



Member of the FM Global Group

Examination Standard for Clean Agent Extinguishing Systems

Class Number 5600

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Foreword

This standard is intended to verify that the products and services described will meet stated conditions of performance, safety, and quality useful to the ends of property conservation. The purpose of this standard is to present the criteria for examination of various types of products and services.

Examination in accordance with this standard shall demonstrate compliance and verify that quality control in manufacturing shall ensure a consistent and reliable product

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1. INTRODUCTION

1.1 Purpose

- 1.1.1 This standard states testing and certification requirements for fixed fire extinguishing systems that use vaporizing liquid or inert gas clean agents as the extinguishant.
- 1.1.2 Testing and certification criteria may include performance requirements, marking requirements, examination of manufacturing and filling facilities, audit of quality assurance procedures, and a surveillance program.

1.2 Scope

- 1.2.1 This standard contains requirements for vaporizing liquid and inert gas clean agent extinguishing systems for total flooding protection. Extinguishing systems shall be designed for automatic control to protect single or multiple hazard areas. The following product categories and class numbers are included in the scope of this standard.

Table 1.2.1 - *Product Categories and Class Numbers*

Class	Product Category
5611	Inert Gas Extinguishing Systems
5612	Liquefied Gas Extinguishing Systems
5613	Clean Agents

- 1.2.2 A basic vaporizing liquid or inert gas clean agent extinguishing system comprises one or more agent storage containers, discharge control valves arranged for automatic or manual/automatic control, lockout valves (when required), piping, and discharge nozzles. Compatible certified detectors and detection and release controls are required for automatic electrical operation of these systems but are not included in the scope of this standard. If a system uses an integral detection and actuation system, it may be evaluated as a part of that system, using criteria derived from those used for standalone detection and control systems.
- 1.2.3 With the exception of Class 5613 clean agents, this standard requires the examination of complete systems. Complete systems shall be submitted along with design, installation, operation, and maintenance instructions for certification. However, the manufacturer may, at any time, submit additional components or auxiliary equipment for use on the certified system. Purchased devices such as thermostats, releases, and timers shall also be submitted by the system manufacturer for evaluation as a part of the system, even though such devices may already be certified and listed by the certification agency. Incomplete systems shall not be certified.

1.3 Basis for Requirements

- 1.3.1 The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, trade associations, jurisdictions, and/or loss control specialists was also considered.
- 1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of clean agent fire extinguishing systems (hereinafter referred to as “systems”) for the purpose of obtaining certification. Systems having characteristics not anticipated by this standard may be certified if performance equal or superior to that required by this standard is demonstrated.

1.4 Basis for Certification

Certification is based on satisfactory evaluation of the product and the manufacturer in the following major areas:

- 1.4.1 Examination and tests on production samples shall be performed to evaluate:
- the suitability of the product,
 - the performance of the product as specified by the manufacturer and required for certification,
 - the durability and reliability of the product.

- 1.4.2 An examination of the manufacturing and filling facilities and quality control procedures may be conducted to evaluate the manufacturer's ability to consistently produce the product that is examined and tested, and the marking procedures used to identify the product. Subsequent surveillance may be required by the certification agency in accordance with the certification scheme to ensure ongoing compliance.

1.5 Basis for Continued Certification

The basis for continued certification may include the following based upon the certification scheme and requirements of the certification agency:

- production or availability of the product as currently certified,
- the continued use of acceptable quality assurance procedures,
- satisfactory field experience,
- compliance with the terms stipulated by the certification,
- satisfactory re-examination of production samples for continued conformity to requirements, and
- satisfactory surveillance audits conducted as part of the certification agency's product surveillance program.

1.6 Effective Date

The effective date of this certification standard mandates that all products tested for certification after the effective date shall satisfy the requirements of this standard.

The effective date of this standard is eighteen (18) months after the publication date of the standard for full compliance with all requirements.

1.7 System of Units

Units of measurement used in this standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement; the converted equivalent value may be approximate. Conversion of U.S. customary units is in accordance with ANSI/IEEE/ASTM SI-10. Two units of measurement (liter and bar), outside of but recognized by SI, are commonly used in international fire protection and are used in this standard.

1.8 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the cited edition applies.

ANSI 12.53/1-2011; ISO 3743-1:2010, *Acoustics – Determination of Sound Power Levels of Noise Sources Using Sound Pressure – Engineering Methods for Small, Movable Sources in Reverberant Fields – Part 1: Comparison Method for a Hard-Walled Test Room*

ANSI 12.53/2-1999; ISO 3743-2:1994, *Acoustics – Determination of Sound Power Levels of Noise Sources Using Sound Pressure – Engineering Methods for Small, Movable Sources in Reverberant Fields – Part 2: Methods for Special Reverberation Test Rooms*

ANSI 12.54-2011; ISO 3744:2010, *Acoustics – Determination of Sound Power Levels and Sound Energy Levels of Noise Sources Using Sound Pressure – Engineering Methods for an Essentially Free Field Over a Reflecting Plane*

ANSI/ASA S1.4, *Specification for Sound Level Meters*

ANSI/ASME B40.1, *Gauges – Pressure Indicating Dial Type – Elastic Element*

ANSI/IEEE/ASTM SI 10, *American National Standard for Metric Practice*

ASTM B 117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*

ASTM D 412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers*

ASTM E – 1, *Standard Specification for ASTM Thermometers*

ASTM E1354, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*

ASTM E2058, *Standard Test Methods for Measurement of Material Flammability Using a Fire Propagation Apparatus (FPA)*

ASTM G36, *Standard Practice for Evaluating Stress-Corrosion-Cracking Resistance of Metals and Alloys in a Boiling Magnesium Chloride Solution*
ASTM G 155, *Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials*
BPVC-CC-N, *Boiler and Pressure Vessel Code*
CGA G-10.1, *Commodity Specification for Nitrogen*
CGA S-1.1, *Pressure Relief Standards Part 1 – Cylinders for Compressed Gases*
ISO 12136, *Reaction to fire tests – Measurement of material properties using a fire propagation apparatus*
ISTA 3E, *Similar Packaged-Products in Unitized Loads for Truckload Shipment* NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*
NIST Technical Note 1278, *Preliminary Screening Procedures and Criteria for Replacements for Halons 1211 and 1301*
SAE J517, *Hydraulic Hose*
Title 49, Code of Federal Regulations (CFR), *Hazardous Materials Regulations of the Department of Transportation*

1.9 Definitions

For the purposes of this standard, the following terms shall apply:

Actuation Device

A means of initiating clean agent fire extinguishing system discharge by opening the discharge valve.

Agent Storage Container

The assembly holding the clean agent supply for a fire extinguishing system. This includes the agent vessel and various accessories necessary for management of the supply, such as valves, siphon tubes, pressure gauges, and pressure relief devices.

Agent Storage Cylinder

See “Agent Storage Container”

Amplitude

The maximum displacement of sinusoidal motion from position of rest, or one-half the total table displacement, during a vibration test.

Area of Coverage

The maximum area that can be protected by a single clean agent discharge nozzle or automatic extinguisher unit.

Authority Having Jurisdiction

The organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure.

Automatic Control

An operating device, or arrangement of devices, that does not require human intervention. The automatic control includes a control panel that monitors fire detection devices and releases the agent when pre-established conditions have been met.

Automatic Extinguisher Unit

A clean agent extinguishing storage container that discharges following the operation of a heat responsive element. Automatic extinguisher units may also include optional mechanical manual controls. A single automatic extinguisher unit shall be used to protect each hazard area unless it is possible to configure multiple units such that operation of any single unit will operate all others simultaneously.

Class A Fires

Fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics.

Class B Fires

Fires in ignitable liquids (also known as flammable or combustible liquids), petroleum greases, tars, oils, oil-based paints, solvents, lacquers, alcohols, and flammable gases.

Class C Fires

Fires that involve energized electrical equipment and during which the electric power is maintained, thereby continuously adding electrical energy.

Clean Agent

Volatile or gaseous fire extinguishant that is electrically nonconducting and that does not leave a residue upon evaporation.

Corrosion Resistant

A material that can withstand damage caused by oxidization or other chemical reactions.

Discharge Head

A removable portion of a discharge valve assembly that is required to be installed for system operation.

Discharge Nozzle

A device with one or more orifices that is connected to a termination of a pipe network for the purpose of controlling the discharge rate and uniformly distributing the extinguishing agent within a specific volume.

Discharge Time

The time interval between the first appearance of extinguishing agent at the discharge nozzle or unit and the time at which 95 percent of the agent has been discharged from the nozzle or unit.

Element Operating Temperature

The nominal temperature at which a heat responsive element operates when subjected to the influence of heat.

Engineered System

A clean agent fire extinguishing system designed using hydraulic calculations to predict mass flows and pressures at individual nozzles. These calculations analyze the entire piping system, considering variables such as friction loss in piping, nozzles, and other components.

Expellant Gas

The medium used to facilitate the discharge of the extinguishing agent from the agent storage container.

Flow Rate

The quantity of fluid passing through a pipe, nozzle, or other device in a unit time.

Fully Mechanical Manual Control

A manual control that can function in the absence of electric power or other energy sources other than stored system pressure.

Halocarbon Clean Agent

A gaseous fire extinguishant, electrically nonconducting and volatile, that does not leave a residue after evaporation. The material is delivered by a fire extinguishing system and acts to suppress or extinguish a fire and includes as primary components one or more organic compounds containing the elements fluorine, chlorine, bromine, and iodine. Such an agent is more properly and more generally called a Vaporizing Liquid Clean Agent.

Heat Responsive Element

An operating device that does not require human intervention and includes an operating element that, when subjected to the influence of heat, ruptures, bursts, or otherwise functions, to cause the release of clean agent into the protected space.

Hydraulic Hose

A hose consisting of three parts:

1. An inner tubing that carries the fluid/agent, typically made of rubber, but may also be constructed from thermoplastics or similar materials.
2. A reinforcement layer consisting of one more sheaths, typically made of braided wire, spiral-wound wire, textile yarn or similar materials.

3. An outer encasing layer used to help protect the hose from the environment.

Inert Gas Clean Agent

A gaseous, electrically nonconducting fire extinguishant that does not leave a residue after discharge. The agent is delivered by a fire extinguishing system and acts to suppress or extinguish a fire and includes as primary components one or more elemental gases such as helium, neon, argon, and nitrogen. Blends of inert gases may also contain carbon dioxide as a secondary component.

Lockout Valve

A supervised, lockable, manually operated valve located in the discharge line between the supply and the nozzles, that can be used to isolate the agent supply from all or part of the system during maintenance and service.

Manual Control

An operating device, or arrangement of devices, that requires action by a human operator. The manual control may be initiated either mechanically or electrically.

Master Agent Cylinder

One or more agent storage containers in a clean agent extinguishing system using multiple agent storage containers that are directly actuated by an operating device, then supply pressure to actuate one or more secondary agent cylinders.

Maximum Discharge Time

The longest allowable discharge time at 70°F (21°C) specified by the manufacturer. This time cannot be longer than 10 seconds for vaporizing liquid agents; for inert gas agents this time cannot exceed 120 seconds for the protection of Class A or Class C fire hazards, or 60 seconds for the protection of Class B fire hazards.

Maximum Working Pressure

The pressure in an agent storage container or other pressurized container, as applicable, associated with the maximum installation temperature.

Minimum Bending Radius

The smallest radius specified by the manufacturer to which a flexible hose is safely allowed to bend without damage.

Minimum Design Concentration

The concentration a system is required to deliver to a given installation, the value of which is the minimum extinguishing concentration multiplied by any applicable safety factors.

Minimum Extinguishing Concentration

The lowest concentration of a clean agent at which extinguishment is consistently achieved for a given fuel or hazard class.

Minimum Working Pressure

The pressure in an agent storage container or other pressurized container, as applicable, associated with the minimum installation temperature.

Operable Pressure Range

The minimum and maximum pressures of the agent storage container or other pressurized container, as applicable, over which the system is specified to be functional. These operating pressures result from the minimum and maximum storage temperatures and the physical characteristics of the agent and/or expellant gas, as applicable.

Operating Device

See "Actuation Device"

Pneumatic Control Assembly

A pressurized cylinder, or other assembly, separate from the agent storage containers, in a clean agent extinguishing system that is directly actuated by an operating device and subsequently supplies pressure to actuate either a master agent cylinder or one or more secondary agent cylinders, or pneumatically controlled selector valves.

Pre-Engineered System

A clean agent fire extinguishing system designed using a predetermined range of piping and nozzle characteristics and configurations to determine individual nozzle flow rates.

Proof Test Pressure

The factory test pressure used to verify the structural integrity of the agent storage containers or other pressurized cylinders used in the system.

Resonance

The maximum magnification of applied vibration during a vibration test.

Secondary Agent Cylinder

One or more cylinders in a clean agent fire extinguishing system using multiple agent storage containers that are operated by pressure supplied from a pneumatic control assembly or master agent cylinder, rather than directly by an operating device.

Selector Valve

A supervised valve normally operated automatically, but that also includes an emergency fully mechanical manual control, that can be used to restrict agent discharge to one of multiple zones protected by the same agent supply. Selector valves are controlled by the detection and control system, and are used to direct the discharge of the clean agent only into the space(s) in which the agent is required.

Siphon Tube

A tube inside a vaporizing liquid clean agent storage container that is attached to the inlet of the discharge valve and extends to near the bottom of the container in order to allow the expellant gas to drive all or most of the liquid agent out of the discharge valve without vapor breakthrough.

Specified

The value of a design parameter set by the manufacturer that shall be equal to, or more conservative than, the limiting values of this standard.

Superpressurized

Pressurization of a vaporizing liquid clean agent with expellant gas above the level of the vapor pressure of the agent alone.

Supervised

A type of device, such as a valve, that is equipped with switches, or is otherwise electrically monitored, to allow its state to be displayed or to initiate an alarm via a control panel.

Total Flooding System

An extinguishing system designed to protect an enclosed hazard volume by discharging clean agent throughout the enclosed volume to reach and maintain an extinguishing concentration for the specific fuels for which it has been designed for a sufficient period of time to extinguish fires in those fuels.

Vaporizing Liquid Clean Agent

An electrically nonconducting, compressed liquid fire extinguishant that is vaporized at discharge and does not leave a residue after evaporation. The material is delivered by a fire extinguishing system and acts to suppress or extinguish a fire and includes as primary components one or more organic compounds containing the elements fluorine, chlorine, bromine, and iodine.

Normal Working Pressure

The pressure in a fully charged agent storage container or other pressurized container, as applicable, at 70° F (21° C) or other temperature appropriate for the local jurisdiction.

Zone

A segment of a fire extinguishing system distribution piping supplied through a selector valve that delivers clean agent to one of the spaces protected by the system.

2. GENERAL INFORMATION

2.1 Application Requirements

The manufacturer shall provide the following preliminary information with any request for certification consideration:

- A complete list of all models, types, sizes, and options for the products being submitted for certification consideration
- General assembly drawings, component drawings, materials list, anticipated marking format, nameplate format, brochures, sales literature, specification sheets, and design, installation, operation and maintenance instructions
- The number and location of manufacturing and filling facilities

All documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level. All documents shall be provided with English translation.

2.2 Requirements for Samples for Examination

- 2.2.1 Following authorization of a certification examination, the manufacturer shall submit samples for examination and testing based on the following:

Sample requirements are to be determined by the certification agency

- 2.2.2 Requirements for samples may vary depending on design features, results of prior or similar testing, and results of any foregoing tests.

- 2.2.3 The manufacturer shall submit samples representative of production.

- 2.2.4 It is the manufacturer's responsibility to provide any necessary test fixtures, such as those that may be required to evaluate the system.

3. GENERAL REQUIREMENTS

3.1 Review of Documentation

During the initial investigation and prior to physical testing, the manufacturer's specifications, technical datasheets, and design details shall be reviewed to assess the ease and practicality of installation and use. The system and its components shall be suitable for use within the defined limits of the final certification.

3.2 Physical or Structural Construction Features

3.2.1 Operating Range

All system components shall operate within the temperature ranges of Table 3.2.1. System and component evaluations will be based on the specified minimum and maximum operating temperatures. Operating temperatures outside these limits shall be specified at discrete 10°F or 5°C increments, as applicable.

Table 3.2.1 *Required Operation Temperature Range*

<i>Allowable Minimum Operating Temperature</i> °F (°C)	<i>Allowable Maximum Operating Temperature*</i> °F (°C)
32°F (0°C), or lower	120°F (49°C), or higher

* Automatic extinguisher units only may specify a 100°F (37.8°C) maximum storage temperature.

3.2.2 Materials

3.2.2.1 All components shall be made of materials suitably corrosion resistant for their intended use.

3.2.2.2 Any seals used in the system shall be compatible with the clean extinguishing agent. Compatibility shall be determined by successful performance when subjected to the requirements listed in Sections 4.9.2 (Long Term Leakage Test), 4.9.3 (30-Day Maximum Temperature Leakage Test), and 4.9.4 (30-Day Minimum Temperature Leakage Test).

3.2.3 Controls

3.2.3.1 For normal operation, a system shall be either automatically controlled or operable from a manual control, easily accessible to the hazard, or both. If the normal manual means of actuation incorporates electric power, the source of that power shall be completely independent of any electric power source used for automatic operation. A power source used for both normal manual and automatic operation shall be provided with an independent backup, such as a battery. All systems shall be provided with an alternate means of fully mechanical manual emergency control, regardless of their normal means of operation. Fully mechanical manual emergency controls shall not require an electric power source but may make use of the clean agent extinguishing system's working pressure to operate the release. These emergency controls shall be located at or near the device being controlled.

3.2.3.2 Control panels shall comply with NFPA 72 and Certification Standards FM 3010 and FM 3810. Control panels are not required to be submitted as a part of a system. However, system design shall be such that the system is operable by a minimum of one certified detection and release panel that is compatible for use with the clean agent extinguishing system.

3.2.3.3 Automatic extinguisher units that are not operable by a certified detection and release panel and/or do not have an alternate means of fully mechanical manual emergency control may only be certified for the protection of Class B (ignitable liquids) hazards.

3.2.4 Pressure Vessels

- 3.2.4.1 Storage containers shall conform to the appropriate regulations for the installation location. In the U.S.A. DOT Title 49 CFR, Parts 171 through 180 are applicable for clean agent storage containers that are shipped under pressure.
- 3.2.4.2 In a system utilizing multiple storage containers, all containers supplying the same manifold shall be of the same size and design, allowing for interchangeability of position.
- 3.2.4.3 The following documents shall be submitted for each storage container design, to demonstrate compliance with the relevant design standard:
- Calculation of wall thicknesses per the method specified in the applicable standard, with appropriate supporting references as necessary
 - Certificate of chemical analysis of materials
 - Certificate of physical properties of materials
- 3.2.4.4 The pressurization level(s) and the minimum and maximum filling densities shall be specified by the manufacturer for vaporizing liquid clean agents. The pressurization level(s) and filling volume(s) shall be specified by the manufacturer for inert gas agents.

3.2.5 Valves

- 3.2.5.1 Discharge valves shall incorporate varying sizes or connection designs for all ports to minimize the likelihood of improper connection during installation.
- 3.2.5.2 Selector, check, and other valves not designed for mounting directly on a storage container may use inlet and outlet connections of the same size and design but shall be marked to indicate correct direction of flow.
- 3.2.5.3 For pressure operated valves, the manufacturer shall provide data for the minimum available force or torque for each actuator and the maximum required operating force or torque for the corresponding valve. Proper operation of the most adverse combinations shall be verified by test.
- 3.2.5.4 If applicable, equivalent tube or pipe length of valves shall be measured to allow accurate calculations for system design; the reference pipe size shall be specified to complete an equivalent pipe length measurement.

3.2.6 Gauges and Indicators

- 3.2.6.1 Pressure gauges(s) shall be included with all extinguishing systems to indicate the pressure in each agent storage container or other pressurized container as applicable, and for mechanical gauges, shall comply with the following requirements:
- The face of the gauge shall indicate the appropriate units of pressure for which it is calibrated
 - The range of the gauge shall be based on the system's operable pressure range
 - The minimum indicated gauge pressure shall be marked on the left side of the gauge's range
 - A pressure value shall be marked at the system's working pressure
 - The maximum gauge pressure shall be between 150 and 250 percent of the system working pressure, and shall be marked on the right side of the gauge's range
 - The gauge shall be provided with a means of pressure relief to allow venting in the event of an internal leak
 - The face of the gauge shall identify the clean agent with which it is specified to be used

Pressure gauges are not required for non-superpressurized agent storage containers or containers with the contents stored at vapor pressure.

- 3.2.6.2 For systems arrangements that utilize a pneumatic control assembly or master agent cylinder, those assemblies shall include a supervisory pressure switch, or equivalent device, that detects leakage beyond the acceptable level, as applicable, and is monitored via the supervisory circuit of the control panel.
- 3.2.6.3 When the storage container cannot be easily weighed due to size or installation location, liquid level indicators or an alternative method of determining agent storage container fill level shall be provided for vaporizing liquid agents. When provided, liquid level indicators shall meet the requirements of Section 4.15 (Liquid Level Indicators)
- 3.2.7 Siphon Tubes
- 3.2.7.1 Systems containing a siphon tube to discharge the clean extinguishing agent from the storage container shall be configured so that the discharge end of the siphon tube is mechanically locked and sealed to remain in place during all conditions of use.
- 3.2.7.2 Vaporizing liquid clean agents are stored as liquids and superpressurized to the working pressure. Siphon tubes in these systems shall be designed to prevent gas discharge until the liquid level drops below the opening on the free end of the siphon tube.
- 3.2.7.3 The free end of the siphon tube shall be configured to prevent restriction of flow by contact with the cylinder wall. If the minimum clearance between the end of the siphon tube and the cylinder wall is less than 0.25 times the tube's inside diameter, equivalent length measurements for the system discharge valve shall be performed with the siphon tube in place and installed in the normal design proximity to the cylinder wall. Compliance with this requirement shall be demonstrated by drawings showing the calculated assembly clearance, based on worst case dimensional tolerance stack-ups. Alternatively, the manufacturer's assembly process may contain controlled procedures for verifying the minimum required clearance.
- 3.2.8 Pressure Relief Devices
- 3.2.8.1 Calculations shall be submitted to verify that the pressure relief device used in the agent storage container or other pressurized container is designed to comply with the flow capacity and operating pressure requirements specified in CGA S-1.1, or equivalent local regulations. The construction and size of the pressure relief device shall, at a minimum, be appropriate for the system pressure at the maximum specified operating temperature.
- 3.2.8.2 In pipe sections where valve arrangements introduce the possibility of closed sections of pipe, such sections shall be equipped with pressure relief devices.
- 3.2.9 Anti-Recoil Devices
- The discharge valve outlet of an agent storage container shall be provided with a metallic anti-recoil device for the purpose of shipping, handling, and storage. The device shall be an integral part of or attached to the container via a chain, or otherwise designed to minimize the likelihood of removal from the container.
- 3.2.10 Discharge Heads and Connectors
- 3.2.10.1 If a system discharge head shall be removed from the valve assembly during weighing or recharging operations, the assembly shall contain a check valve.
- 3.2.10.2 When a pneumatic control line connector shall be removed, a plug or cap shall be provided to seal the disconnected end of the loop.
- 3.2.10.3 Appropriate warnings shall be displayed on these devices to caution the user about the high pressure discharge hazard and the proper procedure for mitigating this hazard.

3.2.11 Manifolds and Piping

3.2.11.1 Manifolds of proprietary designs used in place of standard pipe and fittings shall have minimum internal diameters greater than or equal to that of the corresponding pipe sizes.

3.2.11.2 All cylinders in a manifold arrangement shall be of the same size and design.

3.2.12 Cylinder Supports

Equipment that supports multiple cylinder installations shall be designed to facilitate the removal of individual cylinders for inspection and servicing.

3.2.13 Protective Coverings

3.2.13.1 All valves and control devices with exterior movable parts that are vulnerable to obstruction or physical damage in their installed configuration shall be protected. Operating levers, handles, or buttons requiring manual access for operation shall be exempt from this requirement to the extent necessary to allow for their unimpeded operation.

3.2.13.2 Conduit shall be used for electrical cables and wires, or pressurized tubes outside the enclosures.

3.2.13.3 Tubing used for heat detection may be exposed in the areas being monitored but shall be enclosed where not performing this function and vulnerable to mechanical damage.

3.2.13.4 Mechanical cables shall be sheathed or otherwise protected to minimize the likelihood of damage or mechanical interference with operation.

3.2.14 Actuation Devices

3.2.14.1 The device that operates a cylinder discharge valve shall either be an independent actuation device attached to the valve, or an internal component of either the discharge head or the discharge valve assembly.

3.2.14.2 One action shall actuate all the cylinders in a manifold arrangement appropriate to the zone being protected. This shall be accomplished automatically by the connection of the pneumatic control assembly to agent storage containers, or by a mechanical system acting simultaneously on all cylinder valves. In the former arrangement, pressure from a pneumatic control assembly acts through some mechanism in the agent storage container actuation device, valve assembly, or discharge head, typically to unseat the valve disk and open the valve. Such pistons shall have sufficient area such that, when acted upon by the minimum pneumatic control pressure, sufficient force is generated to overcome the force generated by the maximum system pressure acting over the valve disk sealing area. Compliance shall be demonstrated by testing or by the submission of appropriately annotated drawings displaying the area ratio calculation. Mechanical systems shall be configured to provide sufficient force to operate agent storage containers pressurized to the maximum system pressure when actuated by the minimum available force.

3.2.14.3 Actuation devices on pneumatic control assemblies shall be designed for single or simultaneous multiple unit operation. They shall be actuated automatically by a compatible certified detection and control system, or by a fully manual emergency release device. Handles or levers on manual controls shall not require a force to operate exceeding 40 lb (178 N), a travel distance of more than 14 in. (355 mm), or a rotation of more than 270 degrees.

3.2.14.4 Electric actuation devices shall be designed with a provision for remote supervision of proper installation onto the valve or device they control, or operability for actuators integrated into the discharge valve. Supervisory devices shall be compatible with the appropriate certified control equipment.

- 3.2.14.5 Where puncturing mechanisms are used, all parts subject to movement and open to the surrounding environment shall be made of corrosion resistant material.
- 3.2.14.6 Strike knobs shall not require energy to operate exceeding 27.1 Joules.
- 3.2.15 Auxiliary Manual Controls
- 3.2.15.1 Auxiliary manual controls shall be provided for systems using automatic-only actuation devices or mechanical release devices that do not incorporate a fully mechanical manual control. These auxiliary controls shall be used for remote, manual operation or in emergencies due to failure of the automatic control.
- 3.2.15.2 Auxiliary manual controls that are not located within the protective enclosures provided for other components shall be protected against accidental operation by a suitable enclosure or other means.
- 3.2.15.3 Corner pulleys shall be provided for smooth operation of control devices that require cables.
- 3.2.16 Selector and Lockout Valves
- 3.2.16.1 The actuation of one selector valve shall not open other selector valves in the system.
- 3.2.16.2 Lockout valves shall be designed with a provision for remote supervision of valve position.
- 3.2.16.3 Selector valves shall be designed with a provision for remote supervision of electric actuation device installation, or operability for actuators integrated into the valve. Supervisory devices shall be compatible with the appropriate certified control equipment.
- 3.2.17 Nozzles
- 3.2.17.1 Discharge nozzles or assemblies shall be evaluated for the specified use, including flow characteristics and area of coverage.
- 3.2.17.2 Nozzles or outlets shall be made of metallic, corrosion resistant materials that will not deform or otherwise be damaged by fire exposure or discharge pressure.
- 3.2.17.3 Nozzles shall be permanently marked with their part number. When the part number alone does not identify orifice size, the orifice size shall also be permanently marked on the nozzle.
- 3.2.17.4 Nozzles specified for use in acoustically sensitive environments shall have their sound pressure levels evaluated and documented for installations.
- 3.2.18 Nozzle Caps, Frangible Seals, and Material Plugs
- 3.2.18.1 Caps or frangible seals shall be provided on nozzles for installations in which the nozzles are subject to clogging from external materials, including outdoor vent nozzles used to discharge excess agent. Such caps or seals shall have a maximum releasing pressure no greater than half of the system minimum nozzle pressure as installed and shall not obstruct flow from the outlet subsequent to release.
- 3.2.18.2 For nozzles concealed by a plug of material in an installation (e.g., installations for the protection of anechoic chambers), the maximum allowable releasing force for the plug shall be verified at worst-case system conditions and specified for the certified system. This verification shall consider the following factors:
- Minimum nozzle flow rate
 - Minimum nozzle pressure
 - Nozzle orientation
 - Discharge time

- Plug geometry
- Plug mass
- Plug orientation
- Dimensions of recessed enclosure for discharge nozzle

3.2.19 Clean Agents

3.2.19.1 Clean extinguishing agents for use in fire extinguishing systems shall be recognized under the United States Environmental Protection Agency's Significant New Alternatives Program, shall meet the requirements of NFPA 2001 or equivalent local standard, and shall either be certified as a clean agent system component or shall be examined for the system manufacturer to the same extent as an agent submitted for component certification.

3.2.19.2 All agent storage containers shall be filled at a certified filling location that is included in the certification agency's Surveillance Audit Program.

3.2.20 Expellant Gases

Nitrogen used in a clean agent system shall have a dew point of no greater than -60°F (-51.1°C), water content of no more than 4 ppm, and purity greater than or equal to 99.99% (mol/mol).

3.2.21 Auxiliary Equipment

Auxiliary equipment includes those devices required in a system to protect against a specific hazard. The devices listed below may be required for the system to attain certification for specific applications. Other devices not included below may also be required.

3.2.21.1 Pressure Operated Releases

A pressure operated release shall be provided for all doors and windows in a hazard area that is to be sealed off in the event of fire. The release shall operate at a maximum pressure of 50 psi (3.1 bar) from a piston or plunger driven by clean agent from the extinguishing system. The release shall not permit the escape of excessive gas from the system. It shall automatically reset and may have a control for manual operation.

3.2.21.2 Pressure Operated Switches

Pressure operated switches may be used to shut down fans, conveyors, or other electrical equipment in or near the hazard area, as well as to activate alarm and indicator circuits. These switches shall not require a pressure of more than 40 psi (2.8 bar) to operate and shall not release excessive gas from the system. They may also have an alternate manual control and shall be designed for manual resetting only.

3.2.21.3 Time Delays

A delay device may be installed on systems when the evacuation of personnel from the hazard area prior to system discharge is required. This device may allow discharge to be aborted or immediately initiated through a manual override during the delay period. The duration of delay is a function of both the specific clean agent used and the design concentration.

3.2.21.4 Alarms

Alarms and/or indicators shall be provided to show that the system is operating, warn personnel of the forthcoming discharge of clean agent or of its presence in unventilated areas, and signal the failure of any supervised equipment. Indicators that show the system has been used and requires service shall operate following actuation of the system and require manual resetting. When pneumatically operated alarms are powered by a vaporizing liquid clean agent, the discharge of agent from the device shall

be piped outside of the protected area to minimize potentially damaging products of decomposition prior to system operation.

3.2.21.5 Check Valves

Check valves shall be provided in the manifold piping on system installations incorporating multiple storage containers. They shall open at a maximum pressure of 0.1 times the system pressure at maximum storage temperature.

3.2.21.6 Pressure Venting Devices (Pneumatic Control Lines)

Devices shall be provided to prevent the premature operation of discharge or selector valves by residual pressures that may leak into enclosed manifolds, actuation devices, or discharge heads. They shall have closing pressures of 25 to 100 psi (1.7 to 6.9 bar). If these vents are incorporated in actuation devices, they shall be closed when the control is in operation and open when the control is inoperative.

3.2.21.7 Changeover Devices

Changeover devices, such as valve or switch assemblies, shall be provided on automatic systems having both primary and connected reserve agent storage containers. This will direct the command of the automatic fire detection device to the proper series of containers. The changeover device shall be suitably protected and labeled and shall indicate which containers are subject to operation.

3.2.22 Hazardous Location Rating of Components

Components designed for use in hazardous locations shall be certified only if successfully evaluated for compliance to the relevant requirements of one or more of the following Certification Standards:

Table 3.2.22 *Hazardous Location Electrical Equipment Standards*

<i>FM Approvals Standard Number</i>	<i>Examination Standard Title</i>
3600	Electric Equipment for use in Hazardous (Classified) Locations General Requirements
3610	Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, & III, Division 1, and Class I, Zone 0 & 1 Hazardous (Classified) Locations
3611	Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2, Hazardous (Classified) Locations
3615	Explosionproof Electrical Equipment General Requirements
3620	Purged and Pressurized Electrical Equipment for Hazardous (Classified) Locations
3810	Electrical and Electronic Test, Measuring, and Process Control Equipment

3.3 Markings

3.3.1 Nameplates that are easily visible in the installed configuration shall be affixed to the agent storage container assembly of clean agent extinguishing systems and shall display the following markings at a minimum:

- Manufacturer's name and address
- System type and model number
- The certification agency's mark of conformity
- Clean agent identification
- System working pressure
- Allowable ambient storage temperature range

- Factory test pressure of storage container
- Year of manufacture of the storage container (if not directly stamped on the container)
- Reference to NFPA 2001, and/or any other relevant local standards
- Reference to the manufacturer's design, installation, operation, recharge, and maintenance instructions
- Weight of agent charge and/or charge pressure at nominal temperature, as applicable
- Total container weight (actual is required for vaporizing liquids, nominal acceptable for inert gases)

- 3.3.2 Combination instruction and identification plates shall be mounted on or next to all control devices. All significant components or assemblies shall also individually bear an identification mark, such as a part, catalog, or pattern number.
- 3.3.4 All marking plates shall be made of materials that will not corrode or otherwise become illegible due to system liquids or vapors, or normal environmental conditions.
- 3.3.5 When hazard warnings are needed, the markings shall be universally recognizable.
- 3.3.6 The system's model or type identification shall correspond to the manufacturer's catalog designation and shall uniquely identify the certification agency's mark of conformity.
- 3.3.7 The certification agency's mark of conformity shall be displayed visibly and permanently on the product and/or packaging, as appropriate and in accordance with the requirements of the certification agency. The manufacturer shall exercise control of this mark as specified by the certification agency and the certification scheme.
- 3.3.8 All markings shall be legible and durable.

3.4 Manufacturer's Design, Installation, Operation, and Maintenance Instructions

- 3.4.1 The manufacturer shall provide information required to properly design, install, operate, and maintain the system. These instructions shall be submitted to the certification agency prior to the examination of a system.
- 3.4.2 The manufacturer's design instructions for a system submitted for certification shall be evaluated based on NFPA 2001 and any other relevant local standards.
- 3.4.3 Further guidance on the requirements for design, installation, operation, and maintenance instructions can be found in Section 5.6 (Design, Installation, Operation, and Maintenance Manual).

3.5 Calibration

- 3.5.1 Each piece of equipment used to verify the test parameters shall be calibrated within an interval determined based on stability, purpose, and usage. A copy of the calibration certificate for each piece of test equipment is required. The certificate shall indicate that the calibration was performed against working standards whose calibration is certified and traceable to an acceptable reference standard and certified by an ISO/IEC 17025 accredited calibration laboratory. Unless already provided in the individual calibration certificates, additional documentation showing measurement uncertainty values for each instrument being used in the test program (Confidence Level 95%, $k=2$) shall also be provided. A copy of each applicable service provider's accreditation certificate as an ISO/IEC 17025 accredited calibration laboratory shall be provided. The test equipment shall be clearly identified by label or sticker showing the last date of the calibration and the next due date.
- 3.5.2 When the inspection equipment and/or environment is not suitable for labels or stickers, other methods such as etching of control numbers on the measuring device are allowed, provided documentation is maintained on the calibration status of this equipment.

3.6 Tolerances

Tolerances on units of measure shall be as described in Appendix B, unless otherwise specified.

4. PERFORMANCE REQUIREMENTS

4.1 Class A and B Fire Extinguishment Tests

4.1.1 Requirement

4.1.1.1 Class A Fire Extinguishment Tests

Clean agent extinguishing systems shall successfully extinguish each Class A fire within 600 seconds after the end of system discharge. For the purposes of these tests, the end of discharge shall be considered to be at the maximum discharge time. Following a 600 second soak period, there shall be no signs of re-ignition of the materials defined in Sections 4.1.2.1.A and 4.1.2.1.B. For the polymeric material tests, the weight loss of each sample between 10 seconds and 600 seconds after the end of discharge shall not exceed 15 grams. This test is used to confirm the minimum extinguishing concentration (MEC) for a clean agent for Class A combustible materials. Certified systems shall specify a Class A minimum design concentration based on 1.2 times the maximum MEC determined between these tests and those in Section 4.2 (Nozzle Distribution Verification Tests), if applicable, for the specific agent and system configuration.

4.1.1.2 Class B Fire Extinguishment Tests

Clean agent extinguishing systems shall successfully extinguish each Class B fire within 30 seconds after the end of system discharge. For the purposes of these tests, the end of discharge shall be considered to be at the maximum discharge time. This test is used to confirm the minimum extinguishing concentration for a clean agent for Class B ignitable liquids (also known as flammable or combustible liquids).

Certified systems shall specify Class B minimum design concentrations for the specific agent and system configuration based on 1.3 times on the greater of:

- The MEC per the cup burner value for n-heptane per NFPA 2001 or equivalent local standard, or
- The highest MEC determined between these tests and those in Section 4.2 (Nozzle Distribution Verification Tests).

4.1.1.3 For clean agent extinguishing systems that have a maximum protected volume limitation less than 3531 ft³ (100 m³), the minimum extinguishing concentration shall be determined from the tests described in Section 4.2 (Nozzle Distribution Verification Tests), and shall be the same for Class A and Class B hazards.

4.1.2 Tests/Verification

The test enclosure shall be constructed of, or sheathed internally with, plywood with a minimum thickness of 3/8 inch (9.5 mm), or an equivalent material. The internal material shall be such that it does not reflect heat back into the test enclosure. The enclosure shall contain a minimum volume of 3531 ft³ (100 m³), with a minimum ceiling height of 11.5 ft (3.5 m), and each wall shall be a minimum of 13.1 ft (4 m) long. Openings shall be provided for the purpose of venting prior to system discharge. Additionally, a pressure relief opening shall be provided in the enclosure. Provisions for visual observations of the interior of the enclosure shall be provided. Prior to each fire test, the enclosure shall be maintained at 70°F ± 5°F (21°C ± 3°C) throughout the enclosure.

Each test shall include a piping and discharge nozzle configuration resulting in the minimum specified nozzle design pressure at 70°F (21°C). The same calculation methodology used to determine the nozzle pressure for these tests shall also be used, or the appropriate correlation demonstrated, for Section 4.2 (Nozzle Distribution Verification Tests) and Section 4.6 (Verification of Flow Calculation Method Tests).

The agent storage container shall be conditioned to 70°F ± 5°F (21°C ± 3°C) and maintained at this temperature for the duration of each fire test.