and Subsection 16.6, Repeat Functional Operation after Exposure and Compatibility Tests, shall then be conducted on the same sample.

16.4 Salt Fog Exposure Test

16.4.1 Samples of products that are rated for outdoor use with functional external metals or other components that may be affected by long term exposure to corrosive elements after installation, shall be subjected to 600 h of a 5 % NaCl H_2O Solution (6.5 to 7.2 pH and 1.033 to 1.039 spg) atomized through nozzles at 124 ± 14 kPa (18 ± 2 psig) in 35 ± 2 °C (95 ± 3.6 °F) humid air in accordance with ASTM B117, Standard Practice for Operating Salt Spray (Fog) Apparatus. The test chamber shall be sealed with the samples suspended in the salt fog. For flexible hose with external metal braids, the test shall be conducted after the sample is flexed to the minimum bend radius for 10 cycles to expose potential gaps.

a) Liquid Level Gauges – One sample is permitted to be installed in fittings simulating tank top openings during the test if necessary. Repeat Tests according to the requirements of Subsections 15.4, Impact Test, and 16.6, Repeat Functional Operation after Exposure and Compatibility Tests, shall then be conducted on the same sample;

b) Fill Signal Devices – One sample is permitted to be installed in fittings simulating tank top openings during the test if necessary. Repeat Tests according to the requirements of Subsections 15.4, Impact Test, and 16.6, Repeat Functional Operation after Exposure and Compatibility Tests, shall then be conducted on the same sample;

c) Aboveground Piping Systems – 3 samples at least 30 cm (12 in) long shall be assembled to mating connection fittings or steel pipe for end fittings during the test. Repeat Tests (*) shall be conducted according to the requirements of Subsections 15.4 Impact Test, 15.5 Puncture Test, and 15.8, Crush Test (one test per sample), followed by those of Subsection 13.2, Leakage Test, (all samples); or

(*) Engineered systems with ring gaskets fixed in place between metal pipe & metal fitting are exempt from the repeat Impact, Puncture & Crush Tests prior to Leak Testing.

d) Fill Pipe Cover & Vent Pipe Cap – One sample shall be assembled to a Sch 40 steel pipe with the cap on hand tight. Repeat tests per Subsection 15.4, Impact Test, and Subsection 16.6, Repeat Functional Operation after Exposure and Compatibility Tests, shall then be conducted on the same sample.

16.4.2 Corrosion resistant metals of copper, brass, stainless steel or copper/nickel alloys if of the ASTM types and at least the minimum tube or pipe wall thicknesses according to Clauses 6.2, 6.3 or 6.4 are exempt from this test.

16.4.3 As an alternative to the Salt Fog Test, corrosion resistance of pipes is permitted to be demonstrated by compliance with the requirements of Subsection 16.5, Fuels & Fluids Compatibility Test.

16.5 Fuels & Fluids Compatibility Tests

16.5.1 Samples with components that are intended to be in contact with either external fluids and contained fuels and/or vapors of the tank contents as applicable for the tank accessory, shall be subjected to long term compatibility exposures for 90 days at 60 ± 2 °C (140 ± 3.6 °F) using the test liquids indicated in Clause 16.5.2 and exposure conditions in Clause 16.5.3, followed by additional tests as specified below. Separate samples shall be used for each different fuel and fluid. For flexible hose with external braids of any material, the test shall be conducted after the sample is flexed to the minimum bend radius for 10 cycles to expose potential gaps.

a) Liquid Level Gauges – Internal components to the tank (typically floats, sensors and their connections to the gauge) shall be evaluated for fuel resistance. External components to the tank (typically fittings, globes & gauges) shall be evaluated for fluids resistance. Refer to Subsection 16.3, UV Light Exposure Test, for exposure details. Repeat Tests according to Subsection 15.4, Impact Test, on external components and Subsection 16.6, Repeat Functional Operation after Exposure and Compatibility Tests, shall then be conducted on the same sample;

b) Fill Signal Devices – Internal components to the tank (typically whistles & sensors) shall be evaluated for fuel resistance. External components to the tank (typically fittings & signals) shall be evaluated for fluids resistance. Refer to Subsection 16.3, UV Light Exposure Test, for exposure details. Repeat Tests according to Subsection 15.4, Impact Test, on external components and Subsection 16.6, Repeat Functional Operation after Exposure and Compatibility Tests, shall then be conducted on the same sample;

c) Aboveground Piping Systems – Tests shall be conducted on pipe samples at least 460 mm (18 in) long assembled to intended connection fittings as applicable, and bent to the minimum radius according to the manufacturer's ratings & instructions. It is permitted to combine testing with an internal fuel and external fluid.

1) Internal parts of the pipe & fittings shall be filled with fuel and sealed. Repeat Tests (*) shall be be conducted according to the requirements of Subsections 15.4 Impact Test and 15.8, Crush Test followed by those of Subsection 13.2, Leakage Test, on the same sample;

2) External parts of the pipe & fittings shall be immersed in fluids with the ends sealed. Repeat Tests (*) shall be conducted according to the requirements of Subsections 15.4 Impact Test and 15.8, Crush Test followed by those of Subsection 13.2, Leakage Test, on the same sample; or

3) For pipes with sleeves, the ends shall be sealed prior to external fluid immersions, and shall be visually examined for damage before leak testing. There shall be no holes, tears, cracks or other damage that exposes the pipe, and there shall be no corrosion of the pipe under the sleeve.

(*) Engineered systems with ring gaskets fixed in place between metal pipe & metal fitting are exempt from the repeat Impact & Crush Tests prior to Leak Testing.

d) Fill Pipe Cover & Vent Pipe Cap – Internal components shall be evaluated for fuel resistance. External components shall be evaluated for fluid resistance. Refer to Subsection 16.3, UV Light Exposure Test, for exposure details. Repeat Tests per Subsection 15.4, Impact Test, and Subsection 16.6, Repeat Functional Operation after Exposure and Compatibility Tests, shall then be conducted on the same sample.

16.5.2 The samples shall be installed in a test container that simulates the expected installation, then exposed to each of the applicable test fuels and fluids as identified below which are representative of Class II and Class III Combustible Liquids:

a) 100 % Ref Fuel F (D2 Type S15 Grade) with up to 5 % biodiesel;

b) F75/B25a (See Appendix A for aggressive biodiesel formulas);

c) Motor Oil (commercial grade Type SAE 30W);

d) Kerosene (commercial grade Standard Specification for Kerosene, ASTM D3699, Type K1);

e) Ph 3.0 Sulfuric Acid;

f) Ph 10 Sodium Carbonate/Bicarbonate;

g) Distilled Water; and

h) UL B100 if optionally rated for biodiesel blends up to 100 % per 1.8 and 21.1(d) (See Appendix A for aggressive biodiesel formulas).

Exception: Piping systems are not required to be tested for Motor Oils.

16.5.3 The test conditions for samples of liquid level gauges & fill signal devices shall simulate as close as possible the expected liquid and vapor exposure combinations below:

a) Components such as floats, arms and sensors that are intended to be below the tank fitting shall be exposed to both liquids and vapors in a manner that closely simulates normal use in a half filled tank, with periodic exposure to splashed liquids. The test container shall be shaken once per week to expose all applicable components to liquids; or

b) Components such as indicators, gaskets and enclosures that are intended to be at or above the tank fitting shall be exposed to vapors, except for occasional exposure to overfilled liquids. The test container shall be shaken (*) every 30 days (**) to expose all applicable components to liquids.

(*) – Shaking is intended to be a single gentle up-down motion of the sample in the test container to simulate occasional splashing and condensate formation of liquids. Shaking is not intended to be vigorous, lengthy and/or cause damage to the sample or test container. Alternative equivalents to shaking include extracting the sample from the test container and brushing, spraying, or pouring the test liquid on the applicable parts. Any of the alternate methods can include temporary removal of the test container from the heating equipment, provided the wetting operation is done quickly to avoid cooling, and then immediately returned to the test container and heating equipment.

(**) – Shaking does not start until after the first time increment (week or 30 days), and shall not be done on the last (90^{th}) day.

16.6 Repeat Functional Operation after Exposure and Compatibility Tests

16.6.1 If any material changes or damage from any of the Exposure and Compatibility Tests are likely to result in reduced functional performance of the tank accessory, the Functional Operation Tests in accordance with Section 14 shall be repeated at only room temperature, and pass/fail criteria applied.

16.7 Metallic Stress Crack Test

16.7.1 Tank Accessories with threaded fittings, enclosures or other functional components containing at least 15 % zinc (excluding platings), shall be evaluated for stress cracking with respect to reduced resistance to rain and ice, and reduced operation after exposure to a metallic stress cracking surrogate.

16.7.2 Samples shall be exposed to a moist ammonia-air mixture of minimum 600 mL (20 fluid ounces) of 0.94 spg aqueous ammonia for 10 days at 35 °C (95 °F) in a heated water bath or oven. All samples shall be clean, with components assembled as intended in accordance with the manufacturer's instructions, and positioned above the ammonia mixture in a suitable container.

16.7.3 Following the exposure, samples are to be visually examined, and shall not show any evidence of cracking, crazing, or other damage that would result in reduced resistance to rain or ice, or improper function.

16.7.4 If assessment of the pass/fail criteria cannot be determined by visual exam, the damaged samples shall be used for the Rain Test according to Subsection 17.3, the Icing Test according to Subsection 17.4, and/or repeat Functional Operation Tests according to Section 14, as applicable.

16.8 Nonmetallic Stress Crack Test

16.8.1 Accessories with threaded fittings, enclosures or other functional components containing polyethylene (any type or percentage blend), shall be evaluated for stress cracking with respect to reduced resistance to rain and ice, and reduced operation after exposure to a nonmetallic stress cracking surrogate.

16.8.2 Samples shall be exposed to a 10 % poly-oxyethylated nonylphenol (for example Type CO-630 IGEPAL®) water solution for 180 h at 60 °C (140 °F) in a heated water bath or oven. All samples shall be clean, with components assembled as intended in accordance with the manufacturer's instructions, and immersed in the igepal solution in a suitable container.

NOTE : IGEPAL is a Registered Trade Mark of Rhodia Operations

16.8.3 Following the exposure, samples are to be visually examined, and shall not show any evidence of cracking, crazing, or other damage that would result in reduced resistance to rain or ice, or improper function.

16.8.4 If assessment of the pass/fail criteria cannot be determined by visual exam, the damaged samples shall be used for the Rain Test according to Subsection 17.3, the Icing Test according to Subsection 17.4, and/or repeat Functional Operation Tests according to Section 14, as applicable.

17 Special Tests

17.1 General

17.1.1 Representative sample(s) in accordance with Subsection 12.1, Test Samples, shall be evaluated for each special test conditions in accordance with Subsections 17.2 to 17.7, as applicable.

17.1.2 Following each test, samples shall be evaluated to the individual pass/fail criteria, and if necessary to determine proper function, shall be subjected to repeat Functional Operation Tests (in accordance with Section 14), except only at room temperature.

17.1.3 To determine the worst case sample, assessment of design and materials with respect to the intent of each Special Test and highest failure probability shall be selected, if a worst case sample cannot be determined, different samples variations shall be evaluated.

17.2 Pressure/Vacuum Strength Test

17.2.1 Tank accessories with components that are intended to be installed in a tank fitting or pipe and form part of the liquid containment (such as a gauge indicator globe, or fill signal body) or may be affected by pressure or vacuum changes (such as level detector floats) shall be evaluated for resistance to pressure and vacuum changes.

17.2.2 If necessary, samples with worst case damage from the Assembly and Use Tests (Section 15), Exposure and Compatibility Tests (Section 16), Metallic Stress Crack Test of Subsection 16.7, or Nonmetallic Stress Crack Test of Subsection 16.8, shall be used to determine compliance.

17.2.3 Samples shall be installed in a simulated tank top opening or a small test container filled with water, then subjected to 1 min of pressure at +34 kPa (+5.0 psig), followed by 1 min of vacuum at -6.9 kPa (-1.0 psig). No leakage is permitted through fitting connections or gaskets during the test.

17.2.4 Following the test, samples are to be visually examined, and shall not show evidence of rupture, or excessive leakage or damage that would result in reduced resistance to rain or ice, or improper function.

17.2.5 If assessment of the pass/fail criteria cannot be determined by visual exam, the damaged samples shall be used for the Rain Test according to Subsection 17.3, the Icing Test according to Subsection 17.4, and/or repeat Functional Operation Tests according to Subsection 14, as applicable.

17.3 Rain Test

17.3.1 Tank accessory samples with components that are intended to be installed in a tank top fitting or pipe (such as a gauge indicator globe or pipe fill or vent caps), shall be evaluated for resistance of water entry into the tank.

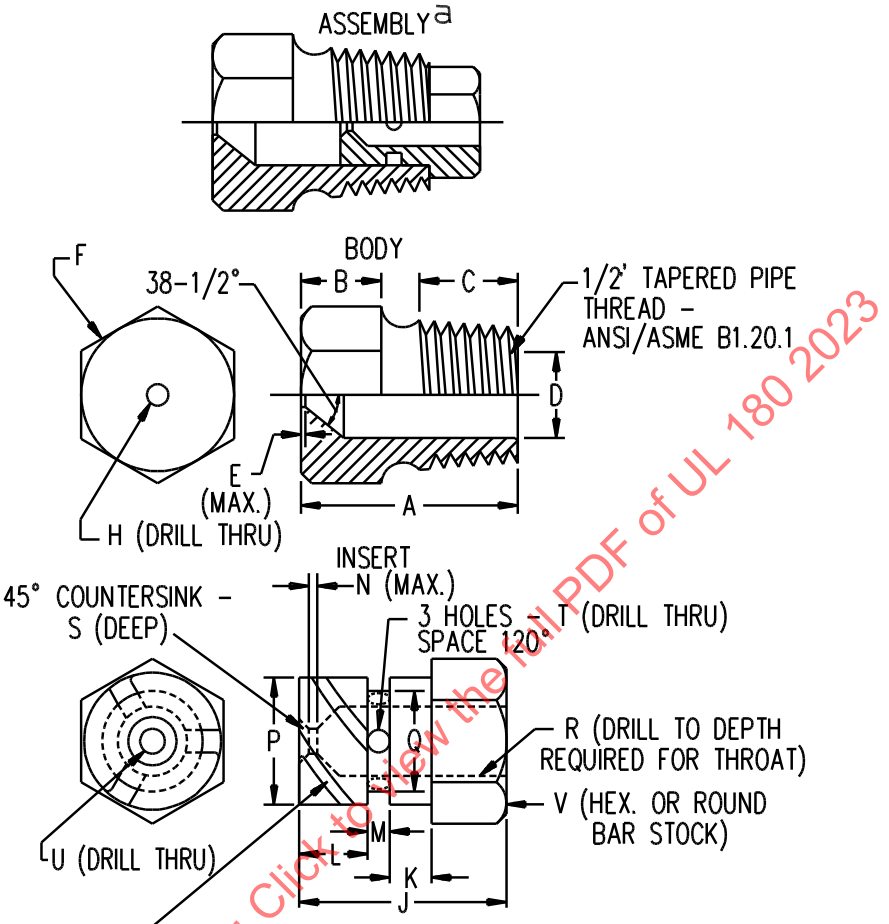
17.3.2 If necessary, samples with worst case damage from the Assembly and Use Tests (Section 15), Exposure and Compatibility Tests (Section 16), Metallic Stress Crack Test of Subsection 16.7, or Nonmetallic Stress Crack Test of Subsection 16.8 or Pressure/Vacuum Strength Test of Subsection 17.2, shall be used to determine compliance.

17.3.3 The samples shall be installed in a simulated flat top tank or pipe end opening, then subjected to a 30 min simulated rain emitted from a Rain Test Spray Head, in accordance with Figure 17.1. The nozzle shall operate at 34 kPa (5.0 psig) within 0.9 to 1.5 m (3.0 to 5.0 ft) of the test area at a 45° angle focused on the sample area(s) most likely to allow entry of water.

17.3.4 Following the rain exposure, the sample shall be visually examined, and assessed for water resistance and operation. There shall be no entry of water into a protective enclosure, or tank or pipe opening, and the sample shall function normally.

Figure 17.1

Spray Head



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

[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.

RT100F

17.4 Icing Test

17.4.1 Tank accessory samples with components that may be affected by formation of ice in or around a specific part (such as a gauge indicator globe or pipe fill or vent caps), shall be evaluated for normal operation after icing.

17.4.2 If necessary, samples with worst case damage from the Assembly and Use Tests (Section 15), Exposure and Compatibility Tests (Section 16), Metallic Stress Crack Test of Subsection 16.7, or Nonmetallic Stress Crack Test of Subsection 16.8 or Pressure/Vacuum Strength Test of Subsection 17.2, shall be used to determine compliance.

17.4.3 The samples shall be installed in a simulated flat top tank or pipe end opening, or as otherwise intended, then placed in a cold chamber at -6.0 ± 2.0 °C (21.2 ± 3.6 °F) ambient and subjected to simulated freezing rain under no-flow conditions. The component(s) in question shall be intermittently sprayed with water at a 45° angle for 4 h at a cycle rate of 14 to 16 s on, and 160 to 180 s off. The water shall be delivered through a nozzle at 3.0 ± 0.38 $L \cdot h^{-1}$ (0.8 ± 0.1 U.S. $gal \cdot h^{-1}$) to simulate rain, and at a temperature, pressure and distance sufficient to cause ice formation on the sample. The sample shall remain in the chamber for 1 h after the last water cycle.

17.4.4 Following the ice exposure while still cold, the samples shall be visually examined and assessed for ice resistance and operation. The sample shall function normally and vent caps shall not have reduced venting.

17.5 Endurance Test

17.5.1 Tank accessory samples with components that are intended to frequently move and may be affected by wear (such as a gauge actuation arm or fill whistle), shall be evaluated for normal operation after the endurance cycling.

17.5.2 The sample shall be installed in a simulated flat top tank opening, or as otherwise intended, then subjected to 6,000 cycles of operation over the full normal movement range at no less than 1 cycle/min. The movement may be simulated by any means representative of actual use.

17.5.3 Following the cyclic endurance, the samples shall be visually examined and assessed for excessive wear and operation. The sample shall function normally.

17.5.4 Tank accessory samples with components that are intended to frequently move and may be affected by wear, shall be evaluated for normal operation after the endurance cycling.

17.6 Interstitial Communication Test

17.6.1 A minimum 1.83 m (6 ft) length of the pipe types listed below in worst case sizes and fittings with respect to minimum interstitial space, shall be subjected to the test described in Clause 17.6.2 to measure the communication rate. A 90° elbow on one end shall be used to add the test liquid. Separate tests shall be conducted on:

a) Field-use combinations of primary pipe and secondary pipe; and

b) Coaxial pipes.

Exception: Pipes with a continuous interstitial space of at least 2.5 mm (0.10 in) between primary pipe and secondary pipe walls and fittings are exempt.

17.6.2 The sample on a flat surface shall be bent to the minimum rated radius, with water added to the interstitial space at the elbow with a hydrostatic head not exceeding 152 mm (6 in). The time between introduction and exit of the test liquid at opposite ends of the pipe shall be measured.

17.6.3 The calculated communication rate (distance/time) shall not be less than 63 $cm \cdot hr^{-1}$ (2 $ft \cdot hr^{-1}$).

17.7 Flow Test

17.7.1 As an alternate test method to show an in-line vent pipe cap or fill signal device does not restrict adequate venting capacity, is permitted to be tested with water instead of air, and may be included in Subsection 14.2, Fill Signal Test, test sequence, except the maximum tank pressure in a overfill condition (water through the device) shall not exceed 35 kPa (5 psig).

17.7.2 For vent pipe caps that do not meet the construction requirements of Section 8, Fill Pipe Covers & Vent Pipe Caps, the flow restriction shall not exceed 3.4 kPa (0.5 psig) under the following test conditions described in Clause 17.7.2.1.

17.7.2.1 The vent pipe cap shall be installed at the end of a 3.05 m (10 ft) long steel pipe run and minimum 378 L (100 US gal) tank test rig per Figure 14.1. Water shall be pumped into the tank at a rate of 303 Lpm (80 US gpm), and the pressure at the tank top monitored until steady pressure conditions are reached.

18 Pipe Cyclic Use Test

18.1 General

18.1.1 Representative worst case piping system sample(s), with re-created damage according to Clause 15.1.2 if necessary, shall be evaluated to the Pipe Cyclic Use Test(s) as applicable with water as the working fluid:

a) Vibration Test per Subsection 18.2 for pipe types intended to be connected directly to diesel generators or similar equipment without instructions to use flex-connectors;

b) Surge Test per Subsection 18.3 for pipe types intended to be connected directly to fuel pumps or pipe runs without instructions to use in-line check valves or pressure dampers; or

c) Flex Test per Subsection 18.4 for pipe types intended for use in construction of either swing joints or swivel joints.

18.1.2 Following completion of each applicable Pipe Cyclic Use Test, samples shall be assessed for damage, and then subjected to a repeat Leakage Test (per Subsection 13.2) at room temperature.

18.2 Vibration Test

18.2.1 One set of three 0.91 m (3 ft) long samples of each pipe system in worst case sizes shall be connected at end fitting(s) to suitable test equipment, then subjected to a continuous vibration per Clause 18.2.2.

Exception: Pipes and fittings conforming to the vibration testing requirements of ASTM F3226.

18.2.2 All samples shall be tested at a 1/2 cycle amplitude of 1.91 ± 0.13 mm (0.075 ± 0.005 in) for a total displacement of 3.81 ± 0.05 mm (0.15 ± 0.02 in) at a frequency of 950 ± 50 cycle/min for 300 h. Samples shall be filled with water to rated pressure, sealed, then fixed at the end(s) on the vibration table in different orientations, so that only one plane of motion is possible per sample:

Sample 1 – (X plane) Longitudinal axis parallel to the displacement;

Sample 2 – (Y plane) Longitudinal axis perpendicular to the displacement; and

Sample 3 – (Z plane) Pipe at minimum bend radius with the upward arc perpendicular to the displacement (both ends may be fixed).

18.2.3 The samples shall not be damaged after vibration or leak after pressurizing.

18.3 Surge Test

18.3.1 One set of three 0.91 m (3 ft) long samples of each pipe system in worst case sizes shall be connected at end fitting(s) to suitable test equipment, then subjected to a cyclic pressure surge per Clause 18.3.2.

Exception: Pipes conforming to the impulse testing requirements of ASTM F3226.

18.3.2 The primary pipe of each sample shall be subjected to 200,000 cycles of hydrostatic pressures between 103 ± 69 kPa (15 ± 10 psig) and 1724 kPa (250 psig) at 4 to 10 cycle/min, with approximately 1 s at the low and high cycle points. Samples shall be filled with water, sealed, and coupled to the test apparatus under the different orientations and forces below:

Sample 1 – 89 N (20 lbf) tension applied to the straight pipe length;

Sample 2 – 89 N (20 lbf) compression applied to the straight pipe length; and

Sample 3 – While bent at the manufacturer's minimum bend radius.

18.3.3 The samples shall not be damaged after surge testing or leak after pressurizing.

18.4 Flex Tests

18.4.1 One sample of each assembled swing joint, swivel joint or other moving joints with pipe at least 30 cm (1 ft) long in worst case sizes shall be connected at end fitting(s) to suitable test equipment, then subjected to a cyclic force per Clause 18.4.2. Flex hose shall additionally be subject to 500 bending cycles to the manufacturers rating at 6 to 10 cycles/min prior to evaluating the joint type.

18.4.2 All samples shall be subjected to the flexing cycles, rate and specified range of motion to be evaluated for the joint type below. Samples shall be filled with water, sealed, fixed at one end under the different orientations and subjected to the test parameters below:

a) Swing Joint Sample – 500 cycles at ± 15° displacement from a perpendicular connection at 6 to 10 cycle/min;

b) Swivel Joint Sample – 5000 cycles at ± 45° displacement from a perpendicular connection at 6 to 10 cycle/min; or

c) Axial Rotation Joint Sample – 10,000 cycles at ± 180° rotation along the longitudinal pipe axis at 10 to 30 cycle/min.

18.4.3 The samples shall not be damaged after flexing or leak after pressurizing.

19 Fire Test

19.1 One sample of tank accessory products designed for continuous fuel containment, as identified in Clause 19.2, shall be subjected to the hydrocarbon pool fire described in Clauses 19.3 to 19.7 for the specified time(s) based on use and protection ratings, while filled with water at rated pressure. Following the fire test, a repeat Leakage Test (according to Subsection 13.2) shall be conducted at room temperature.

19.2 Samples described below shall be attached to the intended connections for the application(s), and if specified by the manufacturer's instructions, protected with additional fire resistant materials prior to fire exposure at optional test times based on installation protection and location:

Pipe Samples – 91 cm (3 ft) worst case size with one connector and end fitting.

19.3 The test durations shall be;

a) 30 min – Recommended for single-family homes, or sprinkler protected multi-family apartments & commercial buildings.

b) 60 min – Recommended for commercial buildings.

c) 2 h – Recommended for locations requiring higher protection levels to mitigate higher risks.

d) For flexible hose tested with a thermally actuated safety shutoff valve, the duration shall be as recorded as per Clause 19.5.

Exception: For fill & vent pipe, the fire test is not applicable.

19.4 The sample shall be capped/plugged at one end and connected to a shutoff valve, pressure gauge, pressure regulator or equivalent means at the other end to maintain the rated pressure throughout the fire exposure. The sample shall then be centered and supported 10 cm (4 in) above the rim of a steel liquid-tight fire pan, approximately 500 mm (20 in) ID by 150 mm (6 in) deep, so that one end fitting, and joints and at least half of the pipe, or 500 mm (20 in) is exposed to the flame.

19.5 For flexible hose, it is permitted, to conduct the fire test with an assembled thermally actuated safety shutoff valve, provided the manufacturer, model and thermal rating tested is included in the markings and instructions as a required component per Clauses 21.1(f) and 22.3(e). The safety shutoff valve shall be exposed over the fire with the flexible hose, and the test shall be discontinued immediately after the valve actuates in the closed position, with the time recorded.

19.6 After the sample is positioned and pressurized, 3.8 L (1.0 U.S. gal) of commercial grade kerosene (K1) shall be ignited in the fire pan, followed by additional amounts of kerosene, as needed, to maintain the fire for the test time. Water may be used as a buffer for the delivery of additional fuel through a metal tube at the bottom of the pan with a control system. The pressure shall be monitored with water adjusted and/or steam removed as needed to maintain the pressure within ± 5 % of the rated value.

19.7 When the test reaches the required time, the fire shall be extinguished using an appropriate method that does not damage the sample. After cooling to lab temperature, the sample shall be visually examined for damage before repeat leak testing. The samples shall not leak during the fire test or after the repeat leakage test.