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ANSI/CAN/UL/ULC 2166:2021

STANDARD FOR SAFETY

Halocarbon Clean Agent Extinguishing System Units

Approved American National Standard
ANSI

ANSI/UL 2166-2021

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UL Standard for Safety for Halocarbon Clean Agent Extinguishing System Units, ANSI/CAN/UL/ULC 2166

Third Edition, Dated May 10, 2017

Summary of Topics

This revision of ANSI/CAN/UL/ULC 2166 dated December 8, 2021 includes a change in requirements to:

– Electronic Documentation for Fire Suppression Standards; 5.1, 58.5A, 59.2, 59.3 and 61.2

– Elastomeric Part Test; 11.1 and Section 53A

– Flammability of Externally Exposed Parts; 20.2

– Salt Spray Applicability; 29.1 and 29.2

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 new and revised requirements are substantially in accordance with Proposal(s) on this subject dated June 18, 2021 and September 10, 2021.

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ANSI/CAN/UL/ULC 2166:2021

Standard for Halocarbon Clean Agent Extinguishing System Units

First Edition – March, 1999
Second Edition – August, 2012

Third Edition

May 10, 2017

This ANSI/CAN/UL/ULC Safety Standard consists of the Third Edition including revisions through December 8, 2021.

The most recent designation of ANSI/UL 2166 as an American National Standard (ANSI) occurred on December 8, 2021. ANSI approval for a standard does not include the Cover Page, Transmittal Pages and Title Page. Any other portions of this ANSI/UL standard that were not processed in accordance with ANSI/UL requirements are noted at the beginning of the impacted sections.

This standard has been designated as a National Standard of Canada (NSC) on December 8, 2021.

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Preface

This is the Third Edition of the ANSI/CAN/UL/ULC 2166, Standard for Safety for Halocarbon Clean Agent Extinguishing System Units.

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

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

Annexes A and B, identified as normative, form a mandatory part of this Standard.

This ANSI/CAN/UL/ULC 2166 Standard is under continuous maintenance, whereby each revision is approved in compliance with the requirements of 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.

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

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This Edition of the Standard has been formally approved by the UL Standards Technical Panel (STP) on Extinguishing Systems, STP 300.

This list represents the STP 300 membership when the final text in this standard was balloted. Since that time, changes in the membership may have occurred.

STP 300 Membership

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This Standard is intended to be used for conformity assessment.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover the construction and operation of halocarbon clean agent fire extinguishing system units intended to be installed, inspected, tested, and maintained in accordance with the Standard on Clean Agent Fire Extinguishing Systems, NFPA 2001 and with the National Fire Code of Canada.

1.2 These requirements also cover halocarbon clean agent automatic extinguisher units that may have a manual means of operation, and are intended to be used in accordance with the manufacturer's installation instructions. Automatic extinguisher units are not intended:

a) For use as a general substitute for pre-engineered or engineered clean agent extinguishing system units; or

b) For protection of fire risks larger than those specified in the manufacturer's instructions for a single unit by using multiple units.

2 General

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

2.2 Where these requirements reference "extinguishing system unit," the requirements also apply to automatic extinguisher units unless specifically noted otherwise.

3 Glossary

3.1 For the purpose of these requirements, the following definitions apply.

3.2 AGENT TIME IMBALANCE – A situation in which the start of agent discharge at a nozzle occurs after agent discharge has been completed at any other nozzle in the system.

3.3 AUTOMATIC EXTINGUISHER UNIT – A unit that discharges extinguishing agent upon thermal actuation and could have mechanical manual operation, is intended for use in normally unoccupied space, and is limited to a single protected area per 1.2.

3.4 CLEAN AGENT – Electrically nonconducting, volatile, or gaseous fire extinguishant that does not leave a residue upon evaporation. The word "agent" as used in this document shall mean "clean agent" unless otherwise indicated.

3.5 CYLINDER/VALVE ASSEMBLY – A container that incorporates a valve and which provides storage of the extinguishing agent and expellant (when applicable) until the valve is actuated. When actuated, the valve releases the agent into the distribution network of the extinguishing system.

3.6 DISCHARGE NOZZLE – A device that is used to uniformly distribute the extinguishing agent:

a) Over a specific area; or

b) Within a specific volume;

or both.

3.7 DISCHARGE TIME – The time required to discharge from the nozzle 95 percent of the agent mass at 21°C (70°F). For some halocarbon agents, it is the time interval between the first appearance of liquid at the nozzle and the time at which the discharge becomes predominantly gaseous.

3.8 DISCHARGE TIME, MAXIMUM – The longest discharge time specified by the manufacturer; but, not greater than 10 s for Class A hazards or 10 s for Class B hazards.

3.9 ENGINEERED SYSTEM – A system that requires individual calculation and design, in accordance with the extinguishing system unit manufacturer's instructions, to determine the flow rates, nozzle pressures, quantities of extinguishing agent, and number and types of nozzles for effective extinguishing agent distribution and fire coverage.

3.10 EXPELLANT GAS – An inert gas used to facilitate the discharge of a superpressurized extinguishing agent at low temperatures.

3.11 EXTINGUISHING SYSTEM UNIT – Identified components that are assembled into system for the discharge of an extinguishing agent through fixed piping and nozzles for the purpose of extinguishing fires.

3.12 HALOCARBON CLEAN AGENT – A clean agent that contains as primary components one or more organic compounds containing one or more of the elements fluorine, chlorine, bromine, or iodine. Examples are: hydrofluorocarbons (HFCs); hydrochlorofluorocarbons (HCFCs); perfluorocarbons (PFCs or FCs); and fluoroiodocarbons (FICs).

3.13 MANUAL MEANS OF ACTUATION – A means of system actuation in which the system operator initiates system discharge, either mechanically or electrically.

3.14 MASTER VALVE – A discharge valve that upon automatic or manual actuation operates other valves or devices in an extinguishing system.

3.15 MINIMUM DESIGN NOZZLE PRESSURE – Typically, the minimum average pressure for a nozzle present during system discharge.

3.16 OPERABLE PRESSURE RANGE – The pressure range corresponding to the pressures in the storage container at the specified minimum and maximum temperatures for which the extinguishing system unit is intended to be operable.

3.17 OPERATING PRESSURE – The pressure in a fully charged storage container at a manufacturer specified normal ambient temperature condition. Currently recognized normal ambient temperature conditions for extinguishing system units using SI (International System) units are 15°C and 20°C. Currently recognized normal ambient temperature condition for extinguishing system units using US customary units is 70°F (21°C).

3.18 OPERATING TEMPERATURE RANGE – The temperature range inclusive of the minimum and maximum temperatures for which the extinguishing system unit or pneumatic control assembly is intended to be stored, used, and operated.

3.19 PNEUMATIC CONTROL ASSEMBLY – A pressure vessel with a valve or puncture disc pressurized with an inert gas that upon automatic or manual means of actuation, releases pressure that controls or results in the discharge process.

3.20 PRE-ENGINEERED SYSTEM – A system that is tested in accordance with the limitations prescribed by the manufacturer for maximum and minimum pipe lengths, accessories, number of fittings, number and types of nozzles and nozzle placement, maximum areas, volumes, or both areas and volumes of protection.

3.21 PROOF TEST PRESSURE – The factory test pressure of each cylinder used to evaluate cylinder leakage and construction integrity. For Department of Transportation (DOT) or Transport Canada, Transportation of Dangerous Good Regulations (TDGR) approved cylinders, the factory test pressure is specified in the appropriate DOT or TDGR specification. For ASME vessels, the factory test pressure is specified in Section VIII, Pressure Vessels, of the ANSI/ASME Boiler and Pressure Vessel Code. For non-DOT cylinders, non-TDGR cylinders, and non-ASME cylinders, the factory test pressure is three times the cylinder operating pressure at 21°C (70°F).

3.22 SELECTOR (DIRECTIONAL) VALVE – A device that is installed in the piping of an extinguishing system and that directs the flow of extinguishing agent to the appropriate protected volume. This valve is used only when more than one volume is being protected by a single extinguishing system.

3.23 TOTAL FLOODING SYSTEM – A system consisting of a supply of halocarbon clean agent arranged to discharge the extinguishing agent into the intended protected volume and to fill that volume to an effective extinguishing agent concentration.

4 Components

4.1 Except as indicated in 4.2, a component of a product covered by this standard shall comply with the requirements for that component.

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

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

b) Is superseded by a requirement in this standard.

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

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

5 Design Manual

5.1 A copy of the design manual is to be furnished for use as a reference in the examination and testing of an engineered clean agent extinguishing system unit. The design manual shall reference the limitations determined by the calculation method and includes at least the following items:

a) A description of the general principles utilized in the calculation method;

b) Limitation on percent of agent in the pipe;

c) Limitations on minimum and maximum pipeline flow rates;

d) Limitations regarding the types of tee splits (for example, bull head, side outlet) and attached fittings. In addition, the intended range of flow splits and information on the orientation, installation, and critical length for each type of split.

e) Limitations on conditions that result in agent time imbalance condition at each nozzle; for example limits on the variance for agent arrival time and runout time between nozzles.

f) Minimum design nozzle pressure;

g) Method for determining nozzle orifice area and selection of nozzle, as well as nozzle flow information; limits for minimum and maximum orifice area in relation to the attached pipe area;

h) Nozzle area coverage limitations, minimum and maximum height limitations, and information on location of nozzle in the protected area;

i) Range of filling weights for each size container;

j) Minimum and maximum design discharge time;

k) Operating temperature range limitations;

l) Description of the system design procedure and a sample problem indicating all computer input required and computer output information calculated;

m) Equivalent length values of all fittings and all system equipment through which the clean agent flows;

n) Reference to installation, operation, and maintenance manual (identified by part number and date), along with the method to obtain;

o) The name of the manufacturer or private labeler or equivalent designation;

p) Date and manual designation number on each page;

q) When the calculation method has not been investigated at temperatures other than the normal ambient temperature, appropriate cautionary information stating that when the storage temperature varies by ±5.5°C (10°F) from the normal ambient temperature, there is the risk that the system will not supply the designed quantity of extinguishing agent;

r) Cautionary information indicating the calculation method has been investigated for specific types of fittings, types of pipe and pipe inside diameter. Also that when the specified limitations are not maintained there is the risk that the system will not supply the required quantity of extinguishing agent.

6 Owner's Manual

6.1 When an owner's manual is provided with an extinguishing system unit, see 59.1, it shall include at least the following:

a) Clear indication that it is not a detailed installation, operation, and maintenance manual or design manual (when applicable).

b) Clear reference to the availability of the installation, operation, and maintenance manual and design manual by contacting the manufacturer.

c) A statement that the system periodically be inspected by trained personnel.

d) Information regarding the essentials required to maintain the system in operation both before and after a fire.

e) A statement that no modifications are to be made to the system without consulting a qualified system designer who is to refer to the detailed installation or maintenance manual. The statement shall include the following or equivalent wording: "This system is made up of units tested within limitations contained in the detailed installation manual. The system designer must be consulted whenever changes are planned for the system or area of protection. An authorized installer or system designer must be consulted after the system has discharged. "

CONSTRUCTION

7 General

7.1 After discharge of the extinguishing agent is initiated, an extinguishing system unit shall maintain the maximum rate of application of the extinguishing agent without requiring a manual action.

7.2 All exposed parts of an extinguishing system, including the finishes on coated or painted parts, the assemblies of moving parts, the nameplates as secured in place, the mounting bracket, or other similar parts, shall be resistant to commonly encountered atmospheric corrosive influences, and to galvanic corrosion, as determined by the Salt Spray Corrosion Test, Section 29.

7.3 When the deterioration, breakage or other malfunction of a material for an extinguishing system unit presents a risk of causing the extinguishing system to become inoperable, the material shall not be susceptible to stress cracking. See 10-Day Moist Ammonia Air Stress Cracking Test, Section 53.

7.4 As covered by these requirements, an extinguishing system unit consists of:

a) Actuating assemblies;

b) An extinguishing agent storage container and valve assembly;

c) Discharge nozzle(s);

d) Indicators that show the condition of the extinguishing system;

e) A means for mounting the extinguishing system;

f) Manifold check valves;

g) Remote manual controls;

h) Selector valves; and/or

i) Other accessory equipment.

7.5 Where U.S. customary units are employed, the minimum storage temperature of an extinguishing system unit shall be 35°F (1.7°C) or higher in increments of 5°F (2.8°C) up to a maximum of 65°F (18.3°C); 32°F (0°C), 0°F (minus 17.8°C), or lower in increments of 10°F (5.5°C); and a maximum storage temperature of either 100°F (37.8°C), 120°F (48.9°C), 130°F (54.4°C), or higher in increments of 10°F (5.5°C), except that the 100°F (37.8°C) maximum storage temperature applies to an automatic extinguisher unit only.

7.6 Where SI (System International) units are employed, extinguishing system units shall have a minimum storage temperature of 1.7°C (35°F) or higher in increments of 2.8°C (5°F) up to a maximum of 18.3°C (65°F); 0°C (32°F), -20°C (minus 4°F) or lower in increments of 5°C (9°F); and a maximum storage temperature of 37.8°C (100°F), 50°C (122°F), or higher in increments of 5°C (9°F), except that the 37.8°C (100°F) maximum storage temperature applies to an automatic extinguisher unit only.

7.7 When used as part of a multiple unit system, an extinguishing system unit shall be provided with a means for simultaneous operation of all system units.

7.8 The design concentrations for an extinguishing system unit and an automatic extinguisher unit shall be in accordance with the Standard for Clean Agent Fire Extinguishing Systems, NFPA 2001. Also, compliance with the Class A and Class B Fire Extinguishing Tests described in Section 35, and Nozzle Distribution Verification Tests described in Section 36, shall be demonstrated.

8 Electrically Operated Alarms

8.1 When an electrically operated alarm is used, it shall comply with the Standard for Audible Signal Appliances, UL 464 or CAN/ULC-S525, Standard for Audible Signal Devices for Fire Alarm Systems.

9 Controls and Indicators

9.1 An extinguishing system shall be provided with:

a) An automatic and manual means of actuation; or

b) A manual means of actuation only.

An automatic extinguisher unit shall incorporate an automatic means of actuation.

9.2 A manual means of operation shall be provided with a seal or other device to minimize the potential for accidental discharge.

9.3 An extinguishing system unit shall incorporate a pressure gauge for each agent storage container filled with a super pressurized agent and each pneumatic control assembly, showing the pressure within the container. See Sections 13A and 14A, respectively.

9.4 When a manual means of actuation is provided (see 9.1) and it utilizes an electrical power source:

a) That electrical power source shall be independent of the power source for the automatic means of actuation; or

b) When the power source is used for both manual and automatic actuation, it shall have an independent back-up source, such as a battery.

9.5 A control unit, such as a control panel, push-button station, or similar unit, used as part of an extinguishing system shall comply with the Standard for Control Units for Fire-Protective Signaling Systems, UL 864 or CAN/ULC-S527, Standard for Control Units for Fire Alarm Systems.

9.6 Removal of an electric actuator from either the agent storage container discharge valve it controls or the selector valve it controls shall result in a visual and audible supervisory signal at the releasing control panel.

9.7 Duplicate terminals or leads, or an equivalent arrangement, shall be provided for circuits of products intended to be connected to initiating-device circuits of a releasing control unit; one for each incoming and one for each outgoing wire. It is not prohibited that a common terminal be used in lieu of duplicate terminals when it is intended to prevent the looping of an unbroken wire around or under a terminal screw in a manner that permits the looped wire to remain unbroken during installation, thereby precluding supervision in the event the wire becomes dislodged from under the terminal. A notched clamping plate under a single securing screw, where separate conductors are intended to be inserted in each notch, is an equivalent arrangement.

10 Pressure Vessels

10.1 A pressure vessel shall be fabricated of a material having rigidity, durability, and resistance to corrosion at least equivalent to:

a) A mild steel alloy, such as SAE 1010, having a minimum thickness of 0.71 mm (0.028 inch).

b) An aluminum alloy, such as 6061-T6 or 6361-T6 (see the Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate, ASTM B209), having a minimum thickness of 0.71 mm (0.028 inch); or

c) An aluminum alloy, such as 1100, 1170, and 3003, having a minimum thickness of 0.71 mm (0.028 inch).

d) Stainless steel, having a minimum thickness of 0.71 mm (0.028 inch).

10.2 The requirements in this section do not apply to a pressure vessel marked as complying with DOT, TDGR, or ASME specifications, unless otherwise specifically indicated.

10.3 An extinguishing system pressure vessel that is not intended to be used where U.S. Department of Transportation, Transport Canada, Transportation of Dangerous Goods Regulations (TDGR) or Section VIII of the ASME Boiler and Pressure Vessel Code are required, is able to be tested in accordance with the National Standard which applies, and is not required to comply with the requirements in this section, Sections 26 and 58.2.

10.4 An extinguishing system pressure vessel under the jurisdiction of the Department of Transportation shall comply with the appropriate DOT specifications for shipping containers.

10.5 An extinguishing system pressure vessel under the jurisdiction of Transport Canada shall comply with the applicable Regulations and standards for pressure vessels.

10.6 An extinguishing system pressure vessel that is not intended to be shipped pressurized shall be designed, constructed, inspected, certified and marked in accordance with Section VIII, Pressure Vessels, of the ANSI/ASME Boiler and Pressure Vessel Code.

10.7 For the purpose of these requirements, thickness measurements of the sidewall are to be measured on uncoated metal. The thickness of the dome and of the bottom is to be measured at several points after forming and before coating.

10.8 The minimum width of a brazed joint on the sidewall shall be at least four times the thickness of the sidewall.

10.9 Automatic extinguisher unit pressure vessels for use with a halocarbon clean agent and with an operating pressure of 2.65 MPa (240 psi) or less at 21°C (70°F) and an internal volume not exceeding 0.018 m^3 (1100 $inches^3$) for a non-liquefied compressed gas, or 0.0009 m^3 (55 $inches^3$) for a liquefied compressed gas, shall be constructed so that the stress in any part of the pressure vessel does not exceed 80 percent of the yield strength of the material or 50 percent of the ultimate tensile strength of the material when subjected to the proof test pressure specified in 26.2. (See 10.10 – 10.19).

Exception: Pressure vessels complying with 10.4, 10.5, or 10.11 are not required to comply with this requirement.

10.10 With reference to the requirements of 10.9, the maximum stress at proof pressure for commonly used materials and fabricating processes shall not exceed the values specified in Table 10.1.

Table 10.1
Maximum stress at proof pressure

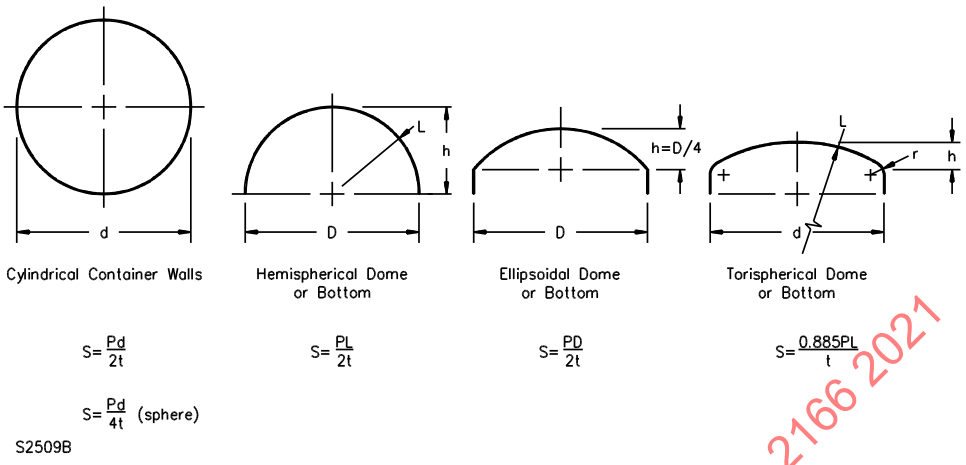
Material	Maximum stress, psi	(MPa)
Copper brazed mild steel	25,000	(172)
Welded mild steel	27,000	(186)
Extruded 6061-T6, 6361-T6 aluminum	27,000	(186)
Extruded 3003 aluminum	16,000	(110)
Extruded 1100 aluminum	14,500	(100)
Extruded 1170 aluminum	11,000	(76)
Stainless steel		

10.11 When the metal and the maximum stress value of the fabricating method used is other than that specified in Table 10.1 or when the mode of use or construction is such that the values specified are not appropriate, pull tests are to be conducted to determine the yield and ultimate strength of the material. Test samples are to be taken either from stock material or from finished parts in accordance with Standard Test Methods and Definitions for Mechanical Testing of Steel Products, ASTM A370. When samples are taken from ruptured pressure vessels, the samples are to be taken in a direction perpendicular to the ruptured opening, as determined during the rupture test specified in 26.8. The maximum stress value is to be based upon the mean values resulting from the test series minus two unbiased standard deviations.

10.12 To determine the stress acting on the pressure vessel at the specified proof test pressure, the formulas specified in Figure 10.1 are to be used.

Figure 10.1

Stress determination formulas



in which:

S is the stress at proof test pressure, psi (kPa)

P is the proof test pressure, psi (kPa)

d is the inside diameter (cylindrical portion of shell), inches (mm)

D is the inside diameter of dome or bottom, inches (mm)

L is the inside spherical radius or dish radius, inches (mm)

t is the material thickness, inches (mm)

r is the "Knuckle" radius, inches (mm)

h is the distance from outside crest of head to tangent point with sidewall

1. Cylindrical Container Walls
2. Hemispherical Done or Bottom
3. Ellipsoidal Dome or Bottom
4. Torispherical Dome or Bottom

10.13 When the pressure is applied to the convex side of an ellipsoidal or torispherical dome or bottom, the material thickness of the dome and bottom used for the calculations of 10.12 is to be multiplied by a factor of 1.67.

10.14 The material of the dome and bottom of a metal pressure vessel shall be of the same material as the sidewall of the pressure vessel and shall have a thickness after forming equal to or greater than the minimum measured wall thickness of the pressure vessel.

Exception No. 1: When the dome or bottom is formed integral with the sidewall and its thickness after forming less than the minimum measured sidewall thickness of the cylinder, the intent of this requirement is met when the measured dome or bottom thickness is more than 87 percent of the thickness of the sidewall (to account for any reduction in thickness which results from the forming process).

Exception No. 2: These requirements do not apply to pressure vessels with a flat dome or bottom as defined in 10.18.

10.15 A dome or bottom is evaluated as being integral with the sidewall when the distance from the point at which the dome or bottom is turned (the tangent point between the dome or bottom and the sidewall) to the nearest circumferential joint of the pressure vessel (excluding the collar) is greater than the radius of the sidewall to the center of the pressure vessel.

10.16 When a torispherical form dome or bottom is used, the knuckle radius r shall be not less than 6 percent of the inside dish radius L, and the cylinder diameter d shall be equal to or larger than the inside dish radius L. See Figure 10.1.

10.17 When either a flat dome or flat bottom is integral with the sidewall, the minimum thickness of the thinnest section of the dome or bottom shall be twice the minimum measured sidewall thickness. The minimum inside knuckle radius shall be 2.5 percent of the inside diameter of the sidewall.

10.18 For the purpose of these requirements, the shape of a dome or bottom shall be determined by calculating the ratio of the inside diameter of the dome or bottom to twice the distance from the outside crest of the head to the inside tangent point with the sidewall. The ratio (D/2h) then shall be applied as specified in Table 10.2.

Table 10.2
Shape determination of domes and bottoms

Ratio range	Shape
1.00 – 1.50	Hemispherical
1.51 – 3.00	Ellipsoidal
3.01 – 3.50	Torispherical
Greater than 3.50	Flat

10.19 A flat dome or bottom shall be used only on seamless pressure vessels or on pressure vessels having a linear sidewall length greater than 1-1/2 times the sidewall inside diameter.

11 Gaskets and "O" Rings

11.1 A gasket of an elastomeric material shall be thick enough to provide a compression-type seal. A seal, gasket, or an "O" ring that is continuously exposed to the extinguishing agent under pressure during intended service shall be made of a material compatible with the halocarbon extinguishing agent. See

Elastomeric Parts Test, Section 53A; 30-Day Elevated Temperature Test, Section 27; and One-Year Time Leakage Test, Section 33.

12 Filling Densities

12.1 The maximum and minimum filling densities shall be specified by the manufacturer.

13 Pressure Gauges and Indicators – Extinguishing System Units

Section 13 revised and relocated as Section 13A

13A Pressure Gauges and Indicators – Agent Storage Containers

Section 13 revised and relocated as Section 13A

13A.1 An agent storage container shall be equipped with a pressure gauge. The operating range of the gauge shall take into account the operating temperature-pressure relationship of the extinguishing system unit, except that the minimum operating pressure indication is able to be higher than the pressure that corresponds to the minimum operating temperature.

Exception: The pressure gauge is not required for an agent storage container that is filled with a halocarbon extinguishing agent only and not charged with an expellant gas.

13A.2 The pressure gauge face shall indicate the appropriate units for which the gauge is calibrated, such as psig, kPa, kg/cm^2, or any combination of pressure units.

13A.3 The pressure gauge face shall be marked to indicate: "Use with _____ Only. " The blank is to contain a description of the clean agent.

13A.4 The pressure gauge shall be marked with the gauge manufacturer's identifying mark. The pressure gauge shall also be marked according to the following, as applicable, using a line extending as wide as, and of the same stroke thickness as, the manufacturer's identifying mark:

a) To indicate galvanic compatibility with aluminum valve bodies – a horizontal line above the manufacturer's identifying mark.

b) To indicate galvanic compatibility with brass valve bodies – a horizontal line below the manufacturer's identifying mark.

c) To indicate galvanic compatibility with aluminum and brass valve bodies – a line above and a line below the manufacturer's identifying mark, or only the manufacturer's identifying mark without any additional line.

13A.5 A pressure gauge shall have a pressure relief that provides for venting in the event of a leak, such as from a bourdon tube or diaphragm.

13A.6 For mechanical pressure gauges, the gauge dial face shall comply with the requirements in 13A.7, 13A.8, and 13A.9.

13A.7 For mechanical pressure gauges, the maximum indicated gauge pressure shall be between 150 and 250 percent of the indicated operating pressure, and not less than 120 percent of the pressure at 48.9°C (120°F). The zero, operating, and maximum indicated gauge pressures shall be shown in numerals and with marks. The minimum use temperature shall be marked on the left side of the operable

pressure range, an operating temperature value shall be marked at indicated charging pressure and the maximum use temperature shall be marked on the right side of the operable pressure range.

13A.8 For mechanical pressure gauges with 110 degrees of arc or greater between the minimum and maximum use temperature at least five separate pressures shall be shown in marks on the portion of the arc between the minimum use temperature and the operating pressure; and the same identifications shall be made between the operating pressure and the maximum use temperature. For gauges with less than 110 degrees of arc between the minimum and maximum use temperature, at least two separate pressures shall be shown on each side of the operating pressure.

13A.9 For mechanical pressure gauges, the portion of the arc between the minimum operating pressure mark and the maximum operating pressure marking shall be indicated in green, except the lower portion of the arc is able to be higher than the minimum operating pressure, but no higher than 90 percent of the operating pressure and the upper portion of the arc is able to be lower than the maximum operating pressure, but no lower than 110 percent of the operating pressure. The background of the gauge face in the area defined as being that above radial lines connecting each of the maximum and minimum markings to the center of the gauge shall be red. The arc of the dial from the zero pressure point to the minimum use temperature marking shall have a red or white background and shall be marked "Recharge." The arc of the dial from the maximum use temperature to the maximum indicated pressure shall have a red or white background and shall be marked "Overcharged." All numerals, letters, and characters shall be black and the remaining background of the gauge shall be white. Pointers shall be yellow, and the tip of the pointer shall end in the arc of the pressure indicating dots, and shall have a maximum tip radius of 0.25 mm (0.010 inch). The minimum length of the pointer from center point of the dial to the tip shall be 9.53 mm (0.375 inch). The minimum length of the arc from the zero pressure to the operating pressure shall be 25.4 mm (1 inch) measured from the center line of the zero pressure mark to the center line of the operating pressure mark.

13A.10 For mechanical pressure gauges, the mark used to indicate the operating pressure shall be not less than 0.64 mm (0.025 inch) nor more than 1.02 mm (0.040 inch) wide.

13A.11 For electronic pressure gauges, the gauge shall show the gauge is powered, such as by a unique character presentation on the display device, either continuously or by depressing a button or similar device.

13A.12 For electronic pressure gauges, if the device is battery operated, there shall be a battery power level indicator available either continuously or by depressing a button or similar device to display the reading.

13A.13 For electronic pressure gauges where a primary and secondary source of power is used, a transfer from the primary power source to secondary power source shall result in no loss of information.

13A.14 For electronic pressure gauges, the indicated gauge pressure shall be shown in numerals either continuously or by depressing a button or similar acting device to display the reading. The temperature at the minimum operating pressure, the temperature at the rated pressure, and the temperature at the maximum operating pressure shall be indicated such that it is clear that the temperature-pressure correlation is or is not correct and additional action might be necessary. When the gauge pressure is less than the minimum operating pressure, there shall be an indication of “Recharge.” When the gauge pressure is greater than the maximum operating pressure, there shall be an indication of “Overcharged.” The maximum indicated pressure shall be greater than the maximum operating pressure and shall be specified.

13A.15 For electronic pressure gauges, a local trouble signal shall require human intervention to assess.

13A.16 For electronic pressure gauges, access control, reprogramming. or querying information shall be conducted during monthly inspections.

13A.17 For electronic pressure gauges, the circuits and construction of parts of the gauge shall comply with the following sections as noted.

Enclosures	UL 864: 5, 6, 8, 9, 10	ULC-S527: 8.1, 8.3, 8.4, 8.5
Printed wiring boards	UL 864: 18	ULC-S527: 8.9, 10.17
Electrical spacings	UL 864: 16 and 17	ULC-S527: 8.8.2; 8.16
Field wiring terminals and leads (battery powered)	UL 864: 11.14, 12	ULC-S527: 8.6
Field wiring terminals and leads (powered from ≥ 120VAC)	UL 864: 24	ULC-S527: 8.6
Field wiring compartment (battery powered)	UL 864: 11, 12	ULC-S527: 8.6.2
Field wiring compartment (powered from ≥ 120VAC)	UL 864: 14	ULC-S527: 8.6.2
Separation of power limited and non-power limited circuits	UL 864: 12.3	ULC-S527: 8.7.2
Risk of shock	UL 864: 3.90	ULC-S527: 3.56
Risk of fire	UL 864: 3.91	ULC-S527: 3.57
Strain relief	UL 864: 12.6.1	ULC-S527: 8.6.3.1
Coil windings	UL 864: 21	ULC-S527: 8.8
Across-the-line components	UL 864: 22.4	ULC-S527: 8.14
Switches	UL 864: 22.1, 22.3	ULC-S527: 8.12, 8.13
Internal wiring	UL 864: 13	ULC-S527: 8.7,
Internal wiring (if utilizing a battery charger)	UL 864: 14	ULC-S527: 8.7, 8.8.9
Battery access (for wireless signaling)	UL 864:56.5.11 (b)	ULC-S527: 4.20.10.11 (b)
Primary batteries	UL 864: 23.2, 23.3;	ULC-S527: 8.15
Battery packs	UL 2054	–

13A.18 For electronic pressure gauges, the markings shall comply with the following sections as noted.

Markings	UL 864: 95.1.1(k), 95.1.1(l), 95.1.25, 95.1.26, 95.2	ULC-S527: 9.3.12, 9.3.2, 9.3.3, 9.3.5

13A.19 For electronic pressure gauges that include supplementary remote communication capability:

a) any reprogramming shall be conducted during monthly inspection and require manual actuation of a security means at the gauge, which permits on-site or off-site programing; and

b) remote communication faulting shall have no effect on electronic pressure gauge operation.

13A.20 For electronic pressure gauges that include remote communication capability to a supervising station:

a) any reprogramming shall be conducted during monthly inspection and require manual actuation of a security means at the gauge or at fire alarm control unit of monitoring station, which permits on-site or off-site programing;

b) the interface to supervising stations maximum response time for monitoring pressure within required pressure range shall be within 24 hours; and

c) when battery powered, shall monitor battery capacity and provide trouble signal within 24 hours at fire alarm control unit of monitoring station when minimum 30 days power remains.

14 Pressure Gauges – Pneumatic Control Assemblies

Section 14 revised and relocated as Section 14A

14A Pressure Gauges – Pneumatic Control Assemblies

Section 14 revised and relocated as Section 14A

14A.1 A pneumatic control assembly shall be equipped with a pressure gauge. The operating range of the gauge shall take into account the operating temperature-pressure relationship of the compressed gas, except that the minimum operating pressure identification is able to be higher than the pressure that corresponds to the minimum operating temperature.

Exception: A pressure gauge is not required for a pneumatic control assembly that is filled with carbon dioxide or a cartridge filled with high pressure inert gas that is intended to be weighed to verify the quantity.

14A.2 The pressure gauge face shall indicate the appropriate units for which the gauge is calibrated, such as kPa, kg/cm^2, psig or any combination of pressure units.

14A.3 The pressure gauge face shall be marked to indicate: "Use with _____ Only. " The blank is to contain a description of the pneumatic control assembly contents.

14A.4 The pressure gauge shall be marked with the gauge manufacturer's identifying mark. The pressure gauge shall also be marked according to the following, as applicable, using a line extending as wide as, and of the same stroke thickness as, the manufacturer's identifying mark:

a) A horizontal line above the gauge manufacturer's identifying mark shall be used to indicate galvanic compatibility with aluminum valve bodies.

b) A horizontal line below the gauge manufacturer's identifying mark shall be used to indicate galvanic compatibility with brass valve bodies.

c) A horizontal line above and below the gauge manufacturer's identifying mark, or only the manufacturer's identifying mark without any additional lines shall be used to indicate galvanic compatibility with aluminum and brass valve bodies.

14A.5 A pressure gauge shall have a pressure relief that provides for venting in the event of a leak, such as from a bourdon tube or diaphragm.

14A.6 For mechanical pressure gauges, the gauge dial face shall comply with the requirements in 14A.7 – 14A.9.

14A.7 For mechanical pressure gauges, the maximum indicated pressure shall be between 150 and 250 percent of the indicated operating pressure, and not less than 120 percent of the pressure at the maximum operating temperature. The zero pressure, operating pressure, and maximum indicated pressure shall be shown with identification marks and in numerals. The minimum use temperature shall be marked on the left side of the operating pressure range; the operating temperature shall be marked at the operating pressure; and the maximum operating temperature shall be marked on the right side of the operating pressure range.

14A.8 For mechanical pressure gauges with at least 110 degrees of arc between the minimum and maximum operating temperature, at least five intermediate pressure identification marks shall be shown on each side of the operating pressure and at least one intermediate identification mark on each side of the operating pressure shall also be shown in numerals. For gauges with less than 110 degrees of arc between the minimum and maximum operating temperature, at least two pressure intermediate identification marks shall be shown on each side of the operating pressure and at least one intermediate identification mark on each side of the operating pressure shall also be shown in numerals.

14A.9 For mechanical pressure gauges, the portion of the arc between the minimum operating pressure marking and the maximum operating pressure marking shall be green except the lower portion of the arc is able to be higher than the minimum operating pressure, but no higher than 90 percent of the operating pressure and the upper portion of the arc is able to be lower than the maximum operating pressure, but no lower than 110 of the operating pressure. The background of the gauge face in the area defined as being that above radial lines connecting each the maximum and minimum identification marks to the green arc of the gauge shall be red. The arc of the dial from the zero pressure point to the minimum operating temperature identification mark shall have a red or white background and shall be marked "Recharge." The arc of the dial from the maximum operating temperature to the maximum indicated pressure shall have a red or white background and shall be marked "Overcharged." All numerals, letters, and characters shall be black and the remaining background of the gauge shall be white. Pointers shall be yellow, and the tip of the pointer shall end in the arc of the pressure identification marks, and shall have a maximum tip radius of 0.25 mm (0.010 inch). The minimum length of the pointer from center point of the dial to the tip shall be 9.53 mm (0.375 inch). The minimum length of the arc from the zero pressure to the operating pressure shall be 25.4 mm (1 inch) from the center line of the zero pressure identification mark to the center line of the operating pressure mark when measured at the maximum radius of the gauge face.

14A.10 For mechanical pressure gauges, the identification mark used for the operating pressure shall be not less than 0.64 mm (0.025 inch) nor more than 1.02 mm (0.040 inch) wide.

14A.11 The requirements in this section do not apply to a high pressure pneumatic control assembly that utilizes a mechanical pressure gauge evaluated in accordance with the Standard for Gauges, Indicating Pressure for Compressed Gas Service, UL 404 or Guide for the Investigation of Gauges, Indicating Pressure for Compressed Gas Service, ULC/ORD-C404. The maximum scale value of the pressure gauge shall be greater than the pressure developed in the container at the maximum operating temperature but not higher than 250 percent of the operating pressure.

14A.12 For electronic pressure gauges, the gauge shall show the gauge is powered, such as by a unique character presentation on the display device, either continuously or by depressing a button or similar device.

14A.13 For electronic pressure gauges, if the device is battery operated, there shall be a battery power level indicator available either continuously or by depressing a button or similar device to display the reading.

14A.14 For electronic pressure gauges, where a primary and secondary source of power is used, a transfer from the primary power source to secondary power source shall result in no loss of information.

14A.15 For electronic pressure gauges, the indicated gauge pressure shall be shown in numerals either continuously or by depressing a button or similar acting device to display the reading. The temperature at the minimum operating pressure, the temperature at the rated pressure, and the temperature at the maximum operating pressure shall be indicated such that it is clear that the temperature-pressure correlation is or is not correct and additional action might be necessary. When the gauge pressure is less than the minimum operating pressure, there shall be an indication of “Recharge.” When the gauge pressure is greater than the maximum operating pressure, there shall be an indication of “Overcharged.” The maximum indicated pressure shall be greater than the maximum operating pressure and shall be specified.

14A.16 For electronic pressure gauges, a local trouble signal shall require human intervention to assess.

14A.17 For electronic pressure gauges, access control, reprogramming. or querying information shall be conducted during monthly inspections.

14A.18 For electronic pressure gauges, the circuits and construction of parts of the gauge shall comply with the following sections as noted.

Enclosures	UL 864: 5, 6, 8, 9, 10	ULC-S527: 8.1, 8.3, 8.4, 8.5
Printed wiring boards	UL 864: 18	ULC-S527: 8.9, 10.17
Electrical spacings	UL 864: 16 and 17	ULC-S527: 8.8.2; 8.16
Field wiring terminals and leads (battery powered)	UL 864: 11.14, 12	ULC-S527: 8.6
Field wiring terminals and leads (powered from ≥ 120VAC)	UL 864: 24	ULC-S527: 8.6
Field wiring compartment (battery powered)	UL 864: 11, 12	ULC-S527: 8.6.2
Field wiring compartment (powered from ≥ 120VAC)	UL 864: 14	ULC-S527: 8.6.2
Separation of power limited and non-power limited circuits	UL 864: 12.3	ULC-S527: 8.7.2
Risk of shock	UL 864: 3.90	ULC-S527: 3.56
Risk of fire	UL 864: 3.91	ULC-S527: 3.57
Strain relief	UL 864: 12.6.1	ULC-S527: 8.6.3.1
Coil windings	UL 864: 21	ULC-S527: 8.8
Across-the-line components	UL 864: 22.4	ULC-S527: 8.14
Switches	UL 864: 22.1, 22.3	ULC-S527: 8.12, 8.13
Internal wiring	UL 864: 13	ULC-S527: 8.7
Internal wiring (if utilizing a battery charger)	UL 864: 14	ULC-S527: 8.7, 8.8.9
Battery access (for wireless signaling)	UL 864: 56.5.11 (b)	ULC-S527: 4.20.10.11 (b)
Primary batteries	UL 864: 23.2, 23.3	ULC-S527: 8.15
Battery packs	UL 2054	–

14A.19 For electronic pressure gauges, the markings shall comply with the following sections as noted.

Markings	UL 864: 95.1.1(k), 95.1.1(l), 95.1.25, 95.1.26, 95.2	ULC-S527: 9.3.12, 9.3.2, 9.3.3, 9.3.5

14A.20 For electronic pressure gauges that include supplementary remote communication capability:

a) any reprogramming shall be conducted during monthly inspection and require manual actuation of a security means at the gauge, which permits on-site or off-site programing; and

b) remote communication faulting shall have no effect on electronic pressure gauge operation.

14A.21 For electronic pressure gauges that include remote communication capability to a supervising station:

a) any reprogramming shall be conducted during monthly inspection and require manual actuation of a security means at the gauge or at fire alarm control unit of monitoring station, which permits on-site or off-site programing;

b) the interface to supervising stations maximum response time for monitoring pressure within required pressure range shall be within 24 hours; and

c) when battery powered, shall monitor battery capacity and provide trouble signal within 24 hours at fire alarm control unit of monitoring station when minimum 30 days power remains.

15 Puncturing Mechanisms

15.1 The parts of a puncturing mechanism, with the exception of unexposed springs and pins, shall be made of nonferrous metal or corrosion-resistant stainless steel.

16 Electrically Operated Valves and Pressure Switches

16.1 An electrically operated valve or pressure switch that is intended to operate an extinguishing system unit shall be capable of being used in such an application.

17 Siphon Tubes

17.1 A siphon tube shall be constructed of a material that is resistant to the corrosive effects of the extinguishing agent with which it is to be used. See 52.2.1 and 52.2.2.

17.2 Joints between the siphon tube and valve shall be constructed so that they do not disengage during use, such as being threaded, locked in position by a set screw, or similar construction.

17.3 The siphon tube shall be notched, scarfed, or otherwise prevented from restricting discharge in an unintended manner when the tip of the siphon tube is resting on the bottom of the shell.

18 Clean Agents

18.1 Halocarbon clean agents shall be used as a fire extinguishing agent in accordance with the United States Environmental Protection Agency's Significant New Alternatives Program or equivalent.

18.2 Halocarbon clean agents shall comply with the standard of quality as specified in the Standard on Clean Agent Fire Extinguishing Systems, NFPA 2001. Clean agent blends shall remain homogeneous throughout the specified storage temperature range.

19 Expellant Gases

19.1 Where nitrogen is used as the expellant gas, the nitrogen shall have a dew point of minus 51.1°C (60°F) or less. The nitrogen shall be grade H, I, J, K, L, M, N, O, or P, as described in Table 1 of Commodity Specification for Nitrogen, CGA G10.1.

20 Polymeric Materials and Nonmetallic Parts

20.1 A polymeric or other nonmetallic part, other than "O" ring or gasket, shall be evaluated on the basis of:

a) Mechanical strength, see Mounting Device Test, Section 34; Hydrostatic Pressure Test, Section 26; Burst Strength Test – Gauges and Indicators, Section 46; Nameplate Exposure Tests, Section 54;

b) Moisture absorption (see 52.3.1 and 52.3.2); Salt Spray Corrosion Test, Section 29; Nameplate Exposure Tests, Section 54;

c) Flammability (see 20.2);

d) Resistance to deterioration due to aging, see Aging Tests – Plastic Materials, Section 52; Nameplate Exposure Tests, Section 54;

e) Exposure to light (see 52.3.1 and 52.3.2); Nameplate Exposure Tests, Section 54; and

f) Exposure to the extinguishing agent (see 52.2.1 and 52.2.2).

20.2 With reference to flammability [see 20.1(c)], plastic materials of externally exposed parts shall be classified as Type HB, V-0, V-1, V-2, or 5V, when tested in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94 or Evaluation of Properties or Polymeric Materials, CSA-C22.2 No. 0.17. Other nonmetallic materials shall have equivalent characteristics.

21 Anti-Recoil Devices

21.1 An anti-recoil device shall be supplied on the outlet of each pressurized extinguishing system unit storage container for shipping, handling, and storage purposes. The anti-recoil device shall be attached to the storage unit by a chain or other equivalent means.

22 Pressure Switches

22.1 A pressure switch intended for use with an extinguishing system unit shall be capable of being used in such applications, as determined by the performance tests specified in these requirements.

22.2 A pressure switch that provides the essential functions for the extinguishing system unit to achieve extinguishment such as ventilation or energy shutdown shall:

a) Incorporate a manual reset; or

b) Be constructed to require recharging of the storage container before the pressure switch is capable of being reset.

Pressure switches intended for supervision of pressurized containers shall be preset to operate at the pressure that corresponds to the minimum operating temperature of the extinguishing system unit or higher.

PERFORMANCE

23 General

23.1 Representative samples of an extinguishing system unit are to be subjected to the tests specified in Sections 24 – 56.

24 Discharge Test

24.1 After the agent storage container (and expellant gas, if applicable) has been conditioned to 21 ±2.8°C (70 ±5°F) by either:

a) Holding in a room maintained at the conditioning temperature for 16 h; or

b) Holding in a room maintained at the conditioning temperature until the internal temperature of the container is shown to be at the required value by measurement.

An extinguishing system unit shall have a maximum discharge time as defined in 3.8. The discharge time for a pre-engineered extinguishing system unit is to be evaluated in accordance with the requirements in 24.2. The discharge time for an engineered extinguishing system unit is to be evaluated in accordance with the Verification of Flow Calculation Method Test, Section 38.

24.2 A fully charged pre-engineered extinguishing system unit is to be connected to the piping arrangements simulating the most severe conditions specified by the manufacturer's limitations, and then discharged. The discharge time is to be measured manually with a stopwatch or automatically by monitoring the pressure at the nozzle with a calibrated pressure transducer or equivalent and an attached chart recorder.

25 Valve Leakage Test

25.1 A cylinder discharge valve shall show no visible leakage while subjected to the cylinder proof test pressure for 1 min. See 26.2.

25.2 A manifold check valve and selector valve shall show no leakage in excess of 0.5 ml/min (1 fl oz/hr) per inch of nominal valve size when subjected to one-half the cylinder proof test pressure for 1 min.

25.3 Prior to conducting this test, the valve is to be threaded in place after the container has been completely filled with water. Care is to be taken to expel all air from the test sample before pressure is applied.

25.4 The apparatus for these tests is to consist of a hand- or motor-operated hydraulic pump capable of producing the required test pressure, a test cage capable of containing the extinguishing system unit and its parts in the event of rupture, the required fittings for attachment to the test sample, a calibrated pressure gauge graduated in at least 0.14 MPa (20 psi) increments to at least 1.38 MPa (200 psi) greater than the test pressure, and the required valves, fittings, and other components, for regulating and maintaining the specified test pressure. Other test methods shall be considered and accepted when determined to achieve equivalent results.

25.5 The pressure is to be increased at a rate of approximately 2.07 MPa (300 psi) per min until the test pressure is attained. The pressure is then to be held for 1 min, during which time any leakage shall be accumulated for measurement.

26 Hydrostatic Pressure Test

26.1 An extinguishing system unit pressure vessel shall withstand for 1 min, without rupture, a pressure of twice the proof test pressure as specified in 26.2.

26.2 With reference to the requirement of 26.1, the proof test pressure is to be determined as follows:

a) For a pressure vessel that is not tested and marked in accordance with the specifications of the DOT or Transport Canada, Transportation of Dangerous Goods Regulations, the proof test pressure is to be three times the intended operating pressure at 21°C (70°F).

b) For a pressure vessel that is tested and marked in accordance with the specifications for shipping containers of the DOT or Transport Canada, Transportation of Dangerous Goods Regulations, the proof test pressure is to be as specified in the applicable DOT or Transport Canada, Transportation of Dangerous Goods Regulations specification.

c) For a pressure vessel that is tested and marked in accordance with ASME specifications, the proof test pressure is to be as specified in Section VIII, Pressure Vessels, of the ANSI/ASME Boiler and Pressure Vessel Code.

d) The minimum proof pressure in any case is to be not less than twice the operating pressure or 0.83 MPa (120 psig), whichever is greater.

26.3 The pressure vessel of an extinguishing system unit that is not provided with a pressure relief and that when tested to rupture as described in 26.8 fractures:

a) Along circumferential joints between the top or bottom dome and the sidewall;

b) At the collar or collar joint; or

c) At the point of attachment of elbows or discharge fittings;

shall not rupture at a pressure of eight times the operating pressure at 21°C (70°F).

Exception: Fractures passing through welds and parallel to the longitudinal axis of a container are to be evaluated according to the requirements specified in 26.1. For the purpose of this requirement the heat affected zone of a weld is a part of the weld. The heat affected zone is that part of the cylinder affected by the welding process.

26.4 The flat dome or bottom of a pressure vessel that is not provided with a pressure relief shall withstand for 1 min, without rupture, an internal pressure of eight times the rated working pressure of the vessel at 21°C (70°F). During this test, the vessel sidewall is to be restrained with a close fitting steel sleeve or similar device to prevent rupture of the sidewall.

26.5 There shall be no permanent volumetric expansion in excess of 10 percent of the total expansion of a pressure vessel of an extinguishing system unit when the pressure vessel is pressurized to the proof test pressure as specified in 26.2 (a), (b), (c), or (d) for 30 s and the pressure then released.

Exception No. 1: The test pressure for pressure vessels that have been proof pressure tested in accordance with 26.2 is to be 110 percent of the proof test pressure. See also 26.9.

Exception No. 2: A pressure vessel that is tested and marked in accordance with ASME specifications is not required to be subjected to permanent volumetric expansion testing.

26.6 A discharge valve assembly, manifold check valve, selector valve and any other pressure retaining device shall withstand, without rupture, damage, or permanent distortion, the pressure specified in 26.1. In addition, no parts shall be "thrown," at a pressure less than or equal to eight times the maximum operating pressure at 21°C (70°F), from a system unit not protected by a pressure relief.

26.7 The apparatus for the tests specified in 26.1 – 26.6 is to consist of a hand- or motor-operated hydraulic pump capable of producing the required test pressure, a test cage that contains the test sample and its parts in the event that parts are thrown off, valves and fittings for attachment to the test sample, and the valves, fittings, and other fixtures, for regulating and maintaining the specified test pressure.

26.8 The test sample is to be filled with water and all air expelled. The pressure is to be increased at a rate of approximately 2.07 MPa (300 psig) per minute until the test pressure is obtained. This test pressure is to be held for 1 min. The pressure then is to be increased until the container ruptures, to determine rupture characteristics as defined in 26.3.

26.9 To determine compliance with the requirements specified in 26.5, the test is to be conducted in accordance with Methods for Hydrostatic Testing of Compressed Gas Cylinders, CGA C-1, and the water jacket test apparatus specified therein is to be used.

27 30-Day Elevated Temperature Test

27.1 An extinguishing system cylinder/valve assembly, including actuating components, conditioned at its maximum storage temperature for a period of 30 days shall not show:

a) Leakage greater than 0.021 percent of the minimum charge weight;

b) Signs of corrosion to components caused by exposure to the clean agent under storage conditions, and pressurized to their operating pressure at 21°C (70°F); nor

c) Elastomeric seal degradation or separation after being discharged.

27.2 Representative sample extinguishing system units, charged to their maximum fill density, are to be placed in the horizontal and vertical positions, and maintained at maximum storage temperature for 30 days. The units are then to be conditioned at 21°C (70°F) for 24 h, and checked for weight and pressure loss. The units are then to be discharged through a representative piping system, the valve disassembled and the seals examined. At least one unit is then to be discharged, and the cylinder, valve, pressure gauge and other components exposed to the extinguishing agent are to be examined for signs of corrosion caused by exposure to the extinguishing agent.

Exception: System units intended for transportation and storage in the vertical position are not required to be tested in the horizontal.

28 Temperature Cycling Test

28.1 An extinguishing system cylinder/valve assembly, including actuating components, shall not show leakage rate greater than 0.25 percent per year of the minimum charge weight after being subjected to the Temperature Cycling Test.

28.2 Representative sample extinguishing system units charged to their maximum fill density are to be placed in the horizontal and vertical positions and maintained at the minimum storage temperature for 24 hours, then at the maximum storage temperature for 24 h, and then again at the minimum storage temperature for 24 h. The units are then to be conditioned at 21°C (70°F) for 24 h, after which it is to be checked for weight and pressure loss.

Exception: System units intended for transportation and storage in the vertical position are not required to be tested in the horizontal.

29 Salt Spray Corrosion Test

29.1 The following are to be subjected to the test described in 29.3 and 29.4.

a) All parts of a fully-charged extinguishing system unit, including the finishes on coated or painted parts, mechanically affixed metallic nameplates as secured in place, and the attachments required for installation.

b) Any other operating components (components having moving parts) that have externally exposed materials without corrosion resistance equivalent to polymeric material, brass or stainless steel.

29.2 After exposure, an extinguishing system unit shall comply with the following:

a) The extinguishing system unit shall show no evidence of corrosion on any surface, other than corrosion that is capable of being easily wiped off after rinsing with tap water. When any part of the system has a corrosion resistant coating, the coating shall be intact and shall not be removable by rinsing with tap water or rubbing with a finger.

b) No galvanic corrosion shall be visible on the system unit.

c) When the system has a pressure gauge, the gauge shall not have moisture inside.

d) Shall operate as intended. When a component being tested is normally charged with a clean agent, air or nitrogen or an equivalent shall be used in lieu of the clean agent.

e) There shall be no significant deterioration of the legibility of a mechanically affixed metallic nameplate, such as darkening, fogging, or blistering; nor shall there be any cracking or buckling at the edges.

29.3 The test samples are to be supported vertically and exposed to salt spray (fog) using the Standard Practice for Operating Salt Spray (Fog) Testing Apparatus, ASTM B117. The apparatus used for salt-spray exposure is to consist of a fog chamber, 1.2 by 0.8 by 0.9 m (48 by 30 by 36 inches) inside dimensions, having a salt solution reservoir, a supply of conditioned compressed air, a dispersing tower for producing a salt fog, sample supports, provision for heating the chamber, and required means of control. The dispersion tower is to be located in the center of the chamber and is to be supplied with salt solution and with warmed, humidified air at a pressure between 117 and 131 kPa (17 and 19 psig), to disperse the salt solution in the form of a fine mist or fog throughout the interior of the chamber. The temperature within the chamber is to be maintained between 33.3° and 36.1°C (92° and 97°F). Condensate accumulation on the cover of the chamber is not to drop onto the test samples, and drops of the solution that fall from the samples are not to be recirculated and are to be removed through a drain located in the floor of the chamber.

29.4 The salt solution is to consist of 20 percent (by weight) of common salt (sodium chloride) and distilled water and the test duration is to be 240 h. The pH value of this solution as collected after being sprayed in the test apparatus is to be between 6.5 and 7.2, and the specific gravity is to be between 1.126 and 1.157 at 36.3°C (95.5°F).

30 500 Cycle Operation Test

30.1 A discharge valve, including actuation devices, shall operate as intended for 500 operations without malfunction or damage. Following this test, the component shall show no leakage at the normal operation pressure at 21°C (70°F).

Exception: This test is not applicable to extinguishing system units of the fusible element type.

30.2 A selector and manifold check valve, including actuation devices, shall operate as intended for 500 operations without malfunction or damage. Following this test, the valve shall comply with the Valve Leakage Test, Section 25.

Exception: This test is not applicable to extinguishing system units of the fusible element type.

30.3 The manual actuator, cable actuator (when provided) fitted with the maximum length of cable and maximum number of corner pulleys, and each electrical contact and relay (when provided) are to be included in this test.

30.4 Each extinguishing system unit to be tested is to be connected to a source of pressurized gas and fitted with a pressure-regulating device or other equivalent means and pressurized to the operating pressure at 21°C (70°F). The valve is to be cycled from fully closed to fully open 500 times.

30.5 After the cycling specified in 30.4, the discharge valve, including actuation devices, is to be subjected to an air or nitrogen under water leakage test at the operating pressure at 21°C (70°F), and there shall be no leakage from any component as evidenced by air or nitrogen bubbles. Sealing portions of the component are to be cleaned before conducting this test. The inlet of the component is to be fitted with a pressure regulating device or other equivalent means and pressurized to its operating pressure at 21°C (70°F). The valve is then to be immersed in water and examined for leakage for 1 min.

30.6 After the cycling specified in 30.4, a selector valve is to be subjected to leakage testing to determine compliance with the requirements of 30.2. The apparatus and test method used is to be as specified in 25.4 and 25.5.

31 Time Delay Verification Test

31.1 Time delay valves tested in accordance with 31.2 and 31.3 shall delay the actuation of a system within minus 0, plus 20 percent of the manufacturer's published delay time and temperature range. Each time delay is to be tested at the operating temperature range specified in the manufacturer's installation instructions.

31.2 Five nonadjustable time delay valves are to be connected to a source of extinguishing agent and pressurized to the operating pressure at 21°C (70°F). The time delay assemblies are then to be tested after being conditioned to both the minimum and maximum operating temperature. A shutoff valve is to be fitted at the outlet of the container storing the extinguishing agent. The shutoff valve is to be opened, introducing the extinguishing agent into the inlet of the time delay valve. The elapsed time from shutoff valve opening to time delay valve activation is to be recorded.

31.3 An adjustable time delay valve is to be tested at the minimum and maximum delay settings and at one intermediate setting. The valve is to be tested three times at each setting.

32 Pressure-Operated Alarm Test

32.1 A pressure-operated alarm, such as a pressure-operated siren, pressure-operated horn, or similar alarm, shall show no evidence of breakage of any of its parts when operated continuously for 50 h at 689 kPa (100 psi) and when operated continuously for 1 h at 75 – 100 percent of its maximum operating pressure. During the test period, the alarm shall receive no lubrication or adjustment.

32.2 An alarm shall produce a distinctive sound having an intensity of not less than 90 decibels at a distance of 3.05 m (10 feet) from the alarm when operated under its minimum pressure and temperature conditions. The alarm(s) are to be installed utilizing the maximum design limitations and the most severe installation conditions specified in the manufacturer's installation manual.

32.3 For pressure operated alarms that utilize clean agents, the flow rate shall be determined and specified in the installation manual.

32.4 The measurement is to be made with a sound level meter that complies with the requirements of the Specification for Sound-Level Meters, ANSI/ASI S1.4 and Amendment S1.4A (ASA47). The "C" weighting network and fast response characteristics are to be used. The alarm is to be mounted in a position of normal use and operated at any pressure within its operating range. A microphone is to be located at a distance of 3.05 m (10 feet) from the alarm and positioned to receive the maximum sound level produced by the device. The measurement is to be made in a free field condition in order to minimize the effect of reflected sound energy. The ambient noise level is to be at least 10 decibels below the measured level produced by the alarm.

32.5 Free field conditions are to be simulated by mounting the alarm not less than 3.05 m (10 feet) from the ground and with the microphone located 10 feet from the alarm and conducting the test outdoors on a

clear day with the wind velocity not more than 2.24 m/s (5 mph) and at ambient temperature of 5 – 25°C (159 – 77°F). Alternatively, an anechoic chamber of not less than 28.3 m^3 (1000 ft^3), with no dimension less than 2.13 m (7 feet), and with an absorption factor of 0.99 or greater between 100 hertz and 10 kilohertz for all surfaces, is also capable of being used for this measurement.

33 One-Year Time Leakage Test

33.1 An extinguishing system cylinder/valve assembly, including actuating components, shall not show leakage greater than 0.25 percent of the minimum charge weight and signs of corrosion to components caused by exposure to the clean agent under storage conditions.

33.2 Representative samples of the charged extinguishing system units are to be maintained at a temperature of 22.2±3.9°C (72 ±7°F) for 360 days. Samples are to be placed in horizontal and vertical positions and their pressures checked after 1, 3, 6, and 12 months. Any loss in pressure or weight at constant ambient temperature is an indication of leakage. At least one of the units is to be discharged, and the valve, pressure gauge and other components exposed to the extinguishing agent are to be examined for signs of corrosion caused by exposure to the extinguishing agent.

Exception: System units intended for transportation and storage in the vertical position are not required to be tested in the horizontal. System units intended for transportation and storage in the horizontal position are not required to be tested in the vertical orientation.

34 Mounting Device Test

34.1 The mounting bracket for an extinguishing system cylinder/valve assembly that is not intended to be directly supported by the floor shall withstand for 5 min, without damage or permanent distortion, a static load, applied vertically downward, of five times the fully charged weight of the extinguishing system unit, and not less than 45.3 kg (100 pounds).

35 Class A and B Fire Clean Agent Extinguishment Tests

35.1 General test parameters

35.1.1 General

35.1.1.0 For extinguishing system units that do not have a maximum protected volume limitation specified in the instruction manual, the minimum extinguishing concentrations shall be determined from the Class A and B Fire Extinguishment Tests and the Nozzle Distribution Verification Tests.

35.1.1.0.1 For extinguishing system units that have a maximum protected volume limitation less than 100 m^3 specified in the instruction manual, the minimum extinguishing concentration shall be determined from the Nozzle Distribution Verification Tests and shall be the same for Class A and B fire hazards.

35.1.1.1 When tested in accordance with 35.2 and 35.3, an engineered or pre-engineered system unit shall extinguish either Class A or B, or both Class A and B test fires.

35.1.1.2 The discharge time shall be the maximum discharge time.

35.1.1.3 For Class A tests, all fires shall be:

a) Extinguished within 600 s + the maximum discharge time (e.g., 10 s) from the start of discharge; and

b) Prevented from re-ignition after the 600 s soak period.

35.1.1.4 For the Class B tests, all fires shall be extinguished within 30 s + the maximum discharge time (e.g., 10 s) from the start of discharge.

35.1.1.5 Tests with each fuel or material are to be repeated three times.

35.1.2 Test enclosure

35.1.2.1 The test enclosure having a minimum volume of 100 m^3 (3531 ft^3) is to be constructed of either indoor or outdoor grade minimum 9.5 mm (3/8 inch) thick plywood or equivalent material and is to have a minimum ceiling height of 3.5 m (11.5 ft) with each wall at least 4 m (13.1 ft) long. Openings are to be provided at the top and bottom of the enclosure for venting prior to system discharge. Also, a pressure relief opening shall be provided in the top of the enclosure. Provisions are to be made for visual observations of fire extinguishment outside the test enclosure. The test enclosure is to be maintained at 21 ±2.8°C (70 ±5°F) prior to the ignition of the test fires.

35.1.3 System arrangement

35.1.3.1 The extinguishing system unit is to be assembled using a piping arrangement and the nozzles intended for use with the system that result in not greater than the minimum nozzle design pressure at 21°C (70°F).

35.1.3.2 The storage containers are to be conditioned to 21 ±2.8°C (70 ±5°F).

35.1.3.3 The agent extinguishing concentration for each test is to be 83.34 percent (for Class A tests) and 76.92 percent (for Class B tests) of the intended end use design concentration or concentrations specified in the manufacturer's design and installation instructions at the ambient temperature of 21°C (70°F) within the enclosure. The concentration within the enclosure for halocarbon clean agents shall be calculated using the following formula:

$$W = [V/S] \times [C/(100-C)]$$

Where:

W is the weight of clean agent, kg (lb),

V is the volume of test enclosure, m^3 (ft^3),

S is the specific volume of clean agent at test temperature m^3/kg (ft^3 /lb),

C is the concentration, percent

35.2 Class A fire extinguishment tests

35.2.1 General

35.2.1.1 The Class A fire test materials are to consist of a wood crib and three polymeric materials.

35.2.2 Wood crib

35.2.2.1 The wood crib is to consist of four layers of six, trade size 2 by 2 (3.8 cm by 3.8 cm) (1-1/2 by 1-1/2 inch) by 46 cm (18 inch) long, kiln spruce, or fir lumber having a moisture content between 9 and 13 percent. The alternate layers of the wood members are to be placed at right angles to one another. The individual wood members in each layer are to be evenly spaced in forming a square determined by the

specified length of the wood members. The wood members forming the outside edges of the crib are to be stapled or nailed together.

35.2.2.2 Ignition of the crib is to be achieved by the burning of commercial grade heptane in a square steel pan 0.23 m^2 (2-1/2 ft^2) in area and not less than 10 cm (4 inches) high. The crib is to be centered with the bottom of the crib 30.5 cm (12 inches) above the top of the pan and the test stand constructed so that the bottom of the crib is exposed to the atmosphere. The percent of oxygen is to be measured by a calibrated analyzer at a location which is at the same height as the bottom of the wood crib and centered from the edge of the crib to the wall. Two additional measurements are to be made at 0.1 H and 0.9 H, with H being the height of the enclosure.

35.2.2.3 The heptane is to be ignited and the crib is to burn freely for 6 min outside the test enclosure or equivalent provisions are to be provided to insure adequate ventilation. The heptane fire is to burn for at least 3 min, with 1.5 liter (0.40 gallons) of heptane providing a 3 to 3-1/2 min burn time. Less than 15 s before the end of the total pre-burn period of 6 min, the crib is to be moved into the test enclosure and placed on a stand such that the bottom of the crib is 60 – 70 cm (24 – 30 inches) above the floor. The time required to position the burning crib within the test enclosure and the initiation of system discharge shall not exceed 15 s. Except for the pressure relief, the vents are to be closed and the system is to be actuated. At the time of actuation, the percent oxygen within the enclosure at the level of the crib shall be within 0.5 units of the normal oxygen level at atmospheric conditions.

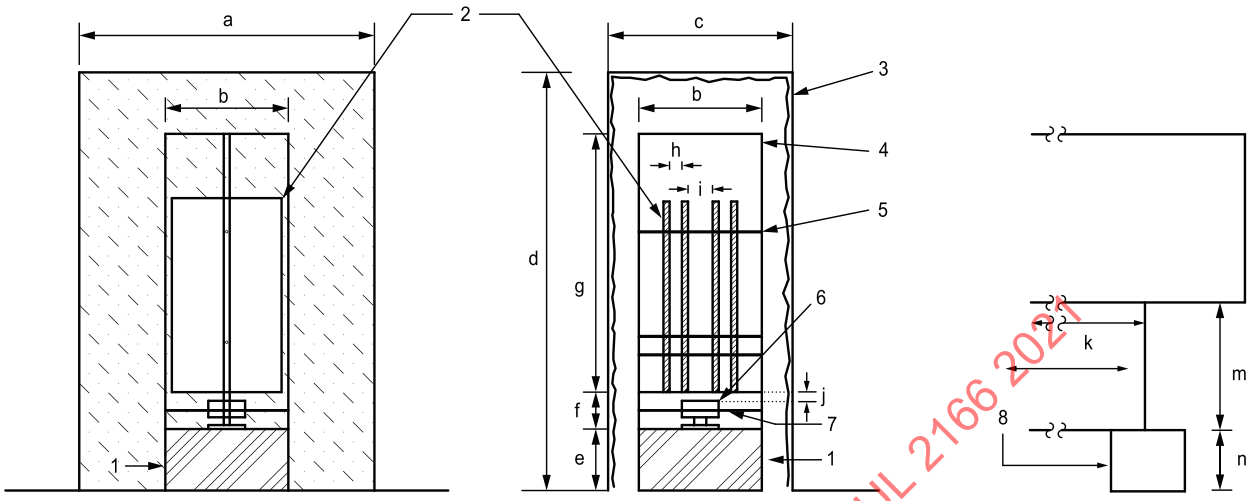
35.2.2.4 After the end of system discharge, observations shall be made for crib extinguishment. The enclosure is to remain sealed for a total of 10 min. After the 10 min soak period, the crib is to be removed from the enclosure, observed to determine whether fuel remains to sustain combustion and for signs of re-ignition.

35.2.3 Polymeric materials

35.2.3.1 Each polymeric fuel array is to consist of 4 sheets of the polymeric material, 9.5 mm (3/8 inch) thick, 40 cm (16 inches) tall, 20 cm (8 inches) wide. Sheets are to be spaced and located as described in Figure 35.1. The bottom of the fuel array is to be located 20 cm (8 inches) from the floor. The fuel sheets shall be mechanically fixed at the specified spacing.

Figure 35.1

Fuel shield



sm1304b

a. 610 mm (24'')

b. 254 mm (10'')

c. 381 mm (15")

d. 851 mm (33.5")

e. 127 mm (5")

f. 76 mm (3")

g. 533 mm (21")

h. 12.7 mm (0.5")

i. 31.8 mm (1.25")

j. 12 mm (0.5")

k. 951 mm (37.5")

l. N/A

m. 305 mm (12")

n. 89 mm (3.5")

1. Load Cell

2. 203 mm x 406 mm x 9.53 mm (8" x 16 " x 3/8")

3. Channel Iron Frame Covered With Steel Sheet on Top and Two Sides

4. Aluminum or Steel Angel Frame

5. 3.2 mm (1/8") All tread Rod Fuel Support

6. 51 mm square x 22 mm (2" square x 7/8" deep) (internal) nHeptane Ignitor Pan

7. Drip Tray

8. Cinder Block

9. Polycarbonate Baffles

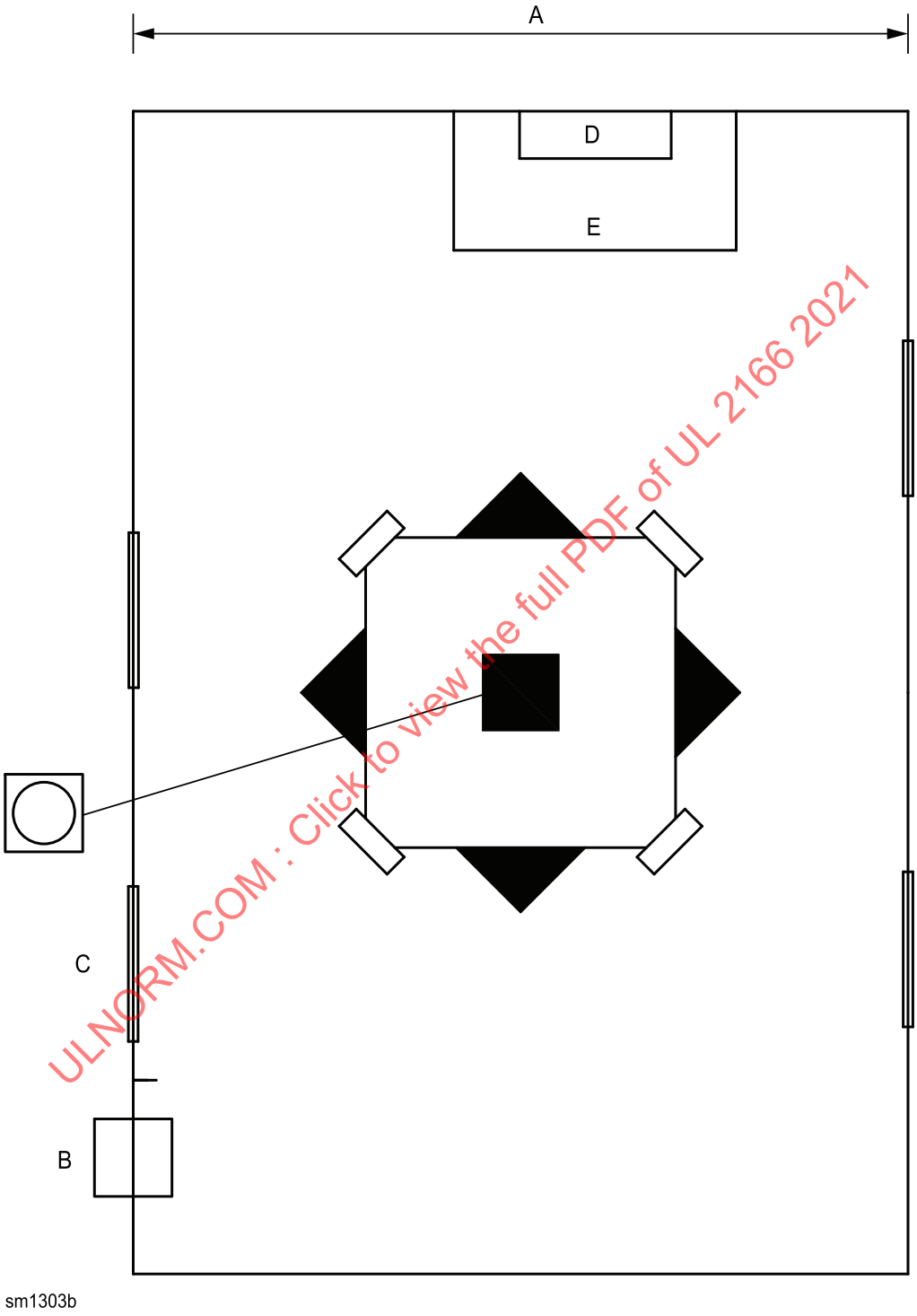
35.2.3.2 A fuel shield consisting of a metal frame with sheet steel on the top and two sides shall be provided around the fuel array as indicated in Figure 35.1. The fuel shield is to be 38 cm (15 inches) wide, 85.1 cm (33.5 inches) high and 61 cm (24 inches) deep. The 61 cm (24 inch) wide by 85.1 cm (33.5 inch) high sides and the 61 cm (24 inch) by 38 cm (15 inch) top are to be sheet steel. The remaining two sides and the bottom are to be open.

35.2.3.3 The fuel array is to be oriented such that the 20 cm (8 inch) dimension of the fuel array is parallel to the 61 cm (24 inch) side of the fuel shield.

35.2.3.4 Two external baffles measuring 1 m (40 inches) square and 30 cm (12 inches) tall are to be located around the exterior of the fuel shield as shown in Figure 35.2. The baffles are to be placed 9 cm (3.5 inches) above the floor. The top baffle is to be rotated 45 degrees with respect to the bottom baffle.

Figure 35.2

Fuel shield baffles



A. 13.1 ft (4 m) minimum

B. Inlet

C. Observation Panels

D. Exhaust

E. Baffle

35.2.3.5 The tests are to be conducted using three polymeric fuels: polymethyl methacrylate (PMMA); polypropylene (PP); and acrylonitrile-butadiene-styrene polymer (ABS). The properties of the materials shall be as described in Table 35.1.

Table 35.1
Polymeric fuel properties

25 kw/m^2 exposure in cone calorimeter – ASTM E 1354								
					180 s average		Effective	
		Density	Ignition time		Heat release rate		Heat of combustion	
Fuel	Color	(g/cm^3)	(sec)	Tolerance	kW/m^2	Tolerance	MJ/kg	Tolerance
PMMA	Black	1.19	77	±30%	286	±25%	23.3	±15%
Polypropylene	Natural (White)	0.905	91	±30%	225	±25%	39.8	±15%
ABS	Natural (Cream)	1.04	115	±30%	484	±25%	29.1	±15%

35.2.3.6 The ignition source is to be a square steel pan 5.1 cm (2 inches) by 5.1 cm (2 inches) by 2.2 cm (0.875 inch) deep centered 1.3 cm (0.5 inches) below the bottom of the polymeric sheets containing heptane. The amount of heptane used is to provide at least 90 s of burning.

35.2.3.7 The heptane pan is to be ignited and is to burn freely for 90 s. The agent is then to be discharged 210 s after ignition of the heptane and observations made for extinguishment. The enclosure is to remain sealed for 10 min after the end of discharge.

35.2.3.8 At the time of system discharge, the percent oxygen within the enclosure at a level of the fuel source is to be within 0.5 units of the normal oxygen level at atmospheric conditions.

35.2.3.9 The following data is to be continuously recorded during the test:

a) Oxygen concentration; and

b) Fuel mass loss.

35.2.3.10 The following events shall be timed and recorded:

a) Time of heptane ignition;

b) Time of ignition of plastic sheet;

c) Time of beginning of discharge of agent;

d) Time of end of discharge of agent; and

e) Time all visible flame is extinguished.

35.2.3.11 After the 600 s soak period, the enclosure is to be ventilated and the material examined for signs of re-ignition. The weight loss for the polymeric samples shall not exceed 15.0 grams between 10 s and 600 s after the end of discharge.

35.3 Class B fire extinguishment tests

35.3.1 General

35.3.1.1 The Class B fire extinguishment tests shall be conducted using commercial grade heptane.

35.3.1.2 The tests are to be conducted using a 0.23 m^2 (2-1/2 ft^2) square pan described in 35.3.1.3 located in the center of the room. The test pan is to contain at least 5 cm (2 inches) of heptane with the heptane 5 cm (2 inches) or more below the top of the pan.

35.3.1.3 The pan is to be of steel not less than 6.4 mm (1/4 inch) thick, with liquid-tight welded joints and provided with a 3.8 cm (1-1/2 inch) by 3.8 cm (1-1/2 inch) by 4.8 mm (3/16 inch) thick angle to reinforce the upper edge. The reinforcing angle is to be continuous around the perimeter of the pan and is to form a turned-out edge flush with the top edge of the pan. The top edge surface so formed is to be 44 mm (1-3/4 inch) in width. The reinforcing angle is to be continuously welded to the outside of the pan at the top edge and tack-welded at the edge of the lower leg of the angle.

35.3.1.4 The top of the pan is to be located 66 – 76 cm (26 – 30 inches) above the floor. The percent of oxygen is to be measured by a calibrated analyzer at a location which is equivalent to the height of the test pan. Two additional measurements are to be made at 0.1 H and 0.5 H, with H being the height of the enclosure.

35.3.2 Description of test fuel

35.3.2.1 The heptane is to be commercial grade having the following characteristics described in Table 35.2.

Table 35.2
Heptane characteristics

Distillation	
Initial boiling point, minimum	88°C (190°F)
Dry point, maximum	100°C (212°F)
Specific gravity (60°F/60°F) (15.6°C/15.6°C)	0.67 – 0.73

35.3.3 Test procedure

35.3.3.1 For each test, the heptane is to be ignited and is to burn freely for 30 s. Just prior to discharging agent into the enclosure, the vents, except for the pressure relief, are to be quickly closed and the extinguishing system is to be manually operated. At the time of actuation, the percent of oxygen measured in the enclosure at the pan level is to be within 0.5 units of the normal oxygen level of at atmospheric conditions. Observations are to be made for the time of fire extinguishment.

36 Nozzle Distribution Verification Tests

36.1 General

36.1.1.0 For extinguishing system units that do not have a maximum protected volume limitation specified in the instruction manual, the minimum extinguishing concentrations shall be determined from the Class A and B Fire Extinguishment Tests and the Nozzle Distribution Verification Tests.

36.1.1.0.1 For extinguishing system units that have a maximum protected volume limitation less than 100 m^3 specified in the instruction manual, the minimum extinguishing concentration shall be determined from the Nozzle Distribution Verification Tests and shall be the same for Class A and B fire hazards.

36.1.1 An engineered or pre-engineered extinguishing system unit shall mix and distribute its extinguishing agent and shall totally flood an enclosure when tested in accordance with the requirements of 36.1.2 – 36.5.1 under the maximum design limitations and most severe installation instructions.

36.1.2 When tested as described in 36.1.3 – 36.5.1, an extinguishing system unit shall extinguish all fires within 30 s after the end of system discharge.

Exception: For extinguishing systems where the discharge time exceeds 30 s at the minimum operating temperature, all fires shall be extinguished within 60 s from the start of system discharge

36.1.3 The tests described in 36.1.4 – 36.5.1 evaluate the intended use and limitations of the extinguishing system unit with specific reference to:

a) Type of nozzles;

b) The area coverage of each nozzle;

c) The minimum operating temperature of the system;

d) Location of nozzles in the protected area;

e) For pre-engineered systems the maximum length and size of piping and number of fittings to each nozzle;

f) For engineered systems, 90 percent of the minimum design nozzle pressure specified in the design manual;

g) Fill density producing lowest nozzle pressure; and

h) Maximum discharge time (±1.0 s).

36.1.4 As an alternate to the use of the heptane steel test cans specified in 36.4.1, agent concentration is capable of being measured with concentration metering devices at the locations specified for the steel test cans. The concentration shall be measured at each location and shall be at least the agent concentration referenced in 36.3.4 within the time limitation specified in 36.1.2.

36.2 Test enclosure

36.2.1 The test enclosures are to be constructed of either indoor or outdoor grade minimum 9.5 mm (3/8 inch) thick plywood or equivalent material. Provisions are to be made for visual observations of fire extinguishment outside the test enclosure. The test enclosures are to be maintained at 21 ±2.8°C (70 ±5°F) prior to the ignition of the test cans and pan.

36.2.2 An enclosure(s) is to be constructed having:

a) The maximum area coverage and minimum height limitation; and

b) The maximum height limitation and maximum volume limitation (as applicable).

Exception: Although the test enclosure(s) representing the maximum height limitation are not required to have the maximum coverage area, for extinguishing system units that do not have a maximum protected

volume limitation specified in the instruction manual, they are to be at least 4 m (13.1 ft) wide by 4 m (13.1 ft) long and 100 m^3 (3531 ft^3) in volume.

36.3 System arrangement

36.3.1 A pre-engineered type extinguishing system unit is to be assembled using its maximum piping limitations with respect to number of fittings and length of pipe to the discharge nozzles and nozzle configuration(s) as specified in the manufacturer's design and installation instructions.

36.3.2 An engineered type extinguishing system unit is to be assembled using a piping arrangement and the intended nozzles that result in 90 percent of the minimum nozzle design pressure at 21°C (70°F) or at a lower design temperature when specified by the manufacturer.

36.3.3 The cylinders are to be conditioned to the minimum operating temperature specified in the manufacturer's installation instructions.

36.3.4 The agent extinguishing concentration for each test is to be 76.92 percent of the intended end use design concentration for heptane specified in the manufacturer's design and installation instructions at the ambient temperature of 21°C (70°F) within the enclosure. The concentration within the enclosure for halocarbon clean agents is to be calculated using the following formula:

$$W = [V/S] \times [C/(100-C)]$$

Where:

W is the weight of clean agent, kg (lb),

V is the volume of test enclosure, m^3 (ft^3),

S is the specific volume of clean agent at test temperature m^3/kg (ft^3/lb),

C is the concentration, volume percent

36.4 Minimum room height/nozzle area coverage test arrangement

36.4.1 Steel test cans, having a maximum nominal thickness of 5.5 mm (0.216 inches) (Schedule 40 pipe), 7.6 – 8.9 cm (3.0 – 3.5 inches) in diameter and at least 102 mm (4 inches) high, containing either heptane or heptane and water, are to be placed within 5 cm (2 inches) of the corners of the test enclosure(s) and 5 cm (2 inches) behind a baffle, and located vertically within 30 cm (12 inches) of the top or bottom of the enclosure, or both top and bottom when such placement is possible. When the cans contain heptane and water, the heptane is to be at least 5 cm (2 inches) deep. The level of heptane in the cans shall be at least 5 cm (2 inches) below the top of the can. Closeable openings shall be provided either directly above or to the side the cans for venting prior to system actuation. A baffle is to be installed between the floor and ceiling at the midpoint between the direction of discharge and a wall. The baffle is to be perpendicular to the direction of nozzle discharge, and be 20 percent of the length or width of the enclosure, whichever is applicable with respect to nozzle location.

36.5 Maximum room height test arrangement

36.5.1 Test cans containing heptane as described in 36.4.1 are to be placed within 5 cm (2 inches) of the test enclosure and located within 30 cm (12 inches) of each of the top and bottom of the enclosure. A baffle is to be installed between the floor and ceiling at the midpoint between the direction of discharge and a wall. The baffle is to be perpendicular to the direction of nozzle discharge, and be 20 percent of the length or width of the enclosure, whichever is applicable with respect to nozzle location. Two additional cans are to be located within 5 cm (2 inches) behind the baffle within 30 cm (12 inches) of the bottom and

at the vertical midpoint of the baffle. Closeable openings are to be provided in the top and bottom of the enclosure for venting during the pre-burn period. An additional test without the baffle is to be conducted separately using the 0.23 m^2 (2-1/2 ft^2) square steel pan and the test methodology described in the Class B Fire Extinguishment Tests in 35.3.

Exception: For extinguishing system units that have a maximum protected volume limitation less than 100 m^3 specified in the instruction manual, the Nozzle Distribution Verification Tests with the pan, the pan is permitted to be of a smaller surface area than specified provided the pan area is a minimum of 1.45 percent of the enclosure's footprint area and the percent oxygen within the enclosure is within 0.5 units of normal oxygen level at atmospheric conditions at the time of the start of discharge when measured by a calibrated analyzer at a location equivalent to the height of the test pan and half the distance to a wall.

37 Automatic Extinguisher Unit Fire Tests

37.1 General

37.1.1 An automatic extinguisher unit shall mix and distribute its extinguishing agent and shall totally flood an enclosure when tested in accordance with the requirements of 37.1.2 – 37.4.2 under the maximum design limitations and most severe installation instructions.

37.1.2 When tested as described in 37.3 an automatic extinguisher unit shall extinguish all fires within 30 s after the end of system discharge. When tested as described in 37.4, an automatic extinguisher unit shall respond to and extinguish the pan fire within 1 min after test fuel ignition.

37.1.3 The tests described in 37.2 – 37.4.2 evaluate the intended use and limitations of the extinguishing system unit including:

a) The area coverage;

b) The minimum operating temperature;

c) Location of unit in the protected volume; and

d) Maximum protected enclosure volume.

The agent extinguishing concentration for each test is to be as specified in 35.1.3.3.

37.2 Test enclosures

37.2.1 The test enclosures are to be constructed of either indoor or outdoor grade minimum 9.5 mm (3/8 inch) thick plywood or equivalent material. Provisions shall be made for visual observation of fire extinguishment outside the enclosure. The test enclosures are to be maintained at 21 ±2.8°C (70 ±5°F) prior to the ignition of the test cans and pan.

37.2.2 The enclosures for the tests described in 37.3 and 37.4 are to be constructed representing the automatic extinguisher:

a) Maximum area coverage and minimum height limitation for the automatic extinguisher unit being tested; and

b) Maximum height limitation.

Each enclosure is to have the maximum volume intended for use with this unit.

37.3 Nozzle distribution extinguishment test

37.3.1 Test arrangement

37.3.1.1 The automatic extinguisher units are to be conditioned to the minimum operating temperature specified in the manufacturer's installation instructions.

37.3.1.2 Steel test cans as described in 36.4.1, containing either heptane or heptane and water, are to be placed within 5 cm (2 inches) of the corners of the test enclosure(s) and directly behind the baffle (see below), and located vertically within 30.5 cm (12 inches) of the top or bottom of the enclosure, or both top and bottom when such placement is possible. When the cans contain heptane and water, the heptane is to be at least 5 cm (2 inches) deep. The level of heptane in the cans shall be at least 5 cm (2 inches) below the top of the can. Closeable openings shall be provided either directly above or to the side of the cans for venting prior to system actuation. A baffle is to be installed between the floor and ceiling in the center of the enclosure. The baffle is to be perpendicular to the direction of nozzle discharge, and be 20 percent of the length or width of the enclosure, whichever is applicable with respect to extinguisher unit location.

37.3.2 Test procedure

37.3.2.1 For the test described in 37.3.1, the heptane is to be ignited and is to burn freely for 30 s with the vents in the enclosure open. The unit is then to be manually operated and observations made for time of actuation and fire extinguishment.

37.4 Automatic operation extinguishment tests

37.4.1 Test arrangement

37.4.1.1 These tests are to be conducted with each enclosure using a 0.23 m^2 (2-1/2 ft^2) square pan containing heptane as described in 35.3.1.3 and located:

a) In the center of the enclosure; and

b) Within 5 cm (2 inches) of a corner which is the most remote from the automatic extinguisher unit.

37.4.1.2 The test enclosure is to be provided with two square openings each having an area of 0.09 m^2 (1 ft^2) to provide an oxygen source for the fire. One opening is to be located next to the 0.23 m^2 (2-1/2 ft^2) square pan when the pan is located in the corner. The other opening is to be located on a wall directly across from the fire with the top of the opening within 5 cm (2 inches) of the ceiling.

37.4.2 Test procedure

37.4.2.1 For the tests described in 37.4, the heptane is to be ignited and allowed to burn freely with the vents open. The unit is to be allowed to operate automatically and observations made for time of unit operation and fire extinguishment.

38 Verification of Flow Calculation Method Test

38.1 An engineered clean agent extinguishing system unit shall be tested as specified in 38.2 – 38.4 to determine that the manufacturer's calculation method accurately predicts the discharge time, nozzle pressure, and distribution of the extinguishing agent. When the manufacturer's calculation method is capable of predicting the discharge time, nozzle pressure, and distribution of the extinguishing agent at temperatures of other than 21°C (70°F), verification tests are to be conducted throughout the temperature range specified for the manufacturer's calculation method.

38.2 Enclosures of varying volumes are to be constructed so to test the limitations of the calculation method. Other test methods shall be considered and accepted when determined to achieve equivalent results. A minimum of five different three and four nozzle piping arrangements are to be installed, using the type of pipe specified in the Installation and Design Manual, and tested to determine the accuracy of the calculation method. The following factors regarding the calculation method limitations and design considerations specified in the manufacturers installation and design manual are to be included in establishing the piping arrangements:

a) The percentage of agent in the piping is to be as large as possible for the piping arrangement and at least one test is to be conducted using the piping arrangement for which the greatest percentage of agent is present in the piping;

b) Minimum distance from the valve discharge outlet to the first tee;

c) Minimum and maximum discharge time;

d) Minimum and maximum container fill density;

e) Minimum and maximum pipeline flow rates;

f) Variance of piping volume to each nozzle;

g) Maximum variance in nozzle pressures within a piping arrangement;

h) Maximum and minimum orifice area of nozzle relative to inlet pipe area;

i) Arrangement expected to exhibit an agent time-imbalance condition at the nozzle (for example the maximum variance in agent arrival time and discharge time between nozzles);

j) All types of tee splits (for example, side-through tees, bullhead tees) which include critical lengths;

k) Minimum and maximum flow split for each type of tee split;

l) Type of pipe and pipe schedules; type of fittings; and

m) Elevation changes.

38.3 The cylinder is to be filled to the intended weight and the pressure is to become stable. The pressure container, piping, and enclosure are to be maintained at a temperature of 21°C (70°F) when possible. When not possible to maintain these items at a temperature of 21°C (70°F), the test is to be conducted at a temperature other than 21°C (70°F), with appropriate temperature correction calculations, when agreeable to all concerned. The extinguishing system unit is then to be discharged. During discharge, pressure measurements are to be taken at the cylinder and nozzle(s), utilizing a calibrated pressure transducer or equivalent pressure measuring device attached to a recorder. The discharge time is to be measured by a stopwatch and verified by pressure chart recorders. Other test arrangements shall be considered and accepted when determined to achieve equivalent results. Approximately one min after the completion of discharge, concentration measurements are to be taken in each enclosure with a calibrated concentration metering device and the weight of the discharged clean agent is to be calculated.

38.4 The measured discharge time, nozzle pressure (as defined by the manufacturer's calculation method), and calculated clean agent weight shall not deviate from the predicted values by more than the following:

a) Discharge time: ±1.0 s;

b) Nozzle pressure: ±10 percent; and

c) Weight of clean agent discharged: ±10 percent, and the standard deviation of the percentage differences between the measured and predicted agent quantities, relative to zero, shall not be greater than 5.

39 Equivalent Length Determination

39.1 An engineered type extinguishing system unit– including the discharge valve, siphon tube assembly, and components that are intended to be installed in the system discharge piping (except nozzles) – is to be tested as specified in 39.2 and 39.3 to determine the equivalent length of the attached pipe. The equivalent length determinations resulting from the test specified in 39.2 and 39.3 shall be included in the design manual. See Section 5, Design Manual.

39.2 Piezometers are to be installed on each end of the device and connected to a differential mercury manometer or equivalent measuring device. The flow of water through the device is to be measured using a set of calibrated nozzles, or equivalent, connected to a single column mercury manometer. Other test arrangements shall be considered and accepted when determined to achieve equivalent results.

39.3 At least four flow velocities greater than 3.0 m/s (10 ft/s) are to be established and the pressure drop between piezometers recorded for each velocity. The test is to be repeated with the devices removed from the line and the piezometers coupled together, and the pressure drop values so obtained are to be subtracted from the pressure drop values obtained with the devices in the line to obtain the pressure drop of the device. Using a Hazen-Williams coefficient of C=130, the equivalent length in feet of pipe is to be calculated.

40 High Pressure Discharge Test

40.1 An extinguishing system unit, including its discharge valve, brackets, manifold check valves, selector valves, other components in contact with clean agent discharge, and discharge piping, shall withstand without permanent distortion, rupture, or other malfunction that renders the device inoperable, the discharge test specified in 40.2.

40.2 The extinguishing system unit is to be filled with extinguishing agent and either:

a) Super-pressurized with nitrogen to a pressure corresponding to the pressure of the system unit at the maximum storage temperature;

b) Super-pressurized with nitrogen to the operating pressure at 21°C (70°F) and conditioned at its maximum storage temperature for a minimum of 16 h; or

c) Non-super-pressurized and conditioned at its maximum storage temperature for 16 h.

The extinguishing system unit is to be connected to the minimum amount of piping and largest nozzle flow rate intended for the system. The extinguishing system unit is then to be installed and discharged. After discharge, the extinguishing system unit is to be visually examined for distortion or damage. This test is to be repeated for all possible extinguishing system unit operating positions.

41 Flexible Hose Low Temperature Test

41.1 A flexible hose assembly shall show no cracking or other damage when conditioned at the minimum storage temperature for 24 h and then bent to the minimum bending radius specified by the manufacturer.

41.2 The hose assembly is to be conditioned at its minimum storage temperature for 24 h. The length of complete hose is then to be bent to the minimum bending radius specified by the manufacturer within a time period of 8 to 12 s, while still in the cold chamber. Gloves are to be worn while handling the sample to

minimize heat transfer to the sample. The hose sample is to be examined for evidence of cracking or other damage in the tube, cover, or reinforcement, and then subjected to a hydrostatic pressure test as specified in 26.1.

42 Operation Test of Manual Actuators and Manual Pull Stations

42.1 A manual actuator or manual pull station shall not require a pull or push of more than 178 N (40 pounds-force) nor a movement greater than 366 mm (14 inches) to release the extinguishing agent.

42.2 A manual pull station is to be fitted with the maximum length of cable and maximum number of corner pulleys.

42.3 A manual actuator that operates against the internal pressure of a system unit is to be tested with the system unit pressurized to simulate maximum operating pressure.

42.4 Following installation, the manual pull station or manual actuator is to be operated to determine compliance with 42.1.

43 Pneumatic Operation Test

43.1 A valve or other component intended to be pneumatically operated by a master valve or other pneumatic means shall operate as intended after being tested as specified in 43.2. A primary means of actuation that is intended to discharge multiple cylinder valve assemblies shall operate all the connected cylinder/valve assemblies within a 1-s maximum time interval between operation of the first cylinder/valve assembly and the last cylinder/valve assembly.

43.2 A master valve and cylinder are to be filled and pressurized to their operating pressure at 21°C (70°F) and then conditioned at their minimum storage temperature for at least 16 h. The maximum number of valves or other devices and the maximum amount and size of tubing or piping intended to be operated by the master valve are then to be installed and pressurized to the operating pressure (when applicable) that corresponds to the pressure at the maximum operating temperature. The system then is to be discharged.

44 Pressure Relief Tests

44.1 The frangible disc of an extinguishing system unit shall comply with the requirements specified in 44.2 and 44.3. A pressure-relief device other than a frangible disc shall comply with the requirements specified in 44.3.

44.2 Each of 30 frangible discs are to be subjected to a pressure that is increased at a rate of 2.1 MPa (300 psig) per min to a value of 85 percent of the rated bursting pressure, maintained at that pressure for at least 30 s, and then increased at a rate of no greater than 689 kPa (100 psig) per min until the disc breaks. The mean bursting pressure of the discs plus two standard deviations shall not exceed the proof test pressure of the cylinder. See 26.2.

44.3 A pressure relief device shall prevent a cylinder and valve assembly from exploding when subjected to the fire exposure test specified in the Procedures for Testing of DOT Cylinder Pressure Relief Device System, CGA C-14. Three cylinder and valve assemblies, charged to their maximum intended operating pressure at 21°C (70°F), are to be tested.

Exception: The fire exposure test is not required to be conducted when the pressure relief device is constructed and sized to comply with the flow capacity requirements as specified by the formulae in the Pressure Relief Device Standards Part 1 – Cylinder for Compressed Gases, CGA S-1.1.

45 Calibration Test – Gauges and Indicators

45.1 The error of a pressure gauge at the indicated charging pressure shall not exceed ±4 percent of the charging pressure. At the upper and lower limits of the operable range, the error shall not exceed ±8 percent of the charging pressure. At the intermediate markings, the error shall not exceed ±6 percent of the charging pressure. At the zero pressure mark, the error shall not exceed plus 12, minus 0 percent of the charging pressure. At the maximum indicated pressure, the error shall not exceed ±15 percent of the charging pressure.

45.2 The pressure gauge or indicator is to be installed on a deadweight gauge tester, or on a piping apparatus having a master gauge with an accuracy of not less than 0.25 percent. The pressurizing medium shall be either oil, water, nitrogen, or air, with all tests on a gauge being conducted using the same medium. The pressure is to be applied to the gauge under test in uniform increments until the upper limit of the gauge is reached. The pressure then is to be reduced in the same increments until the zero point is reached. The applied pressure, the gauge or indicator reading, and net error are to be recorded for each increment in both the increasing and decreasing pressure conditions. Fifteen gauges are to be tested.

46 Burst Strength Test – Gauges and Indicators

46.1 A pressure gauge or an indicator shall withstand, for 1 min without rupture, a pressure of six times the indicated operating pressure. In addition, when the Bourdon tube or pressure-retaining assembly bursts at a pressure less than eight times the indicated operating pressure, no parts of the device shall be thrown.

46.2 The sample gauge or indicator is to be attached to a hydraulic pressure pump after all air has been excluded from the test system. The sample is to be placed in a test cage and the pressure applied at a rate of 2.1 MPa/min (300 psig per minute) until the required test pressure is reached. The pressure is to be held at this point for 1 min and then increased until rupture occurs or a pressure of eight times the indicated operating pressure is reached, whichever occurs first. Five gauges are to be tested.

47 Overpressure Test – Gauges

47.1 The difference in readings of indicated operating pressure before and after a pressure gauge is subjected for 3 h to a pressure of 110 percent of the indicated gauge capacity shall not exceed 4 percent of the indicated charge pressure.

47.2 The sample pressure gauge is to be subjected to the required test pressure for 3 h. The pressure then is to be released and the gauges are to stand at zero pressure for 1 h. Five gauges are to be tested. The gauges then are to be subjected to a calibration test. See Section 45, Calibration Test – Gauges and Indicators.

48 Impulse Test– Gauges

48.1 The difference in readings of indicated charge pressure before and after a pressure gauge is subjected to 1000 cycles of pressure impulse shall not exceed 4 percent of the indicated charging pressure.

48.2 The sample pressure gauge is to be attached to a regulated source of pressure, either air, nitrogen, or water. The pressure then is to be varied at a rate of 6 cycles per min from minimum operating pressure of the extinguishing system unit to the maximum operating pressure of the extinguishing system unit indicated operating pressure. The time for each complete increase/decrease pressure excursion is to be not more than 10 s. Five gauges are to be tested. The samples then are to be subjected to a calibration test. See Section 45, Calibration Test – Gauges and Indicators.

49 Pressure Gauge Relief Test

49.1 The pressure relief of a gauge (see 13A.3) shall function at a pressure of 345 kPa (50 psig) or less within 24 h. The minimum flow capacity of the pressure relief at 345 kPa (50 psig) shall be not less than 1 liter per h (0.25 gal/h) measured at 21°C (70°F).

49.2 This test is to be conducted with the Bourdon Tube cut completely through. The gauge is to be immersed under water with the gauge inlet connected to a regulated source of air or nitrogen. The supply pressure is to be maintained at 345 kPa (50 psig) until the pressure relief functions, or for 24 h, whichever is shorter. The flow rate is to be measured with an inverted water column or other equivalent means. Twelve gauges are to be tested.

50 Water Resistance Test – Gauges and Indicators

50.1 A mechanical gauge or indicator or an electronic gauge or parts intended to be production leakage tested by water submergence shall remain watertight after being immersed in 0.30 m (1 foot) of water for 2 h. Two gauges are to be tested.

50A Primary Battery Tests – Electronic Gauges

50A.1 For electronic pressure gauges, the primary battery shall comply with the following sections as noted.

Primary Battery Tests	UL 864: 87, 55.4	ULC-S527: 4.3.2; 10.24; 4.20.10

50B Electronic Hardware Tests – Electronic Gauges

50B.1 For electronic pressure gauges intended for indoor use, the electronic hardware shall comply with the following sections as noted and marked "indoor use only" or equivalent.

Current and voltage input	UL 864: 63.1, 63.2, 63.3.1	ULC-S527: 10.4.1, 10.4.2.1
Variable voltage	UL 864: 65.1 – 65.8	ULC-S527: 10.6.1 – 10.6.9
Polarity reversal	UL 864, 90.1 – 90.2	ULC-S527: 10.31.11.5
Variable ambient for indoor use dry locations	UL 864:71	ULC-S527:10.10.1 – 10.10.4, 8.17
Humidity for indoor use dry locations	UL 864: 71	ULC-S527:10.10.1 – 10.10.4, 8.17
Component Temperature	UL 864: 68.1 – 68.14, 68.17	ULC-S527: 10.7.1 – 10.7.14, 10.7.17
Strain Relief on field wiring/connectors	UL 864: 88	ULC-S527: 10.19
Charging current and standby tests for rechargeable batteries with only 24 hour discharge	UL 864: 69	ULC-S527: 10.5 9
Special terminal assemblies	UL 864: 82	ULC-S527: 10.18
Transients, when external wired connections	UL 864: 77	ULC-S527: 10.14
Electro static discharge	–	ULC-S527: 10.15
Radio Frequency Interference	–	ULC-S527: 10.16
Evaluation of conformal coating	–	ULC-S527: 10.17

50B.2 Electronic pressure gauges intended for outdoor wet location use shall additionally meet the specific requirements of UL 864, Sections 71 and 92 and/or ULC-S527, Sections 10.10.1 through 10.10.5, as applicable; and not be marked “indoor use only” or equivalent.

51 Liquid Level Indicators

51.1 A liquid level indicator shall indicate the amount of extinguishing agent in the storage container within ±2.5 percent of the actual weight stored in the container when tested as specified in 51.2.

51.2 Sample extinguishing system units, utilizing pressure vessels of each diameter and of the longest length, are to be filled with the minimum and maximum fill density. The extinguishing system units are to be conditioned at the minimum rated storage temperature, at 21 ±5.5°C (70 ±10°F), and at the maximum rated storage temperature for 24 hours. Following each conditioning, the liquid level is to be measured and the weight in the container calculated based on the charts provided by the manufacturer. The weight calculated is then to be compared to the actual weight stored in the container, to verify that it is within ±2.5 percent of the actual weight.

52 Aging Tests– Plastic Materials

52.1 Air-oven aging test

52.1.1 There shall be no cracking of a plastic valve, valve part, part subjected to the flow of clean agent, or bracket, after air-oven aging for 180 days at 100°C (212°F). Aged samples of the valve, valve part, bracket, or container shall perform as intended when tested as specified in 26.6 (valves and parts); Hydrostatic Pressure Test, Section 26 (containers); 34.1 (brackets); High Pressure Discharge Test, Section 40 (nozzles); or the Burst Strength – Gauges and Indicators, Section 46 (pressurized gauge components). See 52.1.4 – 52.3.1.

52.1.2 Following air-oven aging for 90 days at 100°C (212°F), there shall be no cracking of a plastic siphon tube, and aged samples of the siphon tube shall perform as intended. Ring samples cut from the aged tube shall not exhibit a degradation in excess of 40 percent of the original tensile or ring crushing strength values.

52.1.3 When a plastic material is unable to withstand the temperature specified in 52.1.1 and 52.1.2 without excessive softening, distortion, or deterioration, an air-oven aging test at a lower temperature for a longer period of time is permitted to be used. When a plastic material is able to withstand a higher temperature than specified in 52.1.1 and 52.1.2 without excessive softening, distortion, or deterioration, an air-oven aging test at a higher temperature for a shorter period of time is permitted to be used.

For 52.1.1,

$$t = 146040 \cdot e^{-0.067 \cdot T}$$

For 52.1.2,

$$t = 60930 \cdot e^{-0.0652 \cdot T}$$

Where:

t = Aging duration in days; t ≥ 25 days

T = Aging temperature in °C; T ≥ 87°C

52.1.4 When plastic parts are attached to other parts or assemblies, the securement of the parts shall not be impaired after air-oven aging.

52.1.5 To determine the degradation of a plastic material used in a siphon tube, ring samples 12.7 mm (1/2 inch) wide are to be cut from the tube and subjected to air-oven aging. See 52.1.6. The ring samples then are to be subjected to a crush test between parallel flat plates using a machine that applies a compression load at a uniform rate of 5 mm (0.2 inch) per min and records the load applied as a function of the deflection. The test also is to be conducted on unaged parts of identical size for comparative purposes. When the nature of the material is such that meaningful test results are unobtainable, other tests, such as a tension test, are to be conducted.

52.1.6 The plastic valve parts and plastic siphon tube samples to be aged are to be supported in a full-draft, circulating-air oven that has been preheated at full draft to 100 ±1.0°C (212 ±1.8°F). Samples are not to touch one another or the sides of the oven. The samples of the plastic valve parts and siphon tube are to be aged for 180 and 90 days, respectively, at full draft and then cooled in air at 23.0 ±2.0°C (73.4 ±3.6°F) for at least 24 h before conducting any test or dimensional measurement. As used in this test, the term "full draft" refers to the oven used with inlet and outlet vents open and the air vent damper control at a setting that provides 250 to 360 air changes per h.

52.2 Exposure to extinguishing agent test

52.2.1 Plastic siphon tubes that have been immersed for 90 days at 55°C (130°F) in the halocarbon extinguishing agent in which they are to be used shall perform as intended when installed in test extinguishing system units. Ring samples cut from the tube and immersed for 90 days at 48.9°C (120°F) in the halocarbon extinguishing agent with which they are to be used shall not exhibit degradation in excess of 40 percent of the original tensile or ring crushing strength values.

52.2.2 Complete siphon tubes and ring samples, 12.7 mm (1/2 inch) wide and cut from unaged siphon tubes, are to be placed in a container filled with the extinguishing agent. The container, with the samples in place, is to be capped and placed in a preheated oven at 48.9°C (120°F) for 90 days. After the test exposure, the samples are to cool in air at 23.0 ±2.0°C (73.4±3.6°F) for at least 24 h before conducting any tests or dimensional measurements. The ring samples then are to be subjected to a crush test between two parallel flat plates on a testing machine that applies a compressive load at the uniform rate of 5 mm (0.2 inch) per min and records the load as a function of the deflection. When the nature of the material is such that meaningful test results are unobtainable, other tests, such as tensile tests, are to be conducted.

52.3 Light and water test

52.3.1 There shall be no cracking of materials used for a plastic valve, exposed valve part, or bracket after exposure to light and water for 720 h. Samples of the valve or valve part or bracket so exposed shall perform as intended when tested as specified in Hydrostatic Pressure Test, Section 26.6 (valves and parts); Mounting Device Test, Section 34 (brackets); High Pressure Discharge Test, Section 40 (nozzles); or the Burst Strength Tests – Gauges and Indicators, Section 46 (gauges). Gauges or indicators that undergo this test, shall remain watertight.

52.3.2 The ultraviolet light is to be obtained from two stationary enclosed carbon-arc lamps. The arc of each lamp is to be formed between two vertical carbon electrodes, 12.7 mm (1/2 in) in diameter, located at the center of a revolvable vertical metal cylinder, 787 mm (31 in) in diameter and 450 mm (17-3/4 in) in height. Each arc is to be enclosed with a No. 9200-PX clear Pyrex glass globe. The samples are to be mounted vertically on the inside of the revolvable cylinder, facing the lamps, and the cylinder continuously revolved around the stationary lamps at one revolution per min. A system of nozzles is to be provided so that each sample, in turn, is sprayed with water as the cylinder revolves. During each operating cycle (total of 20 min) each sample is to be exposed to the light and water spray for 3 min and to the light only for 17

min. The air temperature within the revolving cylinder of the apparatus during operation is to be 63 ±5°C (145 ±9°F).

52.3.3 An alternate ultraviolet light exposure is obtainable in accordance with ASTM D2565, Standard Practice for Operating Xenon Arc-Type (Water-Cooled) Light-Exposure Apparatus With and Without Water for Exposure of Plastics. The source of radiation is to be a 6500 Watt, water-cooled xenon-arc lamp with borosilicate inner and outer optical filters. The wattage to the lamp is automatically controlled to provide spectral irradiance of 0.35 W/m^2 at 340 nm. The samples are mounted vertically on the inside of a 97 cm (38 in) diameter cylinder, facing the arc, and the cylinder is rotated about the arc at one revolution per minute. During each operating cycle of 120 minutes, each sample is exposed to light for 102 min and to light and water spray for 18 min. The black-panel temperature during the dry portion of the light-on cycle is regulated to 63 ±5°C (145 ±9°F).

52.3.4 The specimens are then to be conditioned for 24 h in air having a temperature of 60°C (140°F) and a relative humidity of 50 percent.

53 10-Day Moist Ammonia Air Stress Cracking Test

53.1 After being subjected to the conditions described in 53.2 – 53.4, a brass part containing more than 15 percent zinc shall show no evidence of cracking when examined using 25X magnification.

Exception: Cracking is not prohibited when the cracking does not impact the ability of the product to comply with the requirements of this standard.

53.2 Each test sample is to be subjected to the physical stresses normally imposed on or within a part as the result of assembly with other components. Such stresses are to be applied to the sample prior to and maintained during the test. Samples with threads, intended to be used for installing the product in the field, are to have the threads engaged and tightened to the torque specified in Table 53.1. Teflon tape or pipe compounds are not to be used on the threads.

Table 53.1
Torque requirements for threaded connections

Nominal thread size, inches	Torque	
	N·m	(pounds-inches)
1	135.6	(1200)
1-1/4	163.8	(1450)
1-1/2	175.1	(1550)
2	186.4	(1650)
2-1/2	197.7	(1750)
3	203.4	(1800)

53.3 Representative samples are to be degreased and then continuously exposed in a set position for ten days to a moist ammonia-air mixture maintained in a glass chamber having a glass cover.

53.4 An amount of aqueous ammonia approximately 600 ml per square foot of chamber floor area and having a specific gravity of 0.94 is to be maintained at the bottom of the glass chamber below the samples. The samples are to be positioned 38.1 mm (1-1/2 in.) above the aqueous ammonia solution and supported by an inert tray. The moist ammonia-air mixture in the chamber is to be maintained at atmospheric pressure and at a temperature of 34°C (93°F).

53A Elastomeric Parts Test

53A.1 An elastomeric part used to provide a seal shall have the following properties when tested as specified in the Standard for Gaskets and Seals, UL 157:

a) For silicone rubber (having poly-organo-siloxane as its constituent characteristic), a minimum tensile strength of 3.4 MPa (500 psi) and a minimum ultimate elongation of 100 percent.

b) For fluoroelastomers, a minimum tensile strength of 6.9 MPa (1000 psi) and a minimum ultimate elongation of 150 percent.

c) For natural rubber and synthetic rubber other than silicone rubber or fluoroelastomers, a minimum tensile strength of 8.3 MPa (1200 psi) and minimum ultimate elongation of 150 percent.

d) Those properties relating to maximum tensile set; minimum tensile strength and elongation after oven aging; and hardness after oven aging, all as specified in UL 157. The maximum service temperature used to determine the oven time and temperature for oven aging is to be 60°C (140°F).

e) After exposure to the extinguishing agent as specified in UL 157, a minimum tensile strength and minimum ultimate elongation of 60 percent of the original.

53A.2 The Standard for Gaskets and Seals, UL 157 provides for the testing of either finished elastomeric parts or sheet or slab material. Sheet or slab material is to be tested when the elastomeric parts are O-rings having diameters of less than 25.4 mm (1 inch). The material tested is to be the same as that used in the product, regardless of whether finished elastomeric parts or sheet or slab material is tested.

54 Nameplate Exposure Tests

54.1 There shall be no significant deterioration of the legibility, such as darkening, fogging, or blistering of a nameplate upon completion of the exposures specified in 54.2 (b) – (g) as compared to 54.2(a), nor shall there be any cracking or curling at the edges.

54.2 Prior to the exposures specified in (a) – (f), sample pressure-sensitive type nameplates are to be applied to test surfaces representative of the surface employed in the intended application. Curvature of this surface is to have the minimum radius anticipated in application. Each of the exposures specified in (b) – (f) is to be preceded by that specified in (a).

a) 72 h at 23 ±1°C (72 ±1.8°F) and 50 ±2 percent relative humidity.

b) 24 h at minus 54.9 ±2°C (minus 65 ±3.6°F) or minus 40°C (minus 40°F), depending on intended use.

c) 6 weeks at 60 ±2°C (140±3.6°F) and 97 ±3 percent relative humidity.

d) 90 days air-oven aging (mechanical convection) 87 ±1°C (189 ±1.8°F).

e) 720 h in ultraviolet light and water. See 52.3.

f) 48 h immersion in distilled water at 23 ±1°C.

55 Nameplate Adhesion Test

55.1 A pressure-sensitive nameplate containing the model number and extinguisher classification shall have an average adhesion after a 72-h exposure to air at 23 ±1°C (73 ±1°F) and 50 ±2 percent relative humidity of not less than 1 pound-force per linear inch (0.16 N/linear mm) of nameplate width. Following