



UL 2166

STANDARD FOR SAFETY

Halocarbon Clean Agent Extinguishing System Units

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UL Standard for Safety for Halocarbon Clean Agent Extinguishing System Units, UL 2166

Second Edition, Dated August 29, 2012

Summary of Topics

This New Edition of ANSI/UL 2166 is being issued to incorporate the following changes in requirements:

Adoption of the Second Edition of the Standard for Safety for Halocarbon Clean Agent Extinguishing System Units, which includes the following changes: (A) Maximum discharge time and editorial changes

The requirements are substantially in accordance with Proposal(s) on this subject dated May 4, 2012 and July 6, 2012.

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that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

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AUGUST 29, 2012



ANSI/UL 2166-2012

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UL 2166

Standard for Halocarbon Clean Agent Extinguishing System Units

First Edition – March, 1999

Second Edition

August 29, 2012

This ANSI/UL Standard for Safety consists of the Second Edition.

The most recent designation of ANSI/UL 2166 as an American National Standard (ANSI) occurred on August 29, 2012. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or effective date information.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover 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.

1.2 These requirements also cover halocarbon clean agent automatic extinguisher units that do not 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 has no manual means of actuation and discharges extinguishing agent upon thermal actuation, 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 70°F (21°C). 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 seconds for Class A hazards or 10 seconds 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 70°F (21°C).

3.18 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.

3.19 PROOF TEST PRESSURE – The factory test pressure of each cylinder used to evaluate cylinder leakage and construction integrity. For Department of Transportation (DOT) approved cylinders, the factory test pressure is specified in the appropriate DOT 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 and non-ASME cylinders, the factory test pressure is three times the cylinder operating pressure at 70°F (21°C).

3.20 **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.

3.21 **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.

Effective date for 4.1 changed from March 31, 2001 to June 30, 2001

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.

Effective date for 4.2 changed from March 31, 2001 to June 30, 2001

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

Effective date for 4.3 changed from March 31, 2001 to June 30, 2001

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.

Effective date for 4.4 changed from March 31, 2001 to June 30, 2001

5 Design Manual

5.1 An engineered clean agent extinguishing system unit shall have a design manual that references 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;
- 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 70°F (21°C), appropriate cautionary information stating that when the storage temperature varies by $\pm 10^\circ\text{F}$ (5.5°C) 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.

Effective date for 5.1 changed from March 31, 2001 to June 30, 2001

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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 28.

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 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;

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- g) Remote manual controls;
- h) Selector valves; and/or
- i) Other accessory equipment.

7.5 An extinguishing system unit shall have a minimum storage temperature of either minus 65°F (minus 53.9°C), minus 40°F (minus 40°C), minus 20°F (minus 28.9°C), 0°F (minus 17.8°C), or 32°F (0°C); and a maximum storage temperature of either 100°F (37.8°C), 120°F (48.9°C), 130°F (54.4°C), 150°F (65.6°C), or higher, except that the 100°F maximum storage temperature applies to an automatic extinguisher unit only.

7.6 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.

7.7 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 34, and Nozzle Distribution Verification Tests described in Section 35, 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.

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 pressure vessel containing a super pressurized agent, showing the pressure within the container. See Pressure Gauges and Indicators, Section 13.

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.

Effective date for 9.5 changed from March 31, 2001 to June 30, 2001

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

10.2 The requirements in this section do not apply to a pressure vessel marked as complying with DOT 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, Canadian Transport Commission 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 25 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 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.

10.6 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.

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

10.8 Automatic extinguisher unit pressure vessels for use with a halocarbon clean agent and with an operating pressure of 240 psi (1.65 MPa) or less at 70°F (21°C) and an internal volume not exceeding 1100 cubic inches (0.018 m³) for a non-liquefied compressed gas, or 55 cubic inches 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 25.2. (See 10.9 – 10.18).

Exception: Pressure vessels complying with 10.4 or 10.10 are not required to comply with this requirement.

10.9 With reference to the requirements of 10.8, the maximum stress at proof pressure for commonly used materials and fabricating processes shall not exceed the values specified in Table 10.1.

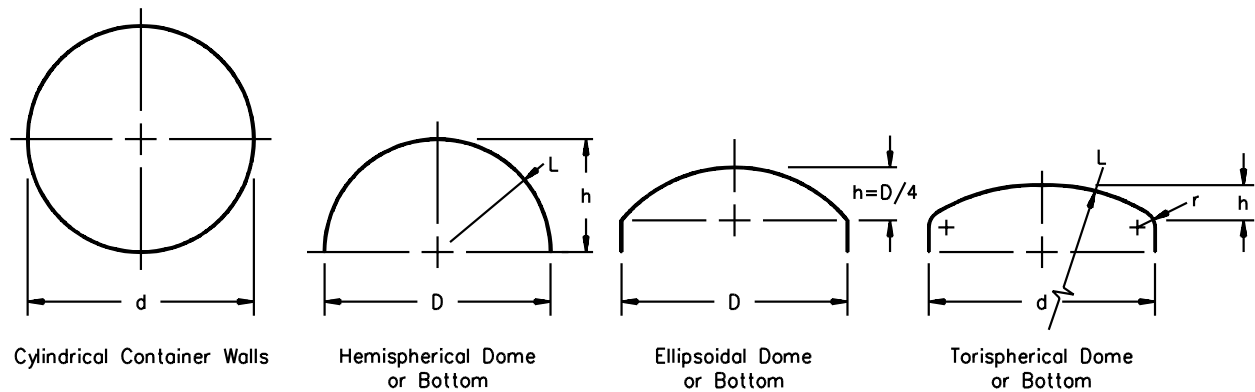
Table 10.1
Maximum stress at proof pressure

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)

10.10 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 25.8. The maximum stress value is to be based upon the mean values resulting from the test series minus two unbiased standard deviations.

10.11 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



$$S = \frac{Pd}{2t}$$

$$S = \frac{PL}{2t}$$

$$S = \frac{PD}{2t}$$

$$S = \frac{0.885PL}{t}$$

$$S = \frac{Pd}{4t} \text{ (sphere)}$$

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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

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10.12 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 10.11 is to be multiplied by a factor of 1.67.

10.13 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 10.17.

10.14 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.

10.15 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.

10.16 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.

10.17 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

10.18 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.

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