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12A

Standard on Halon 1301 Fire Extinguishing Systems

2018

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NFPA® 12A

Standard on

Halon 1301 Fire Extinguishing Systems

2018 Edition

This edition of NFPA 12A, *Halon 1301 Fire Extinguishing Systems*, was prepared by the Technical Committee on Gaseous Fire Extinguishing Systems. It was issued by the Standards Council on November 10, 2017, with an effective date of November 30, 2017, and supersedes all previous editions.

This edition of NFPA 12A was approved as an American National Standard on November 30, 2017.

Origin and Development of NFPA 12A

The Committee on Halogenated Fire Extinguishing Systems was formed in the fall of 1966 and held its first meeting during December of that year. The Committee was organized into four Subcommittees who separately prepared various portions of the standard for review by the full Committee at meetings held in September and December 1967.

The standard was submitted and adopted at the Annual Meeting in Atlanta, Georgia, May 20–24, 1968. The 1968 edition was the first edition of this standard and was adopted in tentative form in accordance with NFPA regulations. In 1969 the Committee determined that the standard had not yet been sufficiently tested and elected to carry it in tentative status for one more year. It was presented for official adoption in 1970. The first official version of the standard was adopted at the Annual Meeting of NFPA held in Toronto, Ontario in May 1970. Revisions were made in 1972, 1973, 1977, and 1980.

The 1985 edition was a complete revision of the standard. The standard was revised in 1987 and again in 1989.

The standard was completely rewritten for the 1992 revision to more clearly state the requirements and to separate the mandatory requirements from the advisory text in an effort to make the document more usable, enforceable, and adoptable. The main topic addressed in this revision was decommissioning and removal of systems.

The standard was updated to conform to the *Manual of Style for NFPA Technical Committee Documents* for the 2004 edition.

For the 2009 edition, the standard was revised to address testing and recharging of Halon 1301 cylinders.

The 2015 edition incorporated support for electronic storage of system maintenance records.

For the 2018 edition, the annex chapter on nozzle and piping calculations (Annex H) was revised to correct errors, comply with the *Manual of Style for NFPA Technical Committee Documents*, and clarify the details of the procedure.

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Foreword

Halon 1301 (bromotrifluoromethane, or CBrF3) is a colorless, odorless, electrically nonconductive gas that is an effective medium for extinguishing fires. Halon 1301 is included in the Montreal Protocol on Substances That Deplete the Ozone Layer signed September 16, 1987. The protocol permits continued availability of halogenated fire extinguishing agents at 1986 production levels. That protocol, and subsequent amendments, restrict the production of this agent. In addition, local jurisdictions within some countries (e.g., the EPA in the United States) have enacted further rules regulating the production, use, handling, and disposal of this agent. The user of this standard is advised to consult local authorities for current regulations. Halon 1301 fire extinguishing systems are useful within the limits of this standard in extinguishing fires in specific hazards or equipment and in occupancies where an electrically nonconductive medium is essential or desirable, or where cleanup of other media presents a problem.

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Committee Scope: This committee shall have primary responsibility for documents on the installation, maintenance, and use of carbon dioxide systems for fire protection.

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This committee shall also have primary responsibility for documents on fixed fire extinguishing systems utilizing bromotrifluoromethane and other similar halogenated extinguishing agents, covering the installation, maintenance, and use of systems.

This committee shall also have primary responsibility for documents on alternative protection options to Halon 1301 and 1211 fire extinguishing systems. It shall not deal with design, installation, operation, testing, and maintenance of systems employing dry chemical, wet chemical, foam, aerosols, or water as the primary extinguishing media.

Documents
Document Sharing Hub
Full document details: NFPA 12A 2018

Contents

Chapter 1 Administration **12A–** 6
1.1 Scope. **12A–** 6
1.2 Purpose. **12A–** 6
1.3 Units. **12A–** 6
1.4 Use and Limitations. **12A–** 6
1.5 Safety. **12A–** 7

Chapter 2 Referenced Publications **12A–** 7
2.1 General. **12A–** 7
2.2 NFPA Publications. **12A–** 7
2.3 Other Publications. **12A–** 7
2.4 References for Extracts in Mandatory Sections. **12A–** 7

Chapter 3 Definitions **12A–** 7
3.1 General. **12A–** 7
3.2 NFPA Official Definitions. **12A–** 8
3.3 General Definitions. **12A–** 8

Chapter 4 Components **12A–** 8
4.1 Halon 1301 Supply. **12A–** 8
4.2 Distribution. **12A–** 9
4.3 Detection, Actuation, Alarm, and Control Systems. **12A–** 10

Chapter 5 System Design **12A–** 11
5.1 Specifications, Plans, and Approvals. **12A–** 11
5.2 System Flow Calculations. **12A–** 11
5.3 Enclosure. **12A–** 11
5.4 Design Concentration Requirements. **12A–** 12
5.5 Determination of Halon 1301 Quantity for Total Flooding Systems. **12A–** 12
5.6 Altitude Adjustments. **12A–** 13
5.7 Distribution System. **12A–** 13
5.8 Nozzle Choice and Location. **12A–** 13

Chapter 6 Inspection, Maintenance, Testing, and Training **12A–** 13
6.1 Inspection and Tests. **12A–** 13
6.2 Container Test. **12A–** 13
6.3 Hose Test. **12A–** 13
6.4 Enclosure Inspection. **12A–** 14
6.5 Maintenance. **12A–** 14
6.6 Training. **12A–** 14
6.7 Approval of Installations. **12A–** 14

Annex A Explanatory Material **12A–** 16

Annex B Enclosure Integrity Procedure **12A–** 20

Annex C Halogenated Extinguishing Agents **12A–** 31

Annex D Hazards to Personnel **12A–** 33

Annex E Storage Containers **12A–** 35

Annex F Piping **12A–** 38

Annex G System Flow Calculations **12A–** 39

Annex H Nozzles **12A–** 41

Annex I Fire Extinguishment **12A–** 56

Annex J Surface Fires **12A–** 57

Annex K Total Flooding Quantity **12A–** 58

Annex L Approval of Installations **12A–** 61

Annex M Informational References **12A–** 63

Index **12A–** 65

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Full document details: NFPA 12A 2018

NFPA 12A

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A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex M. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex M.

Chapter 1 Administration

1.1 Scope. This standard contains minimum requirements for total flooding Halon 1301 fire extinguishing systems. It includes only the essentials necessary to make the standard workable in the hands of those skilled in this field. Only those skilled in this work are competent to design, install, maintain, decommission, and remove this equipment. It might be necessary for many of those charged with purchasing, inspecting, testing, approving, operating, and maintaining this equipment to consult with an experienced and competent fire protection engineer to effectively discharge their respective duties. *(See Annex C.)*

1.2 Purpose. This standard is prepared for the use and guidance of those charged with purchasing, designing, installing, testing, inspecting, approving, listing, operating, maintaining, decommissioning, and removing halogenated agent extinguishing systems (Halon 1301), so that such equipment will function as intended throughout its life. Nothing in this standard is intended to restrict new technologies or alternate arrangements provided the level of safety prescribed by this standard is not lowered.

1.2.1 Pre-engineered systems (packaged systems) consist of system components designed to be installed according to pretested limitations as approved or listed by a testing laboratory. Pre-engineered systems sometimes incorporate special nozzles, flow rates, methods of application, nozzle placement, and pressurization levels that sometimes differ from those detailed elsewhere in this standard. All other requirements of the standard shall apply. Pre-engineered systems shall be installed to protect hazards within the limitations that have been established by the testing laboratories where listed.

1.3 Units.

1.3.1 Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). Two units (liter and bar), outside of but recognized by SI, are commonly used in international fire protection. These units are listed in Table 1.3.1 with conversion factors.

1.3.2* If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated shall be regarded as the requirement. A given equivalent value is often approximate.

1.4 Use and Limitations.

1.4.1 Total flooding Halon 1301 fire extinguishing systems are used primarily to protect hazards that are in enclosures or equipment that, in itself, includes an enclosure to contain the agent. Some typical hazards that shall be permitted to use Halon 1301 are as follows:

(1) Electrical and electronic hazards
(2) Telecommunications
(3) Flammable and combustible liquids and gases
(4) Other high value assets

1.4.2 Halon 1301 shall not be used on the following:

(1) Certain chemicals or mixtures of chemicals such as cellulose nitrate and gunpowder, which are capable of rapid oxidation in the absence of air
(2) Reactive metals such as sodium, potassium, magnesium, titanium, zirconium, uranium, and plutonium
(3) Metal hydrides
(4) Chemicals capable of undergoing autothermal decomposition, such as certain organic peroxides and hydrazine

1.4.3* Electrostatic charging of nongrounded conductors can occur during the discharge of liquefied gases. These conductors can discharge to other objects, causing an electric arc of sufficient energy to initiate an explosion.

Table 1.3.1 Metric Conversion Factors

Name of Unit	Unit	Conversion Factor
Liter	L	1 gal = 3.785 L
Cubic decimeter	dm^3	1 gal = 3.785 dm^3
Pascal	Pa	1 psi = 6894.757 Pa
Bar	bar	1 psi = 0.0689 bar
Bar	bar	1 bar = 10^5 Pa

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1.4.4* Where halon systems are used, a fixed enclosure shall be provided about the hazard that is adequate to enable the specified concentration to be achieved and maintained for the specified period of time.

1.4.5 Halon 1301 shall be used only in enclosures where ambient temperatures are between −70°F and 900°F (−57°C and 482°C). *(See Annex D.)*

1.4.6 Duration of Protection. An effective agent concentration shall be achieved and maintained for a sufficient period of time to allow effective emergency action by trained personnel. This is equally important in all classes of fires since a persistent ignition source (e.g., an arc, heat source, oxyacetylene torch, or "deep-seated" fire) can lead to a recurrence of the initial event once the agent has dissipated. Halon 1301 extinguishing systems normally provide protection for a period of minutes, but are exceptionally effective for certain applications.

1.5 Safety.

1.5.1 Hazards to Personnel. *(See Annex D.)*

1.5.1.1 Unnecessary Exposure. Unnecessary exposure to Halon 1301 and its decomposition products shall be avoided. Exposure to high concentrations or for prolonged periods can produce dizziness, impaired coordination, and disturbances in cardiac rhythm.

1.5.1.2* Safety Requirements. Suitable safeguards shall be provided to ensure prompt evacuation and prevent entry into hazardous atmospheres and also to provide means for prompt rescue of any trapped personnel. Safety items such as personnel training, warning signs, discharge alarms, and self-contained breathing equipment shall be considered.

Δ **1.5.2 Electrical Clearances.** All system components shall be located to maintain no less than minimum clearances from live electrical parts. The following references shall be considered as the minimum electrical clearance requirements for the installation of Halon 1301 systems:

(1) ANSI/IEEE C2
(2) *NFPA 70*
(3) 29 CFR 1910, Subpart S

1.5.2.1 When the design basic insulation level (BIL) is not available and when nominal voltage is used for the design criteria, the highest minimum clearance listed for this group shall be used.

1.5.3* Decommissioning and Removal of Systems. Personnel who are to decommission and remove systems or are to handle system equipment shall be thoroughly trained and competent in safe procedures.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 70®, National Electrical Code®, 2017 edition.

NFPA 72®, National Fire Alarm and Signaling Code®, 2016 edition.

2.3 Other Publications.

Δ **2.3.1 ASME Publications.** American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

ASME B1.20.1, *Standard on Pipe Threads, General Purpose, Inch,* 2013.

ASME B31.1, *Power Piping Code,*2016.

Boiler and Pressure Vessel Code, 2017.

2.3.2 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM A120, *Specification for Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless for Ordinary Uses,* 1984 (withdrawn 1987).

ASTM D5632/D5632M, *Standard Specification for Halon 1301, Bromotrifluoromethane (CF_3 Br),* 2012.

2.3.3 CGA Publications. Compressed Gas Association, 14501 George Carter Way, Suite 103, Chantilly, VA 20151-2923.

CGA C-6, *Standard for Visual Inspection of Steel Compressed Gas Cylinders,*2013.

N **2.3.4 IEEE Publications.** IEEE, 3 Park Avenue, 17th Floor, New York, NY 10016-5997.

ANSI/IEEE C2 , *National Electrical Safety Code,* 2017.

Δ **2.3.5 ULC Publications.** Underwriters Laboratories of Canada, 7 Underwriters Road, Toronto, ON M1R 3A9, Canada.

CAN/ULC S524-14, *Standard for the Installation of Fire Alarm Systems,* 2014.

CAN/ULC S529-16, *Standard for Smoke Detectors for Fire Alarm Systems,* 2016.

2.3.6 U.S. Government Publications. U.S. Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001.

Title 29, Code of Federal Regulations, Part 1910, Subpart S.

Title 49, Code of Federal Regulations.

2.3.7 Other Publications. Coll, John P., "Inerting Characteristics of Halon 1301 and 1211 with Various Combustibles," Fenwal Inc., Report PSR 661, July 16, 1976.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

• **2.4 References for Extracts in Mandatory Sections. (Reserved)**

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

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3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.4 Shall. Indicates a mandatory requirement.

3.2.5 Should. Indicates a recommendation or that which is advised but not required.

N **3.2.6 Standard.** An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Clearance. The air distance between Halon 1301 equipment, including piping and nozzles, and unenclosed or uninsulated live electrical components at other than ground potential.

3.3.2 Filling Density. The number of pounds of Halon 1301 per cubic foot of container volume.

3.3.3* Normally Occupied Area. One that is intended for occupancy.

Chapter 4 Components

4.1 Halon 1301 Supply.

4.1.1 Quantities.

4.1.1.1 The amount of Halon 1301 in the system shall be at least sufficient for the largest single hazard protected or group of hazards that are to be protected simultaneously.

4.1.1.2 Where required, the reserve quantity shall be as many multiples of these minimum amounts as the authority having jurisdiction considers necessary. The time needed to obtain Halon 1301 for replenishment to restore systems to operating conditions shall be considered a major factor in determining the reserve supply needed.

4.1.1.3 Where uninterrupted protection is required, both primary and reserve supply shall be permanently connected to the distribution piping and arranged for easy changeover.

4.1.2* Quality. Halon 1301 shall comply with the requirements of either Table 4.1.2 or ASTM D5632/D5632M.

4.1.3 Storage Container Arrangement.

4.1.3.1 Storage containers and accessories shall be so located and arranged that inspection, testing, recharging, and other maintenance is facilitated and interruption of protection is held to a minimum.

4.1.3.2 Storage containers shall be located as close as possible to the hazard or hazards they protect but shall not be exposed to a fire in a manner likely to impair system performance.

4.1.3.3 Storage containers shall not be located where they are likely to be subject to severe weather conditions or mechanical, chemical, or other damage. Where excessive climatic or mechanical exposures are expected, suitable safeguards or enclosures shall be provided.

4.1.3.4 Storage containers shall be securely mounted per the manufacturer's listed or approved installation manual. This shall include mounting the container to the appropriate mounting surface.

4.1.4 Storage Containers. *(See Annex E.)*

4.1.4.1 The Halon 1301 supply shall be stored in containers designed to hold Halon 1301 in liquefied form at ambient temperatures.

4.1.4.2 Containers shall not be charged to a filling density greater than 70 lb/ft^3 (1121 kg/m^3).

4.1.4.3 Containers shall be superpressurized with dry nitrogen to 360 psi ± 5 percent or 600 psi ± 5 percent gauge pressure at 70°F (2482 kPa ± 5 percent or 4137 kPa ± 5 percent gauge pressure at 21°C).

4.1.4.4 Listed pre-engineered systems shall not be required to comply with 4.1.4.3.

4.1.4.5 Each container shall have a permanent nameplate specifying the agent, tare, and gross weight in addition to the superpressurization level. A label that will require the proper return of the agent shall be affixed to all new and existing

Table 4.1.2 Requirements for Halon 1301 (Bromotrifluoromethane)

Property	Requirement
Bromotrifluoromethane, mole percent, minimum	99.6
Other halocarbons, mole percent, maximum	0.4
Acidity, ppm (by weight), maximum	3.0
Water content, percent by weight, maximum	0.001
Boiling point, °C at 760 mm Hg	–57.75
Boiling range, °C, 5 to 85 percent distilled	0.3
High boiling impurities, grams/100 ml, maximum	0.05
Suspended matter or sediment	None visible

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containers. Filled containers shall be returned for recycling or recovery of the agent when no longer needed.

4.1.4.6* If used as shipping containers, the Halon 1301 containers used in these systems shall be designed to meet the requirements of the U.S. Department of Transportation or the Canadian Transport Commission. If not used as shipping containers, they shall be designed, fabricated, inspected, certified, and stamped in accordance with ASME *Boiler and Pressure Vessel Code*.

4.1.4.7 The design pressure shall be suitable for the maximum pressure developed at 130°F (55°C) or at the maximum controlled temperature limit.

4.1.4.8 A reliable means of indication shall be provided to determine the pressure in refillable containers. The means of indication shall account for variation of container pressure with temperature.

4.1.4.9 When manifolded, containers shall be adequately mounted and suitably supported in a rack that provides for convenient individual servicing or content weighings. Automatic means shall be provided to prevent agent loss from the manifold if the system is operated when any containers are removed for maintenance.

4.1.4.10 In a multiple cylinder system, all cylinders supplying the same manifold outlet for distribution of agent shall be interchangeable and of one select size and charge.

4.1.4.11 Storage temperatures shall not exceed 130°F (55°C) nor be less than −20°F (−29°C) for total flooding systems unless the system is designed for proper operation with storage temperatures outside this range. External heating or cooling shall be used to keep the temperature of the storage container within desired ranges.

4.2 Distribution.

4.2.1* Piping.

4.2.1.1 Piping shall be of noncombustible material having physical and chemical characteristics such that its integrity under stress can be predicted with reliability. Special corrosion-resistant materials or coatings shall be required in severely corrosive atmospheres. The thickness of the pipe wall shall be calculated in accordance with ASME B31.1. The internal pressure for this calculation shall be the maximum storage pressure at the maximum storage temperature [a 70 lb/ft^3 (1121 kg/m^3) density shall be assumed], but in no case shall be less than the following:

(1) For 360 psi (2482 kPa) charging pressure, an internal pressure of 620 psi (4274 kPa) (130°F) (55°C)
(2) For 600 psi (4137 kPa) charging pressure, an internal pressure of 1000 psi (6895 kPa) (130°F) (55°C)

If higher storage temperatures are approved for a given system, the internal pressure shall be adjusted to the maximum internal pressure at maximum temperature. In performing this calculation, all joint factors and threading, grooving, or welding allowances shall be taken into account. *(See Annex F.)*

4.2.1.2 Cast-iron pipe, steel pipe conforming to ASTM A120, or nonmetallic pipe shall not be used.

4.2.1.3 Where used, flexible piping, tubing, or hose (including connections) shall be of approved materials and pressure ratings.

4.2.1.4 Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, utilizing a suitable nonflammable cleaner. The piping network shall be free of particulate matter and oil residue before installation of nozzles or discharge devices.

4.2.1.5* In systems where valve arrangement introduces sections of closed piping, such sections shall be equipped with pressure relief devices or the valves shall be designed to prevent entrapment of liquid. In systems using pressure operated cylinder valves, means shall be provided to vent any container leakage that could build up pressure in the pilot system and cause unwanted opening of the cylinder valve. The means of pressure venting shall be arranged so as not to prevent reliable operation of the cylinder valve.

4.2.1.6 All pressure relief devices shall be of such design and so located that the discharge therefrom will not injure personnel or be otherwise objectionable.

4.2.2 Piping Joints. Piping joints of other than the screwed or flanged type shall be listed or approved for this application.

4.2.3* Fittings. Fittings for 600 psig (4137 kPa) charging pressure systems shall have a minimum working pressure of 1000 psi (6895 kPa). Systems utilizing 360 psig (2482 kPa) charging pressure shall use fittings having a minimum working pressure of 620 psi (4274 kPa).

4.2.3.1 Class 150 lb and cast-iron fittings shall not be used.

4.2.3.2 All threads used in joints and fittings shall conform to ASME B1.20.1. Joint compound, tape, or thread lubricant shall be applied only to the male threads of the joint.

4.2.3.3 Welding, soldering, or brazing alloys shall have a melting point above 1000°F (538°C).

4.2.3.4 Welding shall be performed in accordance with the ASME *Boiler and Pressure Vessel Code*, Section IX, "Welding and Brazing Qualification."

4.2.3.5 Where copper, stainless steel, or other suitable tubing is joined with compression-type fittings, the manufacturer's pressure-temperature ratings for the fitting shall not be exceeded.

4.2.4 Valves.

4.2.4.1 All valves shall be listed or approved for the intended use.

4.2.4.2 Valves shall be protected against mechanical, chemical, or other damage.

4.2.4.3 Special corrosion-resistant materials or coatings shall be used in severely corrosive atmospheres.

4.2.5 Discharge Nozzles.

4.2.5.1 Discharge nozzles shall be listed for use, including the flow characteristics and area of coverage. Discharge orifices shall be of corrosion-resistant metal.

4.2.5.2 Special corrosion-resistant materials or coatings shall be required in severely corrosive atmospheres.

4.2.5.3* Discharge nozzles shall be permanently marked to identify the manufacturer as well as the type and size of the orifice.

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4.2.5.4 Where clogging by external foreign materials is likely, discharge nozzles shall be provided with frangible discs, blow-off caps, or other suitable devices. These devices shall provide an unobstructed opening upon system operation and shall be located so they will not injure personnel.

4.3 Detection, Actuation, Alarm, and Control Systems.

4.3.1 Detection, actuation, alarm, and control systems shall be installed, tested, and maintained in accordance with *NFPA 70* and *NFPA 72*. In Canada refer to CAN/ULC S524-14 and CAN/ULC S529-16.

4.3.1.1 Automatic detection and automatic actuation shall be used, except as permitted in 4.3.1.2.

4.3.1.2 Manual-only actuation shall be permitted if acceptable to the authority having jurisdiction.

4.3.2 Automatic Detection.

4.3.2.1* Automatic detection shall be by any listed or approved method or device capable of detecting and indicating heat, flame, smoke, combustible vapors, or an abnormal condition in the hazard, such as process trouble, that is likely to produce fire.

4.3.2.2 Adequate and reliable primary and 24-hour minimum standby sources of energy shall be used to provide for operation of the detection, signaling, control, and actuation requirements of the system.

4.3.3 Operating Devices.

4.3.3.1 Operating devices shall include Halon 1301 releasing devices or valves, discharge controls, and shutdown equipment necessary for successful performance of the system.

4.3.3.2 Operation shall be by listed or approved mechanical, electrical, or pneumatic means. An adequate and reliable source of energy shall be used.

4.3.3.3 All devices shall be designed for the service they will encounter and shall not be readily rendered inoperative or susceptible to accidental operation. Devices shall be normally designed to function properly from −20°F to 150°F (−29°C to 65°C) or marked to indicate temperature limitations.

4.3.3.4 All devices shall be located, installed, or suitably protected so that they are not subject to mechanical, chemical, or other damage that would render them inoperative.

4.3.3.5 The normal manual control(s) for actuation shall be located for easy accessibility at all times, including time of fire within the protected area. The manual control(s) shall be of distinct appearance and clearly recognizable for the purpose intended. Operation of this control shall cause the complete system to operate in its normal fashion.

4.3.3.6 An emergency release of the system resulting from a single manual operation shall be provided. This shall be accomplished by a mechanical manual release or by an electrical manual release when the control equipment monitors the battery voltage level of the standby battery supply and provides a low battery signal. The emergency release shall cause simultaneous operation of automatically operated valves controlling agent release and distribution.

4.3.3.7* Manual controls shall not require a pull of more than 40 lbf (178 N) nor a movement of more than 14 in. (356 mm) to secure operation. At least one manual control for activation shall be located not more than 5 ft (1.5 m) above the floor.

4.3.3.8 Where gas pressure from the system or pilot containers is used as a means for releasing the remaining containers, the supply and discharge rate shall be designed for releasing all of the remaining containers.

4.3.3.9 All devices for shutting down supplementary equipment shall be considered integral parts of the system and shall function with the system operation.

4.3.3.10 All manual operating devices shall be identified as to the hazard they protect.

4.3.4 Control Equipment.

4.3.4.1 Electric Control Equipment. The control equipment shall supervise the actuating devices and associated wiring and, as required, cause actuation. The control equipment shall be specifically listed or approved for the number and type of actuating devices utilized, and their compatibility shall have been listed or approved.

4.3.4.2 Pneumatic Control Equipment. Where pneumatic control equipment is used, the lines shall be protected against crimping and mechanical damage. Where installations could be exposed to conditions that could lead to loss of integrity of the pneumatic lines, special precautions shall be taken. The control equipment shall be specifically listed or approved for the number and type of actuating devices utilized, and their compatibility shall have been listed or approved.

4.3.5 Operating Alarms and Indicators.

4.3.5.1 Alarms or indicators or both shall be used to indicate the operation of the system, hazards to personnel, or failure of any supervised device. The type (audible, visual, or olfactory), number, and location of the devices shall be such that their purpose is satisfactorily accomplished. The extent and type of alarms or indicator equipment or both shall be approved.

4.3.5.2 Audible and highly visible alarms shall be provided to give positive warning of discharge. The operation of the warning devices shall be continued after halon discharge, until positive action has been taken to acknowledge the alarm and proceed with appropriate action.

4.3.5.3* Where abort switches are provided, they shall be located only within the protected area and shall be of a type that requires constant manual pressure to cause abort. The abort switch shall not be of a type that would allow the system to be left in an aborted mode without someone present. In all cases, the normal manual and emergency manual control shall override the abort function. Operation of the abort function shall result in both audible and distinct visual indication of system impairment. The abort switch shall be clearly recognizable for the purpose intended.

4.3.5.4 Alarms indicating failure of supervised devices or equipment shall give prompt and positive indication of any failure and shall be distinctive from alarms indicating operation or hazardous conditions.

4.3.5.5 Warning and instruction signs at entrances to and inside protected areas shall be provided.

4.3.5.6 Time delays shall be used only where discharge delay is required for personnel evacuation or to prepare the hazard area for discharge. Time delays shall not be used as a means of

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confirming operation of a detection device before automatic actuation occurs.

4.3.6* Unwanted System Operation. Care shall be taken to thoroughly evaluate and correct any factors that could result in unwanted discharges.

Chapter 5 System Design

5.1 Specifications, Plans, and Approvals.

5.1.1 Specifications. Specifications for Halon 1301 fire-extinguishing systems shall be prepared under the supervision of a person fully experienced and qualified in the design of Halon 1301 extinguishing systems and with the advice of the authority having jurisdiction. The specifications shall include all pertinent items necessary for the proper design of the system such as the designation of the authority having jurisdiction, variances from the standard to be permitted by the authority having jurisdiction, and the type and extent of the approval testing to be performed after installation of the system.

5.1.2 Plans and Approvals.

5.1.2.1 Plans and calculations shall be submitted for approval to the authority having jurisdiction before installation begins. Their preparation shall be entrusted only to persons fully experienced and qualified in the design of Halon 1301 extinguishing systems.

5.1.2.2 These plans shall be drawn to an indicated scale or be suitably dimensioned and shall be made so they can be easily reproduced.

5.1.2.3 These plans shall contain sufficient detail to enable an evaluation of the hazard(s) and the effectiveness of the system. The detail of the hazards shall include the materials involved in the hazards, the location of the hazards, the enclosure or limits and isolation of the hazards, and the exposures to the hazards.

5.1.2.4 The detail on the system shall include information and calculations on the amount of Halon 1301; container storage pressure; internal volume of the container; the location, type, and flow rate of each nozzle including equivalent orifice area; the location, size, and equivalent lengths of pipe, fittings, and hose; and the location and size of the storage facility. Details of pipe size reduction method and orientation of tees shall be clearly indicated. Information shall be submitted pertaining to the location and function of the detection devices, operating devices, auxiliary equipment, and electrical circuitry, if used. Apparatus and devices used shall be identified. Any special features shall be adequately explained. The manufacturer's version of the flow calculation program shall be identified on the computer calculation printout. Only the currently listed calculation method shall be used.

5.1.2.5 An as-built instruction and maintenance manual that includes a full sequence of operation and a full set of drawings and calculations shall be maintained in a clearly identified protective enclosure at or near the system control panel.

5.1.3 When field conditions necessitate any material change from approved plans, the change shall be submitted for approval.

5.1.3.1 When such material changes from approved plans are made, corrected as-built plans shall be provided.

5.2 System Flow Calculations. *(See Annex G.)*

5.2.1 As part of the design procedure, system flow calculations shall be performed using a listed calculation method. The system design shall be within the manufacturer's listed limitations.

5.2.2 Nozzle orifice sizes shall be selected to achieve the designed flow rate. The nozzle shall be selected by consulting the discharge characteristic information in the manufacturer's listed design manual. Flow shall be calculated on the basis of an average container pressure during discharge, taking into account the original pressurization level, storage filling density, and percent in piping for 70°F (21°C) storage temperature as shown in Figure H.1(e).

5.2.3 Valves shall be rated for equivalent length in terms of the pipe or tubing sizes with which they will be used. The equivalent length of container valves shall be listed and shall include siphon tube, valve, discharge head, and flexible connector.

5.2.4 The nozzle and fitting orientation shall be in accordance with the manufacturer's listed limitations to ensure proper system performance. *(See Annex H.)*

5.2.5 If the final installation varies from the prepared calculations, new calculations representing the as-built installation shall be prepared.

5.2.6 Halon 1301 total flooding systems shall not be used in concentrations greater than 10 percent in normally occupied areas. Areas that might contain 10 percent Halon 1301 shall be evacuated immediately upon discharge of the agent. Where egress cannot be accomplished within 1 minute, Halon 1301 total flooding systems shall not be used in normally occupied areas in concentrations greater than 7 percent. *(See Annex D.)*

5.2.7 Halon 1301 total flooding systems utilizing concentrations greater than 10 percent but not exceeding 15 percent shall be permitted to be used in areas not normally occupied, provided egress can be accomplished within 30 seconds. Where egress cannot be accomplished within 30 seconds or where concentrations greater than 15 percent must be used, provisions shall be made to prevent inhalation by personnel. *(See Annex D.)*

5.3 Enclosure.

5.3.1 In the design of total flooding systems, the characteristics of the enclosure shall be considered as follows.

5.3.1.1 For all types of fires, the area of unclosable openings shall be kept to a minimum. The authority having jurisdiction can require tests to ensure proper performance as defined by this standard.

5.3.1.2* To prevent loss of agent through openings to adjacent hazards or work areas, openings shall be permanently sealed or equipped with automatic closures. Where reasonable confinement of agent is not practicable, protection shall be extended to include the adjacent connected hazards or work areas.

5.3.1.3 Forced-air ventilating systems including in-room air-conditioning units shall be shut down or closed automatically where their continued operation would adversely affect the performance of the Halon 1301 system or result in propagation of the fire.

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5.4 Design Concentration Requirements.

5.4.1* For a particular fuel, either flame extinguishment or inerting concentrations shall be used.

5.4.1.1 Inerting. The inerting concentrations shall be used where conditions for subsequent reflash or explosion could exist. These conditions are found when both of the following situations occur:

(1) The quantity of fuel permitted in the enclosure is sufficient to develop a concentration equal to or greater than one-half of the lower flammable limit throughout the enclosure.
(2) The volatility of the fuel before the fire is sufficient to reach the lower flammable limit in air (maximum ambient temperature or fuel temperature exceeds the closed cup flash point temperature), or the system response is not rapid enough to detect and extinguish the fire before the volatility of the fuel is increased to a dangerous level as a result of the fire.

CAUTION: Under certain conditions, it could be dangerous to extinguish a burning gas jet. As a first measure, the gas supply should be shut off.

5.4.1.1.1 The minimum design concentrations specified in Table 5.4.1.1.1 shall be used to inert atmospheres involving several flammable liquids and gases. Design inerting concentrations not given in Table 5.4.1.1.1 shall be determined by test plus a 10 percent safety factor. The minimum design concentration shall be 5 percent.

5.4.1.2* Flame Extinguishment. The minimum design concentrations specified in Table 5.4.1.2 shall be used to extinguish normal fires involving several flammable liquids and gases. Design flame extinguishment concentrations not given in Table 5.4.1.2 shall be obtained by test plus a 20 percent safety factor. Minimum design concentrations shall be 5 percent.

5.4.1.3 For combinations of fuels, the flame extinguishment or inerting value for the fuel requiring the greatest concentration shall be used unless tests are made on the actual mixture.

5.4.2 Fires in Solid Materials. Flammable solids shall be classified as those that do not develop deep-seated fires and those that do. *(See Annex I.)*

Table 5.4.1.1.1 Halon 1301 Design Concentrations for Inerting

Fuel	Minimum Conc. % by Volume*
Acetone	7.6
Benzene	5.0
Ethanol	11.1
Ethylene	13.2
Hydrogen	31.4
Methane	7.7
n-Heptane	6.9
Propane	6.7

Note: Includes a safety factor of 10 percent added to experimental values.
*Coll, John P., "Inerting Characteristics of Halon 1301 and 1211 with Various Combustibles," Fenwal Inc., Report PSR 661, July 16, 1976.

Table 5.4.1.2 Halon 1301 Design Concentrations for Flame Extinguishment (in 25°C at 1 atm)

Fuel	Minimum Design Conc. % by Volume
Acetone	5.0
Benzene	5.0
Ethanol	5.0
Ethylene	8.2
Methane	5.0
n-Heptane	5.0
Propane	5.2

5.4.2.1 Solid Surface Fires. To protect materials that do not develop deep-seated fires, a minimum concentration of 5 percent shall be used. *(See Annex J.)*

5.4.2.2 Deep-Seated Fires. Where the solid material is in such a form that a deep-seated fire can be established before a flame extinguishing concentration has been achieved, provisions shall be made to the satisfaction of the authority having jurisdiction for a means to effect complete extinguishment of the fire.

5.5 Determination of Halon 1301 Quantity for Total Flooding Systems.

5.5.1 Total Flooding Quantity. The amount of Halon 1301 required to achieve the design concentration shall be calculated from the following formula:

[5.5.1a]

$$W = \frac{V}{s}\left(\frac{C}{100 - C}\right)$$

where:
W = weight of Halon 1301 required to achieve design concentration (lb)
s = $2.2062 + 0.005046t$
t = minimum anticipated temperature of the protected volume (°F)
V = net volume of hazard ft^3 (enclosed volume minus fixed structures impervious to halon)
C = Halon 1301 concentration, percent by volume

[5.5.1b]

$$W = \frac{V}{s}\left(\frac{C}{100 - C}\right)$$

where:
W = weight of Halon 1301 required to achieve design concentration (kg)
s = $0.14781 + 0.000567t$
t = minimum anticipated temperature of the protected volume (°C)
V = net volume of hazard (m^3) (enclosed volume minus fixed structures impervious to halon)
C = Halon 1301 concentration, percent by volume

5.5.1.1 This calculation in 5.5.1 includes an allowance for normal leakage from a "tight" enclosure due to agent expansion. *(See Annex K.)*

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5.5.2* In addition to the concentration requirements, additional quantities of agent shall be required to compensate for any special conditions that would affect the extinguishing efficiency.

5.6* Altitude Adjustments. The design quantity of Halon 1301 shall be adjusted to compensate for altitudes of more than 3000 ft (1000 m) above or below sea-level and pressures that vary by 10 percent above or below standard sea-level pressure (29.92 in. Hg at 70°F). The Halon 1301 quantity shall be corrected by multiplying the quantity determined in 5.5.1 and 5.5.2 by the ratio of average ambient enclosure pressure to standard sea level pressure.

5.7 Distribution System.

5.7.1* Rate of Application.

5.7.1.1 The minimum design rate of application shall be based on the quantity of agent required for the desired concentration and the time allotted to achieve the desired concentration.

5.7.1.2* Discharge Time. The agent discharge shall be substantially completed in a nominal 10 seconds or as otherwise required by the authority having jurisdiction.

5.7.1.2.1 This period shall be measured as the interval between the first appearance of liquid at the nozzle and the time when the discharge becomes predominantly gaseous.

5.7.2* When an extended discharge is necessary, the rate shall be sufficient to maintain the desired concentration for the duration of application.

5.8 Nozzle Choice and Location.

5.8.1 Nozzles shall be of the type listed for the intended purpose and shall be placed within the protected enclosure in compliance with listed limitations with regard to spacing, floor coverage, and alignment.

5.8.2* The type of nozzles selected, their number, and their placement shall be such that the design concentration will be established in all parts of the hazard enclosure and such that the discharge will not unduly splash flammable liquids or create dust clouds that might extend the fire, create an explosion, or otherwise adversely affect the contents or integrity of the enclosure.

Chapter 6 Inspection, Maintenance, Testing, and Training

6.1* Inspection and Tests.

6.1.1 At least semiannually, all systems shall be thoroughly inspected, tested, and documented for proper operation by trained competent personnel. Tests shall be in accordance with the appropriate NFPA or Canadian standards.

6.1.2 The documented report, with recommendations, shall be filed with the owner.

6.1.3 The documented report shall be permitted to be stored and accessed using paper or electronic media.

6.1.4* The agent quantity and pressure of refillable containers shall be checked. If a container shows a loss in net weight of more than 5 percent or a loss in pressure (adjusted for temperature) of more than 10 percent, it shall be refilled or replaced. When the amount of agent in the container is determined by special measuring devices in lieu of weighing, these devices shall be listed.

6.1.5 All halon removed from refillable containers during service or maintenance procedures shall be collected for recycling.

6.1.6 Factory-charged nonrefillable containers that do not have a means of pressure indication shall be weighed at least semiannually. If a container shows a loss in net weight of more than 5 percent, it shall be replaced. All factory-charged nonrefillable containers removed from useful service shall be returned for recycling of the agent.

6.1.7 The weight and pressure of the container shall be recorded on a tag attached to the container.

6.2 Container Test.

6.2.1 DOT, CTC, or similar design Halon 1301 cylinders shall not be recharged without a retest if more than 5 years have elapsed since the date of the last test and inspection.

6.2.1.1 The retest shall be permitted to consist of a complete visual inspection as described in 49 CFR.

6.2.1.2 In Canada, the corresponding information shall be as set forth by the Canadian Transportation Agency.

6.2.2 Cylinders continuously in service without discharging shall be given a complete external visual inspection every 5 years, in accordance with CGA C-6, Section 5, except that the cylinders need not be emptied or stamped while under pressure.

6.2.3 Where external visual inspection indicates that the container has been damaged, additional strength tests shall be required.

CAUTION: If additional tests used include hydrostatic testing, containers should be thoroughly dried before refilling.

6.2.4 Before recharging a container, a visual inspection of its interior shall be performed.

6.3 Hose Test. All system hoses shall be examined annually for damage. If visual examination shows any deficiency, the hose shall be immediately replaced or tested as specified in 6.3.1.

6.3.1 All hoses shall be tested at 1500 psi (10342 kPa) for 600 psi (4137 kPa) charging pressure systems, and at 900 psi (6205 kPa) for 360 psi (2482 kPa) charging pressure systems. The test shall be performed as follows:

(1) Remove the hose from any attachment.
(2) The hose assembly is then to be placed in a protective enclosure designed to permit visual observation of the test.
(3) The hose must be completely filled with water before testing.
(4) Pressure then is applied at a rate-of-pressure rise to reach the test pressure within a minimum of 1 minute. The test pressure is to be maintained for 1 full minute. Observations are then made to note any distortion or leakage.
(5) If the test pressure has not dropped or if the couplings have not moved, the pressure is released. The hose assembly is then considered to have passed the hydrostatic test if no permanent distortion has taken place.

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(6) Hose assembly passing the test must be completely dried internally. If heat is used for drying, the temperature must not exceed 150°F (66°C).
(7) Hose assemblies failing a hydrostatic test must be destroyed. They shall be replaced with new assemblies.
(8) Each hose assembly passing the hydrostatic test shall be marked to show the date of test.

6.3.2 All hoses shall be tested every 5 years in accordance with 6.3.1.

6.4 Enclosure Inspection. At least every 6 months the halon-protected enclosure shall be thoroughly inspected to determine if penetrations or other changes have occurred that could adversely affect halon leakage.

6.4.1 Where the inspection indicates that conditions exist that could result in inability to maintain the halon concentration, they shall be corrected. If uncertainty still exists, the enclosures shall be retested for integrity.

6.5 Maintenance.

6.5.1 These systems shall be maintained in full operating condition at all times. Use, impairment, and restoration of this protection shall be reported promptly to the authority having jurisdiction.

6.5.2 Any troubles or impairments shall be corrected at once by competent personnel.

6.5.3 Any penetrations made through the halon-protected enclosure shall be sealed immediately. The method of sealing shall restore the original fire resistance rating and tightness of the enclosure.

6.6 Training. All persons who could be expected to inspect, test, maintain, operate, or decommission and remove fire extinguishing systems shall be thoroughly trained and kept thoroughly trained in the functions they are expected to perform.

6.6.1 Personnel working in a halon-protected enclosure shall receive training regarding halon safety issues.

6.7 Approval of Installations. *(See Annex L.)*

6.7.1 The completed system shall be tested by qualified personnel to meet the approval of the authority having jurisdiction. Only listed or approved equipment and devices shall be used in the systems. To determine that the system has been properly installed and will function as specified, the tests in 6.7.2.1, 6.7.2.2, 6.7.2.3, and 6.7.2.4 shall be performed.

6.7.2 Installation Acceptance.

6.7.2.1 Mechanical Acceptance.

6.7.2.1.1 The piping distribution system shall be inspected to determine that it is in compliance with the system drawings and the hydraulic calculations indicated on the computer printout associated with each agent storage container piping and nozzle configuration.

6.7.2.1.2 Nozzles and pipe size shall be in accordance with system drawings. Means of pipe size reduction and attitudes of tees shall be checked for conformance to the design.

6.7.2.1.3 Piping joints, discharge nozzles, and piping supports shall be securely fastened to prevent unacceptable movement during discharge.

6.7.2.1.4 During assembly, the piping distribution system shall be inspected internally to detect the possibility of any oil or particulate matter soiling the hazard area or affecting the agent distribution due to a reduction in the effective nozzle orifice area.

6.7.2.1.5 The discharge nozzle shall be oriented in such a manner that optimum agent dispersal can be effected.

6.7.2.1.6 If nozzle deflectors are installed, they shall be positioned to obtain maximum benefit.

6.7.2.1.7 The discharge nozzles, piping, and mounting brackets shall be installed in such a manner that they will not potentially cause injury to personnel.

6.7.2.1.7.1 The liquid phase of the discharge shall not come in contact with people performing their normal tasks.

6.7.2.1.7.2 Agent shall not directly impinge on any loose objects or shelves, cabinet tops, or similar surfaces where loose objects could be present and become missiles.

6.7.2.1.8 All agent storage containers shall be properly located in accordance with an approved set of system drawings.

6.7.2.1.9 All containers and mounting brackets shall be securely fastened in accordance with the manufacturer's requirements.

6.7.2.1.10 If a discharge test is to be conducted, containers for the agent to be used shall be weighed before and after discharge. Fill weight of container shall be verified by weighing or other approved methods.

6.7.2.1.11 Adequate quantity of agent to produce the desired specified concentration shall be provided. The actual room volumes shall be checked against those indicated on the system drawings to ensure the proper quantity of agent. Fan coast-down and damper closure time shall be taken into consideration.

6.7.2.1.12 The piping shall be pneumatically tested in a closed circuit for a period of 10 minutes at a gauge pressure of 150 psi (1034 kPa).

CAUTION: Pneumatic pressure testing creates a potential risk of injury to personnel in the area, as a result of airborne projectiles, if rupture of the piping system occurs. Prior to conducting the pneumatic pressure test, the protected area shall be evacuated and appropriate safeguards shall be provided for test personnel.

6.7.2.1.12.1 The pressure test shall be permitted to be omitted if the total piping contains no more than one change in direction fitting between the storage container and the discharge nozzle, and where all piping is physically checked for tightness.

6.7.2.1.12.2 When pressurizing the piping, pressure shall be increased in 50 psi (3.5 bar) increments.

6.7.2.1.12.3 At the end of 10 minutes, the pressure drop shall not exceed 20 percent of the test pressure.

6.7.2.1.13 A puff test with nitrogen shall be performed to check for continuous piping.

6.7.2.2* Enclosure Integrity Acceptance. All total flooding systems shall have the enclosure examined and tested to locate and then effectively seal any significant air leaks that could

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Full document details: NFPA 12A 2018

result in a failure of the enclosure to hold the specified Halon 1301 concentration level for the specified holding period.

6.7.2.3 Electrical Acceptance.

6.7.2.3.1 All wiring systems shall be properly installed in compliance with system drawings.

6.7.2.3.2 All field circuitry shall be measured for ground-fault and short-circuit condition. When measuring field circuitry, all electronic components (such as smoke and flame detectors or special electronic equipment for other detectors or their mounting bases) shall be removed and jumpers properly installed to prevent the possibility of damage within these devices. Components shall be replaced after measuring.

6.7.2.3.3 Power shall be supplied to the control unit from a separate dedicated source that will not be shut down on system operation.

6.7.2.3.4 Adequate and reliable primary and 24-hour minimum standby sources of energy shall be used to provide for operation of the detection, signaling, control, and actuation requirements of the system.

6.7.2.3.5 All auxiliary functions such as alarm sounding or displaying devices, remote annunciators, air-handling shutdown, and power shutdown shall be checked for proper operation in accordance with system requirements and design specifications. If possible, all air-handling and power-cutoff controls shall be of the type that, once interrupted, require manual restart to restore power.

6.7.2.3.6 Silencing of alarms (if desirable) shall not affect other auxiliary functions such as air handling or power cutoff if required in the design specification.

6.7.2.3.7 The detection devices shall be checked for proper type and location as specified on the system drawings.

6.7.2.3.8* Detectors shall not be located near obstructions or air ventilation and cooling equipment that would appreciably affect their response characteristics. Where applicable, air changes for the protected area shall be taken into consideration.

6.7.2.3.9 The detectors shall be installed in a professional manner and in accordance with technical data regarding their installation.

6.7.2.3.10 Manual pull stations shall be properly installed, readily accessible, accurately identified, and properly protected to prevent damage.

6.7.2.3.11 All manual stations used to release halon shall require two separate and distinct actions for operation. They shall be properly identified. Particular care shall be taken where manual release devices for more than one system are in close proximity and could be confused or the wrong system actuated. Manual stations in this instance shall be clearly identified as to which zone or suppression area they affect.

6.7.2.3.12 For systems with a main/reserve capability, the main/reserve switch shall be properly installed, readily accessible, and clearly identified.

6.7.2.3.13 For systems using abort switches, the switches shall be of the deadman type requiring constant manual pressure, properly installed, readily accessible within the hazard area, and clearly identified. Switches that remain in the abort position when released shall not be used for this purpose. Manual pull stations shall always override abort switches.

6.7.2.3.14 The control unit shall be properly installed and readily accessible.

6.7.2.4 Functional Testing.

6.7.2.4.1* Preliminary functional tests shall include the following:

(1) If the system is connected to an alarm receiving office, the alarm receiving office shall be notified that the system test is to be conducted and that an emergency response by the fire department or alarm station personnel is not desired. All concerned personnel at the end user's facility shall be notified that a test is to be conducted and instructed as to the sequence of operation.
(2) Each agent storage container release mechanism shall be disabled so that activation of the release circuit will not release agent. The release circuit shall be reconnected with a functional device in lieu of each agent storage container release mechanism. For electrically actuated release mechanisms, these devices shall sometimes include 24-volt lamps, flash bulbs, or circuit breakers. Pneumatically actuated release mechanisms shall sometimes include pressure gauges.
(3) Each initiating device shall be checked for proper response.
(4) All polarized alarm devices and auxiliary relays shall be checked to ensure that polarity has been observed.
(5) All end-of-line resistors shall be checked to ensure that they have been installed across the detection and alarm bell circuits where required.
(6) All supervised circuits shall be checked for proper trouble response.
(7) All supervisory devices shall be checked for proper operation.

6.7.2.4.2 System functional operational test shall include the following:

(1) Operate detection initiating circuit(s). All alarm functions shall occur according to the design specification.
(2) Operate the necessary circuit(s) to initiate halon release.
(3) Operate manual release. Verify that manual release functions occur according to design specifications.
(4) If supplied, operate abort switch circuit. Verify that abort functions occur according to this standard *(see 4.3.5.3)*. Confirm that visual and audible supervisory signals are received at the control panel.
(5) All automatic valves shall be tested unless testing the valve will release halon or damage the valve (destructive testing).
(6) Where required, pneumatic equipment shall be checked for integrity to ensure proper operation.

6.7.2.4.3 Testing of remote monitoring operations, if applicable, shall include the following:

(1) Operate one of each type of input device while on standby power. Verify that an alarm signal is received at remote panel after device is operated. Reconnect primary power supply.
(2) Operate each type of alarm condition on each signal circuit and verify receipt of trouble condition at the remote station.

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Full document details: NFPA 12A 2018

6.7.2.4.4 Testing of the control panel primary power source shall include the following:

(1) Verify that the control panel is connected to a dedicated circuit and labeled properly. This panel shall be readily accessible, yet restricted to unauthorized personnel.
(2) A primary power failure shall be tested in accordance with the manufacturer's specification, with the system fully operated on standby power for the required design period.

6.7.2.4.5 When all functional testing is completed, each agent storage container shall be reconnected so that activation of the release circuit will release the agent. The system shall be returned to its fully operational design condition.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

Δ **A.1.3.2** For additional conversions and information see ASTM SI10.

A.1.4.3 See NFPA 77.

A.1.4.4 From a performance viewpoint, a total flooding system is designed to develop a concentration of Halon 1301 that will extinguish fires in combustible materials located in an enclosed space. It must also maintain an effective concentration until the maximum temperature has been reduced below the reignition point.

The concentration of Halon 1301 required will depend on the type of combustible material involved. This has been determined for many surface-type fires, particularly those involving liquids and gases. For deep-seated fires, the critical concentration required for extinguishment is less definite and has, in general, been established by practical test work.

It is important that an effective agent concentration not only be achieved, but that it be maintained for a sufficient period of time to allow effective emergency action by trained personnel. This is equally important for all classes of fires since a persistent ignition source (e.g., an arc, heat source, oxyacetylene torch, or "deep-seated" fire) can lead to a recurrence of the initial event once the agent has dissipated. Halon 1301 extinguishing systems normally provide protection for a period of minutes but are exceptionally effective for certain applications. Water supplies for standard sprinklers, on the other hand, are normally designed to provide protection for an extended period of time. The designer, buyer, and emergency force in particular need to closely review the advantages and limitations of available systems as applied to the specific situation at hand, the residual risks being assumed, and the proper emergency procedures.

The discharge of minimum extinguishing concentration of Halon 1301 into enclosures containing operating diesel engines not drawing combustion air from outside the space creates a special problem. Experience has shown that the engine will continue to operate, resulting in a decrease in agent concentration and extensive decomposition of the halon.

A.1.5.1.2 The steps and safeguards necessary to prevent injury or death to personnel in areas where atmospheres will be made hazardous by the discharge or thermal decomposition of Halon 1301 can include the following:

(1) Provision of adequate aisleways and routes of exit and keeping them clear at all times.
(2) Provision of emergency lighting and directional signs as necessary to ensure quick, safe evacuation.
(3) Provision of alarms within such areas that will operate immediately upon detection of the fire.
(4) Provision of only outward-swinging, self-closing doors at exits from hazardous areas, and, where such doors are latched, provision of panic hardware.
(5) Provision of continuous alarms at entrances to such areas until the atmosphere has been restored to normal.
(6) Provision of warning and instruction signs at entrances to and inside such areas. These signs should inform persons in or entering the protected area that a Halon 1301 system is installed, and can contain additional instructions pertinent to the conditions of the hazard.
(7) Provision for prompt discovery and rescue of persons rendered unconscious in such areas. This can be accomplished by having such areas searched immediately by trained personnel equipped with proper breathing equipment. Self-contained breathing equipment and personnel trained in its use, and in rescue practices, including artificial respiration, should be readily available.
(8) Provision of instruction and drills for all personnel within or in the vicinity of such areas, including maintenance or construction people who could be brought into the area, to ensure their correct action when Halon 1301 protective equipment operates.
(9) Provision of means for prompt ventilation of such areas. Forced ventilation will often be necessary. Care should be taken to really dissipate hazardous atmospheres and not merely move them to another location. Halon 1301 is heavier than air.
(10) Prohibition against smoking by persons until the atmosphere has been purged of Halon 1301.
(11) Provision of such other steps and safeguards that a careful study of each particular situation indicates are necessary to prevent injury or death.

A.1.5.3 Halon system cylinders contain liquefied compressed gas that, if discharged from a cylinder that is not properly connected to system pipe, can propel the cylinder and other equipment with great force. Before disconnecting cylinders from a system, proper safety precautions should be followed. Cylinder outlets should be fitted with antirecoil devices, listed or approved whenever the cylinder outlet is not connected to the system pipe. Safe handling procedures should be followed to transport system cylinders. Actuators should be disabled or removed before the cylinder is released from its bracketing. Proper equipment should be used to transport cylinders, dollies, or carts, and means to secure the cylinder should be used if cylinders need to be transported within a facility. *(See CGA P-1.)*

Also consult equipment manufacturer representative for specific recommendations.

Further information can be found in the EPA *Safety Guide for Decommissioning Halon Systems*. This guide contains generic information for safe decommissioning of halon systems and manufacturer's specifications for handling specific equipment.

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Full document details: NFPA 12A 2018

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.3 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.3 Normally Occupied Area. Spaces occasionally visited by personnel, such as transformer bays, switch-houses, pump rooms, vaults, engine test stands, cable trays, tunnels, microwave relay stations, flammable liquid storage areas, enclosed energy systems, and so forth, are examples of areas considered not normally occupied.

A.4.1.2 Transfer of full Halon 1301 containers that do not change ownership does not require recycling or quality testing. All other design features should comply with this standard.

A.4.1.4.6 Section VIII, "Rules for Construction of Pressure Vessels," independent inspection, and certification are recommended.

A.4.2.1 Piping should be installed in accordance with good commercial practice. Care should be taken to avoid possible restrictions due to foreign matter, faulty fabrication, or improper installation.

The piping system should be securely supported with due allowance for agent thrust forces and thermal expansion and contraction and should not be subjected to mechanical, chemical, vibration, or other damage. ASME B31.1 should be consulted for guidance on this matter. Where explosions are likely, the piping should be attached to supports that are least likely to be displaced.

Although halon systems are not subjected to continuous pressurization, some provisions should be made to ensure that the type of piping installed can withstand the maximum stress at maximum storage temperatures. Maximum allowable stress levels for this condition should be established at values of 90 percent of the minimum yield strength or 50 percent of the minimum tensile strength, whichever is less. All joint factors should be applied after this value is determined.

A.4.2.1.5 Pressure-operated cylinder valves are opened by the application of "pilot pressure" from the halon cylinder or from a separate pressure source. Depending on the particular valve design, the pilot pressure must be applied either to a special actuation port or to the discharge outlet of the cylinder valve. A leak in source of pilot pressure can build up sufficient pressure in closed sections of pilot actuation pipe to cause the cylinder valve to open. To prevent such accidental discharge, a pressure vent must be installed in any closed section of pipe that is used to supply pressure. The vent must be sized or otherwise designed so that when actuation is required, sufficient pilot pressure can be built up in the pilot pipe or discharge manifold to reliably open all cylinder valves. *[See Table A.4.2.1.5(a) and Table A.4.2.1.5(b).]*

A.4.2.3 Information on specific fittings is provided as follows:

(1) 300 lb class malleable iron fittings, sizes through 3 in., are acceptable. Forged steel fittings should be used for all larger sizes. Flanged joints should be 600 lb class.
(2) 300 lb class malleable iron fittings are acceptable through 3 in. internal pipe size, and 1000 ductile iron or forged steel fittings should be used in larger sizes. Flanged joints should be 300 lb class.
(3) Pressure–temperature ratings have been established for certain types of fittings. A list of ANSI standards covering the different types of fittings is given in Table 126.1 of ASME B31.1. Where fittings not covered by one of these standards are used, the design recommendations of the manufacturer of the fittings should not be exceeded.

The materials listed in (1) and (2) do not preclude the use of other materials that would satisfy the requirements of 4.2.3.

A.4.2.5.3 The type and size of the nozzle can be identified by part number, orifice code, orifice diameter, or other suitable markings. The marking should be readily discernible after installation.

A.4.3.2.1 Detectors installed at the maximum spacing as listed or approved for fire alarm use could result in excessive delay in agent release, especially where more than one detection device is required to be in alarm before automatic actuation results.

A.4.3.3.7 Manual controls should be located at the exit from the enclosure, preferably on the door latch side.

A.4.3.5.3 The abort switch should be located near the means of egress for the area. Abort switches are generally not recommended.

A.4.3.6 Accidental discharge has been recognized as a significant factor in unwanted Halon 1301 emissions.

Equipment lockout or service disconnects can be instrumental in preventing false discharges when the Halon 1301 system is being tested or serviced. In addition, servicing of air-conditioning systems with the release of refrigerant aerosols, soldering, or turning electric plenum heaters on for the first time after a long period of idleness can trip the Halon 1301 system. When used, an equipment service disconnect switch should be of the keyed-access type if external of the control

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Δ **Table A.4.2.1.5(a) Minimum Piping Requirements Halon 1301 Systems — 360 psi Charging Pressure**

Pipe/Tubing Type and Joining Method	Pipe/Tubing Specification	Minimum Wall Thickness
Steel Pipe — Threaded Connections	ASTM A106 Seamless, Grade C	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A106/A53 Seamless, Grade B	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A106/A53 Seamless, Grade A	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A53 ERW Grade B	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A53 ERW Grade A	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A53 Furnace Weld Class F	Schedule 40 — ⅛ in. through 1½ in. NPS
		Schedule 80 — 2 in. through 8 in. NPS
Steel Pipe — Welded or Rolled Groove Connections	ASTM A106 Seamless, Grade C	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A106/A53 Seamless, Grade B	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A106/A53 Seamless, Grade A	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A53 ERW Grade B	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A53 ERW Grade A	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A53 Furnace Weld Class F	Schedule 40 — ⅛ in. through 6 in. NPS
Steel Pipe — Cut Groove Connections	ASTM A106 Seamless, Grade C	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A106/A53 Seamless, Grade B	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A106/A53 Seamless, Grade A	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A53 ERW Grade B	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A53 ERW Grade A	Schedule 40 — ⅛ in. through 5 in. NPS
		Schedule 80 — 6 in. through 8 in. NPS
	ASTM A53 Furnace Weld Class F	Schedule 40 — ⅛ in. through 3 in. NPS
		Schedule 80 — 4 in. through 8 in. NPS
Copper Tubing — Compression Fittings	ASTM B88 Seamless, Drawn	Type K ¼ in. through 8 in.
	ASTM B88 Seamless, Drawn	Type L ¼ in. through 3 in.
	ASTM B88 Seamless, Drawn	Type M ¼ in. through 1½ in.
	ASTM B88 Seamless, Annealed	Type K ¼ in. through 1 in.
	ASTM B88 Seamless, Annealed	Type L ¼ in. through ¾ in.
	ASTM B88 Seamless, Annealed	Type M ¼ in. ONLY

panel or can be of the toggle type if within the locked control panel. Either type should annunciate at the panel when in the out-of-service mode. Written procedures should be established for taking the Halon 1301 system out of service.

A.5.3.1.2 The design of total flooding Halon 1301 systems only beneath the raised floor of electronic data processing (EDP) facilities when the occupied space above the raised floor is not similarly protected by a total flooding Halon 1301 system does not meet the intent of this standard. Such a design does not comply with the definition of a total flooding system or with this chapter.

A.5.4.1 Flammable liquid and gas fires are subject to prompt extinguishment when Halon 1301 is quickly introduced into the enclosure in sufficient quantity to provide an extinguishing concentration for the particular materials involved. NFPA 69 should be referred to when possible flammable concentrations of gases make explosion protection techniques necessary.

Where an explosion potential exists due to the presence of gaseous, volatile, or atomized fuels either before or following a fire, NFPA 68 and NFPA 69, covering vapor detection and explosion venting and suppression, should be consulted. In particular, extreme caution should be taken following inerting of a rich fuel–air mixture since compartment leakage or ventilation will cause the mixture to pass through the explosive range of concentrations when fresh air is admitted.

A.5.4.1.2 The following are flame extinguishment considerations:

(1) *Applicability of Flame Extinguishment Concentrations.* The minimum design concentration required to extinguish normal fires involving certain flammable gases and liquids at atmospheric pressure is applicable if the conditions for reflash or explosion do not exist.

(2) *Temperature Sensitivity.* The flame extinguishing concentration required for some fuels depends on the fuel temperature. All fuels should be tested at least at two temperatures to determine temperature sensitivity.

(3) *Special Fire Consideration.* Where high temperatures or pressures exist or can result from delayed system activation and for configurations other than simple pool or gas jet fires, added tests specific to the intended application should be made.

The basis of Table 5.4.1.2 is covered in this annex material.

A.5.5.2 Halon 1301 discharged into an enclosure for total flooding will result in an air–agent mixture that has a higher specific gravity than the air surrounding the enclosure. Therefore, any opening in the walls of the enclosure will allow the heavier air–agent mixture to flow out of the enclosure, being replaced with lighter outside air flowing into the enclosure through the same opening. The rate at which agent is lost through openings depends on the height and width of the opening, the location of the opening in the wall, and the concentration of agent in the enclosure.

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Δ **Table A.4.2.1.5(b) Minimum Piping Requirements Halon 1301 Systems — 600 psi Charging Pressure**

Pipe/Tubing Type and Joining Method	Pipe/Tubing Specification	Minimum Wall Thickness
Steel Pipe — Threaded Connections	ASTM A106 Seamless, Grade C	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A106/A53 Seamless, Grade B	Schedule 40 — ⅛ in. through 5 in. NPS
		Schedule 80 — 6 in. through 8 in. NPS
	ASTM A106/A53 Seamless, Grade A	Schedule 40 — ⅛ in. through 2½ in. NPS
		Schedule 80 — 3 in. through 8 in. NPS
	ASTM A53 ERW Grade B	Schedule 40 — ½ in. through 3 in. NPS
		Schedule 80 — 4 in. through 8 in. NPS
	ASTM A53 ERW Grade A	Schedule 40 — ⅛ in. through 1¼ in. NPS
		Schedule 80 — 1½ in. through 8 in. NPS
	ASTM A53 Furnace Weld Class F	Schedule 40 — ⅛ in. through ½ in. NPS
		Schedule 80 — ¾ in. through 2½ in. NPS
		Schedule 120 — 3 in. through 8 in. NPS
Steel Pipe — Welded Connections	ASTM A106 Seamless, Grade C	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A106/A53 Seamless, Grade B	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A106/A53 Seamless, Grade A	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A53 ERW Grade B	Schedule 40 — ⅛ in. through 8 in. NPS
	ASTM A53 ERW Grade A	Schedule 40 — ⅛ in. through 6 in. NPS
		Schedule 80 — 8 in. NPS
	ASTM A53 Furnace Weld Class F	Schedule 40 — ⅛ in. through 3 in. NPS
		Schedule 80 — 4 in. through 6 in. NPS
Copper Tubing — Compression Fittings	ASTM B88 Seamless, Drawn	Type K ¼ in. through 1¼ in.
	ASTM B88 Seamless, Drawn	Type L ¼ in. through ¾ in.
	ASTM B88 Seamless, Drawn	Type M ¼ in. through ⅜ in.
	ASTM B88 Seamless, Annealed	Type K ¼ in. through ⅜ in.
	ASTM B88 Seamless, Annealed	Type L DO NOT USE
	ASTM B88 Seamless, Annealed	Type M DO NOT USE

Fresh air entering the enclosure will collect toward the top, forming an interface between the air–agent mixture and fresh air. As leakage proceeds, the interface will move toward the bottom of the opening. The space below the interface will contain essentially the original extinguishing concentration of agent, whereas the upper space will be completely unprotected. The rate at which the interface moves downward increases as concentrations of agent increase, so that simply injecting an overdose of agent initially will not provide an extended period of protection.

A.5.6 At elevations above sea level, Halon 1301 vapor expands to a greater specific volume because of the reduced atmospheric pressure. A system designed for sea-level conditions will therefore develop an actual higher concentration at elevations above sea level. For example, a system designed to produce a 6 percent Halon 1301 concentration at sea level would actually produce an 8.7 percent concentration if installed at 10,000 ft (3000 m) elevation. This concentration would be higher than recommended for normally occupied areas and with egress times longer than 1 minute. *(See 5.2.6 and 5.2.7.)*

To correct for this effect, the quantity indicated at sea-level conditions should be reduced for installations at higher elevations of altitude above sea level. Correction factors are given in Table A.5.6.

For elevations substantially below sea level, the effect is the opposite of that described for elevations above sea level. For those instances, the reciprocal of the appropriate correction factor in Table A.5.6 should be used.

Table A.5.6 Correction Factors for Altitude

Altitude		
ft	m	Correction Factor
3000	914	0.90
4000	1219	0.86
5000	1524	0.83
6000	1829	0.80
7000	2134	0.77
8000	2438	0.74
9000	2743	0.71
10,000	3048	0.69
11,000	3353	0.66
12,000	3658	0.64
13,000	3962	0.61
14,000	4267	0.59
15,000	4572	0.56

A.5.7.1 The minimum rates established are considered adequate for the usual surface or deep-seated fire. However, where the spread of fire could be faster than normal for the type of fire, or where high values or vital machinery or equipment are involved, rates higher than the minimums can, and in many cases should, be used. Where a hazard contains material that will produce both surface and deep-seated fires, the rate of application should be at least the minimum required for surface fires. Having selected a rate suitable to the hazard, the tables and information that follow in the standard should be

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