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Examination Standard for Dry Chemical Extinguishing Systems

Class Number 5320

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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 which use dry chemical as the primary means of 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 Pre-engineered dry chemical fire extinguishing systems are classified into one of two general categories according to protection type: total flooding or local application. Total flooding systems are designed to uniformly discharge dry chemical throughout the entire protected volume, and are intended to be used for the protection of Class A hazards, Class B hazards, or both. Local application systems are designed to discharge dry chemical directly onto a specific area of protection, and are intended to be used for the protection of Class B hazards only. Either type shall be designed for automatic and manual control to protect single or multiple hazard areas.

1.2.2 A basic dry chemical extinguishing system typically comprises one or more agent storage containers, discharge valves arranged for automatic or manual/automatic control, lock-out 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 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 must 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 dry chemical 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 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 produce the product which was 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 continual 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.
- satisfactory surveillance audits conducted as part of the certification agency's surveillance program.

1.6 Effective Date

The effective date of this examination standard mandates that all products tested for certification after that 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 referenced 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.

ASME BPVC-CC-N, *Boiler and Pressure vessel Code*
ASTM B 117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*
ASTM D 412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension*
ASTM Standard E-1, *Standard Specification for ASTM Thermometers*
ASTM G 36, *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*
CGA G10.1, *Commodity Specification for Nitrogen*
CGA S-1.1, *Pressure Relief Standards Part 1 - Cylinders for Compressed Gases*
NFPA 17, *Standard on Dry Chemical Extinguishing Systems*
Title 49, Code of Federal Regulations (CFR), *Hazardous Materials Regulations of the Department of Transportation*
ANSI/IEEE/ASTM SI 10, *American National Standard for Metric Practice*

1.9 Definitions

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

Accepted
Installations acceptable to the authority having jurisdiction and enforcing the applicable installation rules. Acceptance is not a characteristic of a product; acceptance is installation specific for that one location/occupancy. A product "Accepted" for one installation may not be suitable at another location/occupancy.

Actuation Device
A means of initiating the dry chemical fire extinguishing system discharge.

Agent Storage Container
The assembly holding the dry chemical supply for a fire extinguishing system. This includes the pressure vessel and

various accessories necessary for management of the supply, such as valves, dip 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 dry chemical 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, which 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 total flooding dry chemical 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 volume, unless it is possible to configure multiple units such that operation of any one 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 liquids), combustible liquids, petroleum greases, tars, oils, oil-based paints, solvents, lacquers, alcohols, and flammable gases.

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

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.

Discharge Time
The time interval between the first appearance of extinguishing agent at the discharge nozzle or unit and the time at which the discharge becomes predominantly gaseous.

Dry Chemical

A powder composed of very small particles, typically sodium bicarbonate-, potassium bicarbonate-, or ammonium phosphate-based with added particulate material. These powders are also generally supplemented to provide resistance to packing and moisture absorption and maintain proper flow capabilities.

Element Operating Temperature

The nominal temperature in degrees Fahrenheit (°F) or Celsius (°C) at which a heat responsive element operates when subjected to the influence of heat.

Expellant Gas

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

Flow Rate

The quantity of extinguishing agent passing through a nozzle or other device in a unit time. When a minimum discharge rate is indicated, reference is made to the minimum quantity of agent discharged per unit time, measured within ± 1 second.

Gas Cartridge

The container used to store the expellant gas in a gas cartridge operated extinguishing system.

Gas Cartridge Operated

A type of dry chemical extinguishing system that utilizes expellant gas stored in a separate container from the dry chemical agent storage container.

Heat Responsive Element

An operating device that does not require human intervention. This device includes an operating element that, when subjected to the influence of heat, ruptures, bursts, or otherwise functions, to cause the release of dry chemical agent.

Local Application System

An extinguishing system with a supply of dry chemical permanently connected to fixed piping with nozzles arranged to discharge directly onto a specific hazard area.

Lock-Out Valve

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

Maintenance

Any work performed to ensure that the equipment operates as intended.

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.

Maximum Working Pressure

The pressure in an agent storage container associated with the maximum installation temperature.

Minimum Bending Radius
The smallest radius (expressed in inches [mm]) specified by the manufacturer to which a flexible hose is safely allowed to bend without damage.

Minimum Working Pressure
The pressure in an agent storage container associated with the minimum installation temperature.

Operable Pressure Range
The minimum and maximum pressures of the agent storage container over which the system is intended to be functional. These pressures result from the minimum and maximum storage temperatures and the physical characteristics of the agent and expellant gas.

Operating Device
See "Actuation Device"

Operating Pressure
See "Working Pressure"

Pilot Container
One or more pressurized containers in a dry chemical extinguishing system that are directly actuated by an operating device, and that supply pressure to initiate full system discharge.

Pilot Cylinder
See "Pilot Container"

Pilot Line
Pneumatic piping or tubing used to connect pilot containers with agent containers.

Pipe
Circular conduit used to transport the extinguishing agent from the agent storage container to the discharge nozzles. Wherever *pipe* or *piping* is used in this standard, it is also understood to refer to any tubing, flexible piping, or hose used for the same purpose.

Pre-Engineered System
A fire extinguishing system with predetermined flow rates, nozzle pressures, and quantities of extinguishing agent, using specific piping specifications and number and types of nozzles.

Proof Test Pressure
The factory test pressure used to verify the structural integrity of the agent storage container.

Resonance
The maximum magnification of applied vibration during a vibration test.

Secondary Cylinder
One or more cylinders in a dry chemical fire extinguishing system that are operated by pressure supplied from a pilot cylinder, rather than directly by an operating device.

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.

Stored Pressure

A type of dry chemical extinguishing system that utilizes expellant gas stored in the dry chemical agent storage container.

Supervised

A type of device, such as a valve, which 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 with a supply of dry chemical permanently connected to fixed piping with nozzles designed to uniformly discharge agent throughout the enclosed volume surrounding the hazard.

Working Pressure

The pressure in a fully charged agent storage container or gas cartridge, as applicable, at 70° F (21° C).

2. GENERAL INFORMATION

2.1 Certification 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 or services 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 procedures; and
- The number and location of manufacturing 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 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 which may be required to evaluate the system.

3. GENERAL REQUIREMENTS

3.1 Review of Documentation

3.1.1 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 certification examination results may further define the 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 10ºF (5.6ºC) increments.

Table 3.2.1 *Required Operation Temperature Range*

Allowable Minimum Operating Temperature ºF (ºC)	***Allowable Maximum Operating Temperature ºF (ºC)***
32°F (0°C), or lower	120°F (49°C), or higher

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 dry chemical agent and expellant gas. Compatibility shall be determined by successful performance when subjected to the requirements listed in Sections 4.5.2 (Long Term Leakage Test), 4.5.3 (30-Day Maximum Temperature Leakage Test), 4.5.4 (30-Day Minimum Temperature Leakage Test), and 4.16 (Elastomeric Materials Tests).

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.

3.2.3.3 Control panels shall comply with NFPA 72 and FM 3010. 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 dry chemical extinguishing system.

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 dry chemical storage and expellant gas containers that are shipped under pressure.

3.2.4.2 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

3.2.4.3 The pressurization level shall be specified by the manufacturer.

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. Other types of valves not designed for mounting directly on an agent storage container may use inlet and outlet connections of the same size and design, but shall be marked to indicate correct direction of flow.

3.2.5.2 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.

3.2.6 Gauges and Indicators

A pressure gauge shall be included with all extinguishing systems to indicate the pressure in the agent storage container and/or pilot container, and shall comply with the following requirements:

- The face of the gauge shall indicate the appropriate units of pressure
- 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 70°F (21ºC) 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 at 70°F (21°C), 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 agent with which it is intended to be used

For gas cartridge operated systems where the gas cartridge can be removed and weighed to determine the amount of expellant gas, a pressure gauge is not required.

3.2.7 Siphon Tubes

3.2.7.1 Systems containing a siphon tube to discharge the dry chemical 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 Siphon tubes shall be designed to prevent gas discharge until the dry chemical 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. The minimum clearance between the end of the siphon tube and the cylinder wall shall be at least 0.25 times the tube's inside diameter. 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

Calculations shall be submitted to verify that pressure relief devices used on agent storage containers are designed to comply with the flow capacity and operating pressure requirements specified in CGA S-1.1, or equivalent regulations in the location of intended installation. 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.

3.2.9 Anti-Recoil Devices

The discharge valve outlet of an agent storage container shall be provided with an 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 Pilot Line Connections

When a pilot line must be disconnected from a container during maintenance operations, a plug or cap shall be provided to seal the disconnected end of the line. Appropriate warnings shall be displayed on these devices to caution the user with regard to the high pressure discharge hazard and the proper procedure for mitigating this hazard.

3.2.11 Agent Distribution Connectors and Piping

3.2.11.1 Agent distribution connectors 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 Flexible hose used for distribution of dry chemical agent shall be of one of the following types:

- Corrosion-resistant metallic hose
- Polymeric hose with metallic reinforcement
- Polytetrafluoroethylene hose with metallic or non-metallic reinforcement

Polymeric flexible hose assemblies that are 5 ft (1.52 m) or less in length do not require metallic reinforcement if they are used only for connecting the discharge valve to the agent distribution piping.

3.2.12 Cylinder Supports

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

3.2.13 Protective Covering

All valves and control devices with exterior movable parts that are vulnerable to obstruction or physical damage shall be protected by paneled enclosures or cages. 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. Conduit shall be used for electrical cables and wires, or pressurized tubes outside the enclosures. 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. 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 which opens a cylinder discharge valve or gas cartridge shall either be an independent actuation device attached to the valve, or an internal component of the valve assembly itself.

3.2.14.2 Actuation devices shall be actuated automatically by a compatible certified detection and control system, or by a fully manual emergency release device.

3.2.14.3 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 Where puncturing mechanisms are used, all exposed parts shall be made of nonferrous metal or stainless steel.

3.2.14.5 Electric actuation devices shall be designed with a provision for remote supervision of installation onto the valve or device they control, or operability for actuators integrated into the discharge valve (remote supervision of electric actuation devices required by January 1, 2017).

3.2.15 Auxiliary Manual Controls

Auxiliary manual controls shall be provided for systems using automatic 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. 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. Corner pulleys shall be provided for smooth operation of control devices that require cables.

3.2.16 Nozzles

Discharge nozzles shall be evaluated for the intended use, including flow characteristics and area of coverage. 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. Nozzles shall be permanently marked with their part number or other identifier traceable to the manufacturer's certified manual.

3.2.17 Nozzle Caps or Frangible Seals

Caps or frangible seals shall be provided on nozzles for installations in which the nozzles are subject to clogging from external materials. Such caps or seals shall release under the most adverse system conditions, and shall not obstruct flow from the outlet subsequent to release.

3.2.18 Dry Chemical Agents

All dry chemical agents used shall comply with the fire extinguishment tests as specified in Sections 4.1 and 4.2, as appropriate to the product category.

3.2.19 Expellant Gases

Nitrogen used in a dry chemical system shall have a dew point of no greater than -60°F (-51.1°C), and shall have a purity greater than or equal to 99.99 % (mol/mol).

3.2.20 Auxiliary Equipment

Auxiliary equipment includes those devices required in a system to protect against a specific hazard. The need for these devices shall be determined by the certification agency according to the nature of the 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.

3.2.20.1 Pressure Operated Release

A pressure operated release shall be provided on all doors and windows in a hazard area which is to be sealed off in the event of fire. The release shall operate at a maximum pressure of 50 psi (3.5 bar) from a pilot line or expellant gas 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.

3.2.20.2 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 operate at a maximum pressure of 50 psi (3.5 bar) from a pilot line or expellant gas from the extinguishing system. The release shall not permit the escape of excessive gas from the system. They may also have an alternate manual control, and shall be designed for manual resetting only.

3.2.20.3 Alarms and Indicators

Alarms and/or indicators shall be provided to show that the system is operating, warn personnel of the forthcoming discharge of dry chemical, 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

3.2.20.4 Venting Valves

Devices shall be provided to prevent the premature operation of discharge valves by residual pressures that may leak into actuation devices. They shall have closing pressures of 25 to 100 psi (1.7 to 6.9 bar). These vents shall be closed when the control is in operation and open when the control is inoperative.

3.2.20.5 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 container. The changeover device shall be suitably protected and labeled and shall indicate which container is subject to operation.

3.2.20.6 Pressure Regulator

Where a pressure regulator is used to fix the flow of expellant gas at a constant pressure, it shall be factory preset and pinned, or otherwise mechanically locked, in order to reduce the risk of tampering or unauthorized adjustment.

3.2.21 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 standards:

Table 3.2.21 *Hazardous Location Electrical Equipment Standards*

FM Approvals Class Number	***Examination Standard Title***
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 Easily visible nameplates shall be affixed to the agent storage container assembly of dry chemical 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
- 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 17, *Standard for Dry Chemical Extinguishing Systems*, and/or any other relevant local standards
- Reference to the manufacturer’s design, installation, operation, recharge, and maintenance instructions
- Agent storage container empty weight (if not directly stamped on the container), weight of agent, and total container weight
- Gas cartridges shall include easily visible markings identifying the manufacturer’s name, gas type, container empty weight, weight of gas, and total weight

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 which will not corrode or otherwise become illegible due to system liquids or vapors, or normal environmental conditions.

3.3.5 Hazard warnings, when supplied by the manufacturer, should conform to local requirements for the location of the intended system installation, and if possible, be universally recognizable.

3.3.6 The system's model or type identification shall correspond with 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 17, and any other relevant local standards.

3.5 Calibration

3.5.1 Each piece of equipment used to verify the test parameters shall be calibrated within an interval determined on the basis of 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. The test equipment shall be clearly identified by label or sticker showing the last date of the calibration and the next due date. A copy of the service provider's accreditation certificate as an ISO/IEC 17025 accredited calibration laboratory should be available.

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 thus equipment.

3.6 Tolerances

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

4. PERFORMANCE REQUIREMENTS

4.1 Total Flooding Fire Tests

4.1.1 Requirements

Total flooding dry chemical extinguishing systems shall successfully flood the test enclosure and extinguish all fires in each Class A and Class B hazard fire scenario at the most adverse systems conditions, as applicable to the intended protection. Additionally, automatic extinguisher units shall successfully flood the test enclosure and extinguish the applicable Class B hazard fire scenario within one minute of test fuel ignition when operated by the automatic means provided.

4.1.2 Tests/Verification

The test enclosure(s) shall be constructed of plywood with a minimum thickness of 3/8 inch (9.5 mm), or an equivalent material. Providing protection for areas of the plywood exposed to the test fires for Class A and Class B fire tests shall be allowed. All areas of the enclosure plywood shall be unprotected for automatic extinguisher unit tests.

A test enclosure or enclosures, as necessary, shall be constructed with the following parameters:

- The maximum area and volume limitation as specified by the manufacturer
- The maximum height and volume limitation for the nozzles as specified by the manufacturer
- For a total flooding system designed for enclosures having uncloseable openings not exceeding 5 percent of the total surface area of the enclosure, the enclosure(s) shall include openings totaling the maximum percentage of uncloseable opening specified by the manufacturer
- For a total flooding system designed for enclosures having uncloseable openings in excess of 5 percent of the total surface area of the enclosure, the enclosure(s) shall include a single opening having the maximum height and width specified by the manufacturer

The test configurations shall be designed to evaluate the most adverse specified configurations of the extinguishing system with respect to the following:

- Area of coverage of each nozzle
- Maximum volume of protected enclosure
- Maximum height of protected enclosure
- Minimum system operating temperature
- Location of nozzles or automatic unit in the enclosure
- Caps or frangible seals on nozzles
- Maximum piping and discharge nozzle limitations, including the most conservative piping configuration, length of pipe, number of fittings, and discharge nozzles configuration

- Minimum flow rate for the nozzles
- Percentage of uncloseable openings
- Most adverse combinations of interdependent parameters, such as maximum height and maximum discharge time or maximum area and minimum discharge time. The necessity of evaluating such combinations shall be subject to the judgment of the certification agency in consultation with the manufacturer and, if necessary, verified by exploratory testing

4.1.2.1 Class A Fire Extinguishment Tests

The Class A fire extinguishment tests shall include two wood cribs. The cribs shall be constructed of eight layers of four 1-1/2 x 1-1/2 x 12 in long (38 x 38 x 305 mm long) wood members. The wood shall be kiln dried spruce or fur lumber having a moisture content not exceeding 5 percent. Within each layer, the wood members shall be evenly spaced to form an 12 in. x 12 in. (305 mm x 305 mm) square. The members of successive layers shall be positioned at right angles to those of the adjacent layer. The outside edge of the outer members of each layer shall be placed flush with the ends of the members of each adjacent layer. The wood members shall be stapled or nailed together at the outside edges of the crib.

The cribs shall be placed on the floor supported by four 2 in (50.8 mm) tall bricks, with one placed under each corner of the crib. The cribs shall be placed in the most adverse locations in the enclosure(s) with respect to agent distribution. Exploratory discharge testing may be required to determine which areas receive the least amount of extinguishing agent by visual inspection. If agent distribution is uniform, one wood crib shall be placed directly under extinguishing nozzle and the other shall be placed in the furthest corner from the extinguishing nozzle. Each crib shall have 0.25 lb (113.5 g) of shredded newspaper centered between the bricks under the crib. Eight ounces (236 ml) of denatured ethyl alcohol shall be poured evenly over each crib and newspaper, and then ignited. After ignition, the cribs shall be allowed to burn freely for two minutes, then the system should be discharged. Observations shall be made for extinguishment of all test fires.

The Class A fire tests shall be performed as many times as necessary to evaluate all system parameters identified in Section 4.1.2.

4.1.2.2 Class B Fire Extinguishment Tests

Steel test cans, having a maximum nominal thickness of 0.216 in., 3.0 to 4.0 in. (76 to 101.6 mm) in diameter, and at least 4 in. (102 mm) tall, shall be placed in the following locations:

- One point within 2 in. (50 mm) of each wall at each corner of the enclosure, located vertically within 12 in. (300 mm) of the top or bottom of the enclosure (eight total)
- For enclosure heights less than 3 ft (1 m), only one level of sampling points is required (four

total).

These cans shall be filled with a minimum of 2 in (50.8 mm) of heptane meeting the requirements in Table 4.1.2.2 to a level a minimum of 2 in below the top of the can. Provisions must be made to monitor each can for extinguishment. The heptane shall be ignited and allowed to burn freely for 30 seconds with the enclosure door and/or vents open. The vents shall be closed, and the system discharged. Observations shall be made for extinguishment of all test fires.

Table 4.1.2.2 *Required Heptane Characteristics*

Characteristic	***Required Value***
Minimum Initial Boiling Point	190°F (88°C)
Maximum Dry Point	212°F (100°C)
Specific Gravity at 60°F (15.6°C)	0.67 – 0.73

For protection of enclosures having uncloseable openings not exceeding 5 percent, an additional test is to be conducted with a steel pan with an area of at least 2.5 ft^2 (0.23 m^2), inside side dimensions of at least 19 in (482.6 mm), and an inside depth of at least 8.0 in (203 mm). The pan shall be constructed from steel at least 1/4 in. (6.4 mm) thick, with the joints welded and liquid tight. A 1.5 in. (38 mm) by 1.5 in. (38 mm) by 3/16 in. (5 mm) thick reinforcing angle, forming a 1.75 in. (44 mm) wide turned out edge that is flush with the top edge of the pan, shall be provided along the perimeter of the pan. The reinforcing angle shall be continuously welded to the outside of the pan at the top edge, and tack welded at the edge of the lower leg of the angle. The pan shall be filled with at least 2 in (50.8 mm) of heptane meeting the requirements specified in Table 4.1.2.2, and the surface of the heptane layer is to be located 6 ± 0.25 in (152 ± 6 mm) below the top of the pan. The pan shall be located in the most adverse location in the enclosure with respect to agent distribution. Exploratory discharge testing may be required to determine which areas receive the least amount of extinguishing agent by visual inspection. If agent distribution is uniform, the pan shall be placed in the furthest corner from the extinguishing nozzle. The heptane shall be ignited and allowed to burn freely for 30 seconds, and the system shall then be discharged. Observations shall be made for extinguishment of the test fire. Automatic extinguisher units shall not be subjected to this test.

For protection of enclosures having uncloseable openings in excess of 5 percent, an additional test is to be conducted with a steel pan with an area of at least 5.0 ft^2 (0.46 m^2), inside side dimensions of at least 26.8 in (680.7 mm), and an inside depth of at least 8.0 in (203 mm). The pan shall be constructed per the same requirements as the 2.5 ft^2 pan described above. The pan shall be located in the most adverse location in the enclosure with respect to agent distribution. Exploratory discharge testing may be required to determine which areas receive the least amount of extinguishing agent by visual inspection. If agent distribution is uniform, the pan shall be placed in the furthest corner from the extinguishing nozzle. An additional pan measuring 12 in (304.8 mm) wide and having a length equal to that of the widest specified uncloseable opening, constructed per the same requirements as the 2.5ft^2

pan described above, shall be installed in the enclosure at the entrance of the uncloseable opening. The pans shall be filled with at least 2 in (50.8 mm) of heptane meeting the requirements specified in Table 4.1.2.2, and the surface of the heptane layer is to be located 6 ± 0.25 in (152 ± 6 mm) below the top of the pans. The heptane in both pans shall be ignited and allowed to burn freely for 30 seconds, and the system shall then be discharged. Observations shall be made for extinguishment of both test fires. Automatic extinguisher units shall not be subjected to this test. When requested by the manufacturer for safety considerations, the 12 in (304.8 mm) wide pan fire scenario and 5.0 ft^2 (0.46 m^2) fire scenario may be conducted as separate tests.

For automatic extinguisher units, the test with the 2.5 ft^2 pan described above shall be performed with the pan located within 2 in (50.8 mm) of the corner of the enclosure farthest from the extinguisher unit. Two 1 ft^2 (0.09 m^2) openings shall be included in the enclosure. One opening shall be located next to the heptane pan, with the top of the opening located within 2 ft (0.6 m) of the floor. The other opening shall be located on the opposite wall, directly across from the first opening, with the top of the opening within 2 in (50.8 mm) of the ceiling. The heptane shall be ignited and allowed to burn freely. The extinguisher unit shall be allowed to operate automatically using the means provided under the most adverse conditions specified by the manufacturer. Observations shall be made for extinguishment of the test fire.

The Class B fire tests shall be performed as many times as necessary to evaluate all system parameters identified in Section 4.1.2.

4.2 Local Application Fire Tests

4.2.1 Requirements

Local application dry chemical extinguishing systems shall successfully extinguish the fires in the specified Class B hazard scenarios at the most adverse system conditions, and the extinguishment process shall not result in visible splashing of fuel outside of the test pan that could create a risk of spreading the fire.

4.2.2 Tests/Verification

The test configurations shall be designed to evaluate the most adverse specified configurations of the extinguishing system with respect to the following:

- Area of coverage of each nozzle, including discharge perpendicular and/or parallel to the hazard
- Location of nozzles with respect to the protected area, including minimum and maximum height above and/or distance from the hazard
- Caps or frangible seals on nozzles
- Minimum system operating temperature
- Maximum piping and discharge nozzle limitations, including the most conservative piping configuration, length of pipe, number of fittings, and discharge nozzle configuration

- Minimum flow rate for the nozzle
- Maximum system operating temperature
- Minimum piping and discharge nozzle limitations, including the least conservative piping configuration, length of pipe, number of fittings, and discharge nozzle configuration
- Maximum flow rate for the nozzle
- For systems intended for outdoor use, an air flow with a minimum velocity of 10 miles per hour (16 km per hour) crossing the test pan in the most adverse direction

A test pan having an inside area of at least the maximum coverage area for the nozzle being tested and an inside depth of at least 8.0 in (203 mm) is to be constructed. The pan shall be constructed from steel at least 1/4 in. (6.4 mm) thick, with the joints welded and liquid tight. A 1.5 in. (38 mm) by 1.5 in. (38 mm) by 3/16 in. (5 mm) thick reinforcing angle, forming a 1.75 in. (44 mm) wide turned out edge that is flush with the top edge of the pan, shall be provided along the perimeter of the pan. The reinforcing angle shall be continuously welded to the outside of the pan at the top edge, and tack welded at the edge of the lower leg of the angle. The pan shall be filled with at least 2 in (50.8 mm) of heptane meeting the requirements specified in Table 4.1.2.2, and the surface of the heptane layer is to be located 6 ± 0.25 in (152 ± 6 mm) below the top of the pan.

The first test scenario shall be conducted with the extinguishing system using the maximum specified piping and discharge nozzle limitations, including the most conservative piping configuration, length of pipe, number of fittings, and discharge nozzle configuration, and minimum system operating temperature, resulting in the minimum flow rate for the nozzle. The heptane shall be ignited and allowed to burn freely for 30 seconds, and the system shall then be discharged. Observations shall be made for extinguishment of the test fire.

The second test scenario shall be conducted with the extinguishing system using the minimum specified piping and discharge nozzle limitations, including the least conservative piping configuration, length of pipe, number of fittings, and discharge nozzle configuration, and maximum system operating temperature, resulting in the maximum flow rate for the nozzle. The heptane shall be ignited and allowed to burn freely for 30 seconds, and the system shall then be discharged. Observations shall be made for extinguishment of the test fire, and there shall be no visible splashing of fuel outside the test pan.

The local application fire tests shall be performed as many times as necessary to evaluate all system parameters identified above.

4.3 Flow Distribution Tests

4.3.1 Requirement

The measured flow rate and amount of agent discharged out of each nozzle under the most adverse combination(s) of system conditions specified in the manufacturer's installation instructions shall not be less than those used in the fire tests performed in accordance with Section 4.1 (Total Flooding Fire Tests) or 4.2 (Local Application Fire Tests), as applicable. Additionally, the flow rate out of each nozzle under the most adverse combination(s) of

system conditions specified in the manufacturer's installation instructions shall not be greater than that used in the splash test in accordance with Section 4.2 (Local Application Fire Tests), as applicable.

4.3.2 Test/Verification

The pre-engineered system shall be assembled to include a piping configuration and discharge nozzles representative of the maximum specified limitations, resulting in the minimum possible flow rate. Multiple tests may need to be run to address all system limits. For local application systems, the system shall also be assembled to include a piping configuration and discharge nozzles representative of the minimum specified limitations, resulting in the maximum possible flow rate. Multiple tests may need to be run to address all system limits.

For each test, the agent storage container shall be filled with the extinguishing agent to its rated capacity and the appropriate container shall be pressurized to its working pressure. It shall be conditioned to 70°F ± 5°F (21°C ± 3°C), and maintained at this temperature until the system is discharged. The system shall be actuated, and the agent discharged from each nozzle and discharge time shall be measured. The agent discharged from each nozzle shall then be weighed to determine compliance.

4.4 Cycle Operation Test

4.4.1 Requirement

All components required for system operation having moving parts shall operate through a total of 500 cycles at the working pressure without damage. Following the test, all components shall continue to operate normally.

4.4.2 Tests/Verification

The test samples shall include all components required for operation, including valves and other parts undergoing mechanical movement during system operation; electrical, pneumatic, and mechanical operating devices; switches; relays; and indicators. Valves shall be subjected to the working pressure and cycled from the fully closed to fully open position 500 times. At minimum, the largest and smallest valve sizes of each design shall be tested. Pressure actuated valves having the lowest ratio of available actuator torque to required operation torque shall also be tested. If applicable, manual actuators shall include the maximum length of cable, number of pulleys, etc.

Subsequent to the cycle operation test, each component shall be visually inspected for damage. All components included in the test shall show no sign of physical deterioration that would affect performance, and shall continue to operate normally. Discharge valves shall be actuated by all available discharge devices. The pressure required for pneumatic operating devices shall be recorded, and manual controls shall be subjected to Section 4.10.3 (Manually Operated Controls).

Any system components that are replaced after each operation, such as rupture discs or pyrotechnic actuators, shall be evaluated by operation of a minimum of 30 samples. All shall operate within the manufacturer's specified parameters.

4.5 Agent Storage Containers

4.5.1 Construction Design

4.5.1.1 Requirements

Agent storage containers shall be fabricated, tested, certified, equipped, and provided with labeling in accordance with recognized international standards, such as the current specifications of ASME BPVC-CC-N, or the requirements of U.S. Department of Transportation, Title 49, Code of Federal Regulations, Parts 171 to 180, or equivalent national codes for the country of use. The design working pressure shall be in accordance with the pressure at the manufacturer's maximum specified installation temperature.

4.5.1.2 Tests/Verification

All documentation concerning the fabrication and testing of the cylinders shall be provided to the certification agency for initial evaluation of the following:

- Verification that the pressure vessel standard is appropriate for the system storage pressure, and appropriate to the jurisdiction in which the equipment will be used.
- Verification that the design is in accordance with the standard. Typical verification includes a review of certification to manufacture to the standard, minimum wall thickness calculations, authorized materials, material tests, and general chemical analysis tests.

4.5.2 Long Term Leakage Test

4.5.2.1 Requirement

Stored pressure agent storage container assemblies and gas cartridge assemblies for dry chemical systems shall not leak in excess of a rate that would result in the pressure dropping below the minimum operating pressure over a six year period, when monitored over a one year period at 70°F ± 5°F (21°C ± 3°C).

4.5.2.2 Tests/Verification

A minimum of three stored-pressure agent storage container and valve assemblies of each leak path design and size shall be filled to the highest rated capacity with the applicable dry chemical, and pressurized to the working pressure. For gas cartridge systems, a minimum of three gas cartridge container assemblies shall be pressurized to the working pressure. Test sample assemblies shall incorporate all components subjected to the working pressure, including operating devices.

Each sample shall have the pressure checked or be weighed, as appropriate, at 0, 1, 3, 6, and 12 months, and where applicable, the projected weight or pressure loss over a one year period shall be extrapolated. The test shall be suspended if the calculated leakage at any time exceeds the allowable quantity. Subsequent to the one year test period, one sample of each valve design and size shall be successfully discharged using one of the manufacturer's compatible operating devices. The duration of this test for minor modifications to previously certified configurations, such as a new seal or any change to a leak path, shall be reduced to 6 months.

4.5.3 30-Day Maximum Temperature Leakage Test

4.5.3.1 Requirements

Stored-pressure agent storage container assemblies for dry chemical agents, conditioned at the maximum operating temperature for 30 days, shall discharge not less than 85 percent (by weight) of the dry chemical extinguishing agent. There shall be no visible signs of leakage from the container, including any pressurized actuation devices, during or after the conditioning period.

4.5.3.2 Tests/Verification

A minimum of three stored-pressure agent storage container and valve assembly of each leak path design and size shall be filled to its highest rated capacity with applicable dry chemical, and pressurized to the working pressure.

The samples shall be weighed prior to the elevated temperature exposure, and shall be subjected to the maximum specified operating temperature for 30 days. Immediately following the exposure period, the samples shall be discharged using one of the manufacturer's compatible operating devices, then re-weighed to determine compliance.

4.5.4 30-Day Minimum Temperature Leakage Test

4.5.4.1 Requirements

Stored-pressure agent storage container assemblies for dry chemical agents, conditioned at the minimum operating temperature for 30 days, shall discharge not less than 85 percent (by weight) of the dry chemical extinguishing agent. There shall be no visible signs of leakage from the container, including any pressurized actuation devices, during or after the conditioning period.

4.5.4.2 Tests/Verification

A minimum of three stored-pressure agent storage container and valve assembly of each leak path design and size shall be filled to its highest rated capacity with applicable dry chemical, and pressurized to the working pressure.

The samples shall be weighed prior to the low temperature exposure, and shall be subjected to the minimum specified operating temperature for 30 days. Immediately following the exposure period, the samples shall be discharged using one of the manufacturer's compatible operating devices, then re-weighed to determine compliance.

4.5.5 Hydrostatic Integrity

4.5.5.1 Requirement

Agent storage containers and gas cartridges shall be hydrostatically tested without failure at a pressure equal to 1.5 times the rated pressure of the pressure relief device, or in accordance with the applicable standard to which it is designed, whichever pressure is greater. No cracking, fracture, or failure to retain the test pressure shall be allowed.

4.5.5.2 Tests/Verification

Each sample shall be subjected to the required test pressure, using water as the pressurizing medium. For the final 20 percent of the required pressure, the rate of pressure increase shall be no more than 10 percent per minute. The required test pressure shall be maintained for a minimum of one minute, or in accordance with the applicable published standard, whichever is longer.

Two samples of each container size intended for use with the system shall be tested. Container designs consisting of the same diameter, wall thickness, and material of construction, but with differing heights, may be evaluated by testing selected representative samples rather than samples of all container heights.

Samples that deviate from the calculated minimum wall thickness (refer to Section 4.1.1.2) may be accommodated by increasing the test pressure in proportion to the wall thickness. This may be used for up to a maximum difference of 20 percent.

Physical testing may be waived for pressure vessels being manufactured under continuous surveillance to a recognized pressure vessel regulation. In these circumstances, in lieu of physical testing, the manufacturer shall provide documentation detailing continuous oversight of the pressure vessel manufacturing, sample test results appropriate to the regulation, and certification documentation for the overseeing body.

4.5.6 Permanent Volumetric Expansion

4.5.6.1 Requirement

Permanent volumetric expansion testing is required under some pressure vessel standards. If required by the standard to which the agent storage container or gas cartridge is designed, such tests shall be conducted in accordance with that standard.

When subjected to the proof test pressure, the permanent volumetric expansion of a storage container shall not exceed 10 percent of the total expansion. The proof test pressure shall be as specified in the ASME BPVC-CC-N, or the U.S. Department of Transportation, Title 49, Code of Federal Regulations, Parts 171 to 180, or the equivalent national codes for the country of use. In cases where the pressure vessel is not tested or marked in accordance with one of these specifications, the proof test pressure shall be equal to three times the extinguishing system's working pressure.

4.5.6.2 Tests/Verification

Each sample shall be subjected to the required test pressure, using water as the pressurizing medium. For the final 20 percent of the required pressure, the rate of pressure increase shall be no more than 10 percent per minute. The required test pressure shall be maintained for a minimum of one minute, or in accordance with the applicable published standard, whichever is longer. The total expansion of the cylinder shall be measured. The applied pressure shall then be removed from the sample, and the permanent volumetric expansion shall be measured.

Two samples of each container size intended for use with the system shall be tested. Cylinder designs consisting of the same diameter, wall thickness, and material of construction, but with differing heights, may be evaluated by testing selected representative samples rather than samples of all cylinder heights.

Physical testing may be waived for pressure vessels being manufactured under continuous surveillance to a recognized pressure vessel regulation. In these circumstances, in lieu of physical testing, the manufacturer shall provide documentation detailing continuous oversight of the pressure vessel manufacturing, sample test results appropriate to the regulation, and certification documentation for the overseeing body.

4.6 Hydrostatic Pressure Test

4.6.1 Requirement

All components subjected to system pressure, either during storage or system discharge, shall withstand the pressure described in Section 4.5.5 (Hydrostatic Integrity) for one minute. No cracking, fracture, or failure to retain the test pressure shall be permitted.

4.6.2 Tests/Verification

Each sample shall be subjected to the required test pressure. For the final 20 percent of the required pressure, the rate of pressure increase shall be no more than 10 percent per minute. The required test pressure shall be maintained for a minimum of one minute, or in accordance with the applicable published standard, whichever is longer.

Leakage is acceptable during the hydrostatic tests, as long as the pressure source is adequate to maintain the required test pressure.

4.7 Pressure Relief Devices

4.7.1 Pressure Relief Operation

4.7.1.1 Requirement

The pressure relief device pressure ratings of agent storage container and gas cartridge assemblies shall be selected as specified in Section 3.2.8. The operating pressure of the device shall be within -10/+0 percent of the manufacturer's specified rating.

4.7.1.2 Test/Verification

A minimum of ten pressure relief device assemblies shall be pressurized until operation. If the device does not contain a rupturing component, but rather operates similarly to a pressure relief valve, the same device shall be subjected to all ten trials. Pressure may be increased rapidly to 85 percent of the device's rated pressure, then shall be increased until operation at a rate no greater than 10 percent per minute. The operating pressure shall be recorded.

4.7.2 Pressure Relief Calculations

4.7.2.1 Requirement

Documentation shall be submitted to verify that the construction and size of agent storage container and gas cartridge pressure relief device complies with the flow capacity requirements.

The construction and size of the burst disc and dispersion device shall, at a minimum, be appropriate for the system pressure at the maximum specified operating temperature.

4.7.2.2 Tests/Verification

Appropriate documentation and calculations shall be submitted to verify that the construction and size of the pressure relief device complies with the flow capacity requirements specified in CGA S-1.1, or equivalent.

4.8 Mounting Device Test

4.8.1 Requirement

An extinguishing system mounting bracket shall not show evidence of permanent distortion or other damage when subjected to a static load equal to five times the weight of the extinguishing system at its highest rated capacity.

4.8.2 Test/Verification

An extinguishing system mounting bracket shall be assembled in its intended orientation. A static load equal to five times the weight of the system at its highest rated capacity, but not less than 100 pounds (45.3 kg), shall be applied vertically downward to the bracket. The load shall be maintained for 5 minutes. The mounting bracket shall be observed for damage throughout the 5 minute period.

The mounting device test shall not apply to mounting brackets for containers that are intended to be directly supported by the floor.

4.9 Flexible Hose

4.9.1 Low Temperature Resistance

4.9.1.1 Requirement

Flexible hoses shall withstand damage when conditioned at the minimum specified extinguishing system storage temperature. Following the conditioning period, the flexible hose shall withstand the minimum specified bending radius, as well as the hydrostatic pressure described in Section 4.6 (Hydrostatic Pressure Test) for a period of one minute. No cracking, fracture, or failure to retain the test pressure shall be permitted.

4.9.1.2 Tests/Verification

One sample of each representative size flexible hose shall be tested. Each hose assembly shall be conditioned for 16 hours at the minimum specified storage temperature. The sample shall be maintained at the minimum temperature and bent to the minimum specified bending radius. Bending shall be performed smoothly and continuously within an approximate 10 second time interval.

The flexible hose shall be visually inspected for cracking or other damage. Subsequent to this inspection, hose shall be subjected to the required test pressure for a period of one minute, or in accordance with the applicable standard, whichever is longer. No rupture or separation from end connections shall occur.

4.9.2 Resilience

4.9.2.1 Requirement

Flexible hoses shall withstand damage and remain functional after 3000 cycles of flexure to the maximum specified angle from straight. Following the cycle test, flexible hose shall withstand the hydrostatic pressure described in Section 4.11 (Hydrostatic Pressure Test) for one minute. No cracking, fracture, or failure to retain the test pressure shall be permitted.

4.9.2.2 Test/Verification

Each hose assembly shall be conditioned for 16 hours at 70°F ± 5°F (21°C ± 3°C). The sample shall be maintained at this temperature and bent to the minimum specified bending radius or to the maximum specified angle. Bending shall be performed smoothly and continuously. The sample shall then be straightened to complete one cycle. The bending and straightening cycle shall be repeated for a total of 3000 cycles.

The flexible hose shall be visually inspected for cracking or other damage. Subsequent to this inspection, hose shall be subjected to the required test pressure for a period of one minute, or in accordance with the applicable standard, whichever is longer. No rupture or separation from end connections shall occur.

4.9.3 Fire Exposure Resistance

4.9.3.1 Requirement

Flexible hoses intended for use in the protected space shall withstand damage and remain functional after exposure to the fire conditions described in Section 4.9.3.2. Following the fire exposure test, flexible hose shall withstand the hydrostatic pressure described in Section 4.6 (Hydrostatic Pressure Test) for one minute. No cracking, fracture, or failure to retain the test pressure shall be permitted.

4.9.3.2 Test/Verification

A pan with an area of at least 2.5 ft^2 (0.23 m^2), inside side dimensions of at least19 in (482.6 mm), and an inside depth of at least 4 in (102 mm) shall be constructed from steel at least 1/4 in. (6.4 mm) thick, with the joints welded and liquid tight. A 1.5 in. (38 mm) by 1.5 in. (38 mm) by 3/16 in. (5 mm) thick reinforcing angle, forming a 1.75 in. (44 mm) wide turned-out edge that is flush with the top edge of the pan, shall be provided along the perimeter of the pan. The reinforcing angle shall be continuously welded to the outside of the pan at the top edge, and tack welded at the edge of the lower leg of the angle. The pan shall be filled with at least 1 in (25.4 mm) of heptane meeting the requirements specified in Table 4.1.2.2.

The flexible hose sample is to be installed in a “U” configuration at its minimum specified bending radius such that the bottommost section of the hose is centered 36 ± 0.5 in above the bottom of the pan. The heptane shall be ignited and burn freely for 120 seconds.

Two flexible hose samples are to be subjected to this exposure. Subsequent to the fire exposure, one hose sample shall withstand the pressure described in Section 4.6 (Hydrostatic Pressure Test) for one minute. No cracking, fracture, or failure to retain the test pressure shall be permitted. The second sample shall be subjected to at least one representative flow distribution test in accordance with Section 4.3.

4.10 Control and Actuator Operation

4.10.1 General

4.10.1.1 Requirement

All control devices shall operate under the most adverse system pressure when conditioned to the maximum and minimum specified installation temperatures.

4.10.1.2 Tests/Verification

A minimum of one sample of each device shall be conditioned to the minimum specified installation temperature for 16 hours. While still at that temperature, the device shall be installed on the valve for which it is designed and operated and display no hesitation, partial operation, or other failure. Devices operated by pressure shall be tested at maximum or minimum working pressure, whichever is more conservative for the design of the specific component. If the most adverse condition is not easily discernable, the device shall be operated at both extremes of pressure.

A minimum of one sample of each device shall be conditioned at the maximum specified installation temperature for 16 hours, and the evaluations described above shall be repeated.

4.10.2 Electrically Operated Devices

4.10.2.1 Requirement

Electrically operated control devices shall operate properly at 85 and 110 percent of the rated voltage while at maximum and minimum specified installation temperatures.

4.10.2.1 Tests/Verification

A minimum of one sample of each device shall be conditioned in accordance with the parameters described in Section 4.10.1.2. Following the conditioning period, each sample shall operate when supplied with 85 percent of rated voltage, and again when supplied with 110 percent of rated voltage. The device shall display no hesitation, partial operation, or other failure.

4.10.3 Manually Operated Controls

4.10.3.1 Requirement

Manual controls shall operate properly with applied forces no greater than 40 lb (178 N), linear movement no more than 14 in. (355 mm), nor rotational movement of over 270 degrees when configured with the most adverse arrangement specified by the manufacturer’s installation instructions.

4.10.3.2 Tests/Verification

A minimum of one sample of each device shall be tested. Calibrated force gauges, torque meters, and measuring tapes shall be used to measure operational requirements. Tests shall be conducted under the most adverse conditions with respect to system working pressure, if applicable. Devices using flexible mechanical cable actuation shall be tested with the most adverse cable routing, including the maximum cable length and number of changes of direction. No impairment of operation shall be allowed.

4.10.4 Pilot Operated Controls

4.10.4.1 Requirement

Pneumatically operated pilot-secondary cylinder arrangements of the most adverse specified configuration shall operate all connected cylinders within one second.

4.10.4.2 Tests/Verification

The pilot container shall be pressurized to its working pressure and conditioned to the minimum specified storage temperature for 16 hours. Secondary cylinders shall be pressurized to their working pressures and conditioned to the maximum specified storage temperature for 16 hours. The maximum number of secondary cylinders shall be connected to the pilot cylinder through the most restrictive piping arrangement permitted by the manufacturer's installation instructions. The pilot cylinder shall be actuated, and the time interval between operation of the pilot cylinder and the last secondary cylinder shall be measured. A data acquisition system, capable of recording pressure readings for the pilot and most remote secondary cylinder at a minimum of 10 Hz, shall be used to record the timing. The last secondary cylinder shall operate within 1 second of the first significant pressure decrease in the pilot cylinder.

4.11 Dielectric Withstand

4.11.1 Requirement

Electrical components shall withstand an applied voltage between all terminals provided for external connections and ground, as well as between all combinations of individual connections. There shall be no breakdown of the insulation between the test points. Components shall continue to function normally subsequent to this test.

4.11.2 Tests/Verification

For a device with a rated voltage not exceeding 90 V, the test voltage shall be equal to 500 V. For all other devices, the test voltage shall be calculated as 1000 V plus two time the rated voltage of the circuit. The required voltage shall be applied between each terminal and ground, and between all individual terminals. The voltage shall be increased steadily to the specified value in a period of not less than 10 seconds and maintained for a minimum of 60 seconds.

4.12 Corrosion – Salt Spray

4.12.1 Requirement

System components shall withstand a 240-hour exposure to the test described in Section 4.18.2 without incurring damage that would impair function. Following the exposure period, the system shall be successfully discharged using one of the manufacturer's compatible operating devices.

4.12.2 Tests/Verification

Test samples shall be selected to represent all material combinations and configurations. A minimum of one agent storage container assembly, including the mounting bracket, shall be included among the test samples. Actuation devices with moving parts subject to fouling from external corrosion shall also be subject to this test. Test sample agent storage containers shall be pressurized to the working pressure, but need not contain the actual agent. Discharge nozzles manufactured from a corrosion resistant material are not subject to salt fog testing, provided that material specifications are submitted for review.

The samples shall be exposed to salt spray (fog) as specified by ASTM B117. The salt solution shall consist of 20 percent (by weight) of common salt (sodium chloride) dissolved in deionized water with a pH between 6.5 and 7.2 and a specific gravity between 1.126 and 1.157.
Following the exposure to the salt fog, the sample shall remain fully functional and exhibit no corrosion, galvanic action, loss of legibility of markings, or separation of protective coatings which would impair future functionality. Superficial discoloration with no substantial attack of the underlying material shall be acceptable. The fully charged agent storage container and valve assembly shall be successfully discharged using one of the manufacturer's compatible operating devices.

4.13 Corrosion – Stress Cracking

4.13.1 Requirement

Extinguishing system components shall be resistant to stress corrosion cracking resulting from exposure to the processes described in Section 4.13.2. Following the exposure period, the samples shall not show evidence of cracking, delamination, or degradation.

4.13.2 Test/Verification

4.13.2.1 Copper Based Parts (Ammonia Test)

Devices manufactured of copper alloys with a zinc content exceeding 15 percent shall be exposed to a moist ammonia environment. The inlet end of each sample shall be filled with deionized water and sealed with a non-reactive material (e.g., plastic cap) so as to prevent the introduction of the ammonia atmosphere to the interior of the component. The samples to be tested shall be free from any non-permanent protective coating and, if necessary, shall be degreased. If a permanent coating is an inherent part of the design, such coating shall be subjected to the test. The samples shall be tested in

their intended orientation. Samples shall be assembled using the manufacturer's specified torque on threaded connections and flange bolts to replicate the as-installed loads.

There shall be provisions in the test chamber to prevent droplets of condensation from falling from the top of the enclosure directly onto the samples. Such a shield or other means shall be constructed of glass or other non-reactive materials.

The samples shall be exposed to the moist ammonia-air mixture maintained in a glass chamber with a volume of 0.73 ± 0.34 ft^3 (0.02 ± 0.01 m^3).

Aqueous ammonia having a density of $5.86x10^{-5}$ lb/ft^3 (0.94 g/cm^3) shall be maintained in the bottom of the chamber, approximately 1.5 in. (40 mm) below the bottom of the samples. The volume of ammonia to be used shall be determined by multiplying the enclosure volume in ft^3 (L) by 0.075 gal/ft^3 (10 L/m^3). This will result in approximately the following atmospheric concentrations: 35 percent ammonia, 5 percent water vapor, and 60 percent air. Prior to beginning the exposure, the chamber shall be conditioned to a temperature of 93°F ± 4°F (34°C ± 2°C) for a period of not less than one hour, and shall be maintained at this temperature throughout the exposure period. The moist ammonia-air mixture shall be maintained at essentially atmospheric pressure. Provision shall be made for venting the chamber, such as by the use of a capillary tube, to avoid buildup of pressure.

Following exposure to the moist ammonia environment for a period of 10 days, the samples shall be removed, rinsed in potable water, and air dried. Following a minimum two-day drying period, visual examination of the samples shall be made.

4.13.2.2 Austenitic, Ferritic, and Duplex Stainless Steel Parts (Boiling Magnesium Chloride Test)

Samples shall be degreased and exposed to a boiling magnesium chloride solution for a period of 500 hours, in accordance with ASTM G36.

Samples are to be placed in a flask fitted with a wet condenser. The flask shall be approximately half filled with a nominal 42 percent by weight magnesium chloride solution, placed on a thermostatically-controlled electrically-heated mantle, and maintained at a boiling temperature of 302 °F ± 4 °F (150 °C ± 2 °C).

Following exposure, the samples shall be removed and rinsed in potable water. Following a two-to four-day drying period, visual examination of the samples shall be made.

4.13.2.3 Parts Manufactured from Other Materials

Parts manufactured from other materials shall withstand comparable tests, based on the type of material employed.

4.14 High Temperature Exposure

4.14.1 Requirement

Components, such as nozzles, that are exposed to the protected space shall not show significant deformation, blistering, or fracture following exposure to an elevated temperature as detailed in Section 4.14.2. In the case of a nozzle, no cracking or distortion that would potentially alter discharge characteristics shall be allowed.

4.14.2 Test/Verification

The component shall be placed in an oven and heated to 1470 ± 20 ºF (800 ± 11ºC) for a period of 15 minutes. Following this exposure, the nozzle shall be removed and promptly submerged in a water bath with a temperature of 60 ± 10 ºF (15 ± 6ºC).

4.15 Aging Tests – Plastic Materials

4.15.1 Air-Oven Aging Test

4.15.1.1 Requirements

Nonmetallic components, including valves, valve parts, siphon tubes and other parts subjected to the flow of dry chemical, and mounting brackets, shall be subjected to air-oven aging tests at 212°F (100°C). There shall be no cracking or crazing as a result of this test. Subsequent to exposure, valves and valve parts shall then be subjected to the requirements of Section 4.6 (Hydrostatic Pressure Test), agent storage containers shall be subjected to the requirements of Section 4.5.5 (Hydrostatic Integrity), and mounting brackets shall be subjected to the requirements of Section 4.8 (Mounting Device Test).

4.15.1.2 Test/Verification

Samples shall be subjected to air-oven aging tests for 180 days at 212°F (100°C), and then allowed to cool a minimum of 24 hours in air at 74°F (23°C) at 50 percent relative humidity. At the conclusion of the test, the samples shall be inspected for cracking or crazing. The samples shall then be subjected to the applicable tests listed in Section 4.15.1.1.

4.15.2 Ultraviolet Light and Water Test

4.15.2.1 Requirements

Nonmetallic components, including valves, exposed valve parts, and mounting brackets, shall be exposed to ultraviolet light and water for 720 hours in accordance with Table X3.1, Condition 1, of ASTM G 155. At the conclusion of the test, there shall be no cracking or crazing of the component. Valves and valve parts shall then be subjected to the requirements of Section 4.6 (Hydrostatic Pressure Test). Mounting brackets shall be subjected to the requirements of Section 4.8 (Mounting Device Test).

4.15.2.2 Test/Verification

Samples shall be exposed to ultraviolet light and water for 720 hours. The samples shall be inspected for cracking and crazing after 360 hours. If no cracking or crazing is apparent, the exposure shall continue for the full 720 hours. During each operating cycle, each sample shall be exposed to light and water spray for 18 minutes and to only light for 102 minutes (total 120 minutes). The air temperature within the apparatus during operations shall be 109 ± 4.5ºF (43 ± 2.5ºC) and the relative humidity 30 ± 5 percent. At the conclusion of the test, the samples shall be inspected for cracking or crazing. The samples shall then be subjected to the applicable tests listed in Section 4.15.2.1.

4.15.3 Exposure to Extinguishing Agent Test

4.15.3.1 Requirements

Plastic siphon tubes or other plastic components exposed to the dry chemical extinguishing agent shall not show degradation following exposure to the agent at elevated temperature.

4.15.3.2 Test/Verification

Three 1/2 in. (12.7 mm) wide ring samples shall be cut from a plastic siphon tube and immersed in a container filled with the dry chemical extinguishing agent. Samples of other non-cylindrical components shall be cut to expose their cross-sections and be of approximately 1/2 in. (12.7 mm) in length, perpendicular to the cut, if longer than that dimension in their initial configuration. The container shall be sealed and conditioned to the maximum specified operating temperature for a period of 210 days. The samples shall be subsequently rinsed in water and allowed to dry for 24 hours in air at 70°F ± 5°F (21°C ± 3°C) and 50 percent relative humidity. At the conclusion of the test, the samples shall be inspected for any signs of degradation.

4.16 This Section Intentionally Left Blank

4.17 Pressure Gauges and Supervisory Pressure Switches

4.17.1 Accuracy

4.17.1.1 Requirement

Agent supply container pressure gauges shall exhibit accuracy within the limits of Table 4.17.1.1.

Table 4.17.1.1 *Pressure Gauge Limits*

Area of Range	***Accuracy Required, percent***
Zero Point	-0/+12
Low Pressure Alarm Point	± 6
Working Pressure	± 4
Full Scale	± 15

Supervisory pressure switches shall activate within ±6 percent of the low-pressure alarm point under falling pressure. Samples must be tested after being conditioned at the minimum specified operating temperature, at 70°F ± 10°F (21°C ± 5.5°C), and at the maximum specified operating temperature for a period of four hours.

4.17.1.2 Test/Verification

Readings of a minimum of three sample agent storage container gauges and switches of each type at each of the points specified shall be compared to readings of a calibrated test gauge having a minimum accuracy of ±1 percent. A test gauge having a minimum accuracy of ± 0.25 percent shall be used to evaluate an inert gas system maintenance gauge at each of its major scale divisions. Readings shall be taken in both ascending and descending order. All sample gauge readings and pressure switch activation points shall match those of the test gauge within the tolerances specified in Section 4.17.1.1.

4.17.2 Impulse Resistance

4.17.2.1 Requirement

Pressure gauge and supervisory pressure switch accuracy shall remain within the limits of Table 4.17.1.1 after 1000 cycles of pressure impulse from zero to 125 percent of the system's nominal operating pressure, or from zero to 60 percent of the gauge capacity, whichever is higher.

4.17.2.2 Test/Verification

One sample gauge and switch of each type shall be connected to an apparatus capable of varying pressure from over the range described in Section 4.17.2.1 six times per minute. After 1000 cycles have been completed, the sample shall be retested for accuracy as described in Section 4.17.1.

4.18 Automatic Extinguisher Unit Tests

In addition to the applicable requirements listed elsewhere in this standard, operating devices associated with automatic extinguisher units, unless a certified automatic fire sprinkler shall be subjected to the following performance requirements, as applicable.

4.18.1 Assembly Load/Frame Strength

4.18.1.1 Requirements

The frame of a heat responsive automatic operating device shall be capable of withstanding twice the assembly load without sustaining permanent elongation or deformation in excess of 0.2 percent of the distance between the load bearing parts of the device.

4.18.1.2 Test/Verification

A minimum of ten previously untested samples shall be individually tested to determine the assembly load. With the threaded portion of the device restrained from movement, the heat responsive element of the test sample shall be removed and the negative axial deflection of the frame, due to the release of the assembly, recorded. A force necessary to return the deflection of the frame to the original zero position shall be reapplied and the value of the force recorded.

Each of the devices shall then be subjected momentarily (1 to 5 seconds) to twice the sum of the recorded force plus the force applied to the device as a result of the system's specified working pressure. The amount of permanent set after the load application shall be determined.

4.18.2 Strength of Heat Responsive Element

4.18.2.1 Requirements

The lower tolerance limit for bulb strength shall be greater than two times the upper tolerance limit for assembly load of a heat responsive automatic operating device based on calculations with a degree of confidence of 0.99. Calculations shall be based on the Normal or Gaussian Distribution except where another distribution can be shown to be more applicable due to manufacturing or design factors. The method for calculating the upper and lower tolerance limits is shown in Appendix D.

4.18.2.2 Test/Verification

The results of Section 4.18.1 (Assembly Load/Frame Strength) shall form the basis for the upper tolerance limit for the assembly load calculations. The lower tolerance limit for bulb strength shall be determined using the results obtained from subjecting a minimum of 20 sample bulbs to an increasing load until the bulbs fail. Each test shall be conducted with the bulb mounted in hardened steel inserts with seating surfaces or dimensions which conform to the actual mating components of the automatic operating device. The inserts shall have a hardness within the range Rockwell C 38-50 (see Figure E-7). They shall be provided by the manufacturer each time the test is specified. The load shall be applied at a rate of compression not exceeding 0.05 in./min (1.27 mm/min). The results obtained from the two sets of data shall be used for the tolerance limit calculations as described in Appendix D, Tolerance Limit Calculations.

4.18.3 Hydrostatic Strength

4.18.3.1 Requirements

Heat responsive automatic operating devices shall be capable of withstanding, without rupture, an internal hydrostatic pressure equal to the maximum specified working pressure or 700 psi (48.3 bar), whichever is higher, for a period of 1 minute.

4.18.3.2 Test/Verification

Each sample shall be subjected to a gradually increasing hydrostatic pressure to the required test pressure at a rate not exceeding 300 psi (20.0 bar) per minute. The test pressure shall be maintained for 1 minute.

4.18.4 Operating Temperature (Liquid Bath)

4.18.4.1 Requirements

The operating temperature of a group of a minimum of 10 heat responsive automatic operating devices shall fall within the specified range of the nominal operating temperature. The operating temperature for all samples shall be within ±5 percent of the marked nominal temperature rating.

4.18.4.2 Test/Verification

Ten previously untested samples shall be immersed in a vessel containing water or, for nominal temperature ratings in excess of 200°F (93°C), vegetable oil.

The samples shall be placed on a grate suspended above the bottom of the vessel. The liquid level shall not exceed 1 in. (25.4 mm) above the element. The vessel shall be provided with a source for heating the liquid, a means to agitate the liquid, and a device to measure the temperature of the liquid bath. The device used to measure the temperature of the liquid bath shall be calibrated in accordance with the ASTM Standard E-1, or the equivalent.

The temperature of the bath shall be raised until the liquid is 20°F (11.1°C) below the nominal temperature rating of the heat responsive element. The temperature rise shall then be controlled at a rate not exceeding 1°F (0.56°C) per minute until operation, or until a bath temperature ten percent above the nominal temperature of the sample is reached. The temperature of the liquid bath at the time of operation of each sample shall be recorded.

5. OPERATIONS REQUIREMENTS

5.1 Demonstrated Quality Control Program

5.1.1 A quality assurance program is required to assure that subsequent systems produced by the manufacturer shall present the same quality and reliability as the specific system(s) examined. Design quality, conformance to design, and performance are the areas of primary concern.

- Design quality is determined during the examination and tests, and may be documented in the certification report
- Continued conformance to this standard is verified by the certifier's surveillance program
- Quality of performance is determined by field performance and by periodic re-examination and testing

5.1.2 The manufacturer shall demonstrate a quality assurance program that specifies controls for at least, the following areas:

- Existence of corporate quality assurance guidelines
- Incoming quality assurance, including testing
- In-process quality assurance, including testing (if applicable)
- Final inspection and tests
- Equipment calibration
- Drawing and change control
- Packaging and shipping; and
- Handling and disposition of nonconforming materials

5.1.3 Documentation/Manual

There should be an authoritative collection of quality procedures/policies. It should provide an accurate description of the quality management system and serve as a permanent reference for implementation and maintenance of that system. The system should require that sufficient records are maintained to demonstrate achievement of the required quality and verify operation of the quality system.

5.1.4 Records

To assure adequate traceability of materials and products, the manufacturer shall maintain a record of all quality assurance tests performed for a minimum period of two years from the date of manufacture.

5.1.5 Drawing and Change Control

- The manufacturer shall establish a system of product configuration control that shall allow no unauthorized changes to the product. Changes to critical documents, identified in the certification report,

may be required to be reported to, and authorized by the certification agency prior to implementation for production.

- Records of all revisions to all certified products shall be maintained.

5.2 Surveillance Audits

5.2.1 An audit of the manufacturing facility may be part of the certification agency's surveillance requirements to verify implementation of the quality assurance program. Its purpose is to determine that the manufacturer's equipment, procedures, and quality program are implemented and maintained to ensure a uniform product consistent with that which was tested and certified.

5.2.2 Certified products or services shall be produced or provided at, or provided from, location(s) disclosed as part of the certification examination. Manufacture of products bearing a certification mark is not permitted at any other location without prior to disclosure to the certification agency.

5.3 Manufacturer's Responsibilities

The manufacturer shall provide complete instructions for the usage and recharge of systems. The instructions shall provide specific quality assurance procedures on the use of calibrated equipment, such as scales, pressure gauges, and other critical equipment, in the recharging of a system.

5.4 Manufacturing and Production

5.4.1 The manufacturer shall design systems in accordance with NFPA 17 and/or any other standard specifically referenced in the certification report and listing.

5.4.2 The manufacturer shall fabricate and test pressure cylinders in accordance with the standard(s) referenced in the certification report and listing.

5.4.3 The manufacturer shall leak test all filled agent storage containers prior to release for shipment. The leak test method shall employ appropriately calibrated and sensitive leak detection devices.

5.5 Design, Installation, Operating, and Maintenance Manual

5.5.1 A design, installation, operation, and maintenance manual shall be provided with each extinguishing system, or be made available upon request. A copy of the manual shall be provided to the certification agency as a reference prior to the examination and testing of the system. Subsequent to the successful completion of the examination, an electronic copy of the manual shall be provided to the certification agency for future reference. Updated electronic copies of the manual shall be provided to the certification agency as revisions are made.

5.5.2 The manual shall include the following information, at a minimum, if applicable:

- Manufacturer's name and address
- Date and part number designation on each page of the manual
- Description of equipment and accessories, including part numbers and model numbers
- Description of the minimum required dry chemical flow rate
- Material Safety Data Sheets
- Piping and fitting limitations
- Discharge nozzle limitations, including maximum area of coverage, and minimum and maximum installation height, nozzle location
- System configuration limitations, including allowable percentage of uncloseable openings for each system type
- Installation instructions
- Calculation method to determine uncloseable opening percentage
- Detection devices and control panels for use with the extinguishing system
- Range of filling weights for each agent storage container size
- System working pressure at 70°F (21°C)
- Acceptance test requirements
- Inspection requirements
- Maintenance requirements
- Recharge instructions
- Reference to NFPA 17, Standard for Dry Chemical Extinguishing Systems, or other relevant local standards
- Acceptance test form to document satisfactory operational status of the system upon completion of installation
- A clearly labeled section listing any part numbers included in the manual, but not within the scope of the certification

6 BIBLIOGRAPHY

ANSI/NFPA 72, *National Fire Alarm and Signaling Code*
FM 3010, *Fire Alarm Signaling Systems*
FM 3600, *Electric Equipment for Use in Hazardous (Classified) Locations General Requirements*
FM 3610, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, and Class I, Zone 0 and 1 Hazardous (Classified) Locations.*
FM 3611, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2, Hazardous (Classified) Locations*.
FM 3615, *Explosionproof Electrical Equipment General Requirements*.
FM 3620, *Purged and Pressurized Electrical Equipment for Hazardous (Classified) Locations*.
FM 3810, *Electrical and Electronic test, Measuring, and Process Control Equipment*.
FM Global Property Loss Prevention Data Sheet 4-0, *Special Protection Systems.*
FM Global Property Loss Prevention Data Sheet 4-10, *Dry Chemical Systems.*
ISO 7202, *Fire Extinguishing Media – Powder*
ISO/IEC 17025: 2017 *General Requirements for the Competence of Testing and Calibration Laboratories*
ISO 9000, *Quality Management Principles*

APPENDIX A:

Appendix A is intentionally blank.

APPENDIX B: Tolerances

Unless otherwise stated, the following tolerances shall apply:

Angle:	±2°
Frequency (Hz):	±5 percent of value
Length:	±2 percent of value
Volume:	±5 percent of value
Rotation:	±1 RPM
Pressure:	±3 percent of value
Temperature:	±3°F
Time:	+5/–0 seconds +0.1/–0 minutes +0.1/–0 hours +0.25/–0 days

Unless stated otherwise, all tests shall be carried out at a room (ambient) temperature of 68 ± 9°F (20 ± 5°C).

APPENDIX C:

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APPENDIX D: Tolerance Limit Calculations

Using the data obtained as described in Sections 4.24.1 (Assembly Load/Frame Strength) and 4.24.2 (Strength of Heat Responsive Element), the mean and standard deviation for the assembly load and the bulb strength shall be calculated using the following equation:

$$\sigma_{n-1} = \left[\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1} \right]^{1/2}$$

where:

σ_{n-1} = standard deviation

x = sample mean

x_i = individual values of each sample tested

n = number of samples tested

Based on the number of devices or bulbs tested (n), a value, γ, shall be selected from Table D1 where the degree of confidence is 0.99 and the proportion of samples is 0.99.

Table D1 *γ Factors for One-Sided Tolerance Limits for Normal Distributions (99 Percent of Samples)*

n	***γ***	***n***	***γ***	***n***	***γ***
10	5.075	17	4.038	24	3.638
11	4.828	18	3.961	25	3.601
12	4.633	19	3.893	30	3.446
13	4.472	20	3.832	35	3.334
14	4.336	21	3.776	40	3.250
15	4.224	22	3.727	45	3.181
16	4.124	23	3.680	50	3.124

Tolerance limits shall then be calculated as follows:

$$LTL = \bar{x}_B - \gamma_B \sigma_{(n-1)B}$$

$$UTL = \bar{x}_S - \gamma_S \sigma_{(n-1)S}$$

where:

LTL = lower tolerance limits for device strength

UTL = upper tolerance limit for assembly load

$\bar{x}_B$ = mean device strength

γ_B = device strength factor (γ) from Table D1

$\sigma_{(n-1)B}$ = sample unbiased standard deviation for the bulb

$\bar{x}_S$ = mean assembly load

$\sigma_{(n-1)S}$ = sample unbiased standard deviation for the assembly load

γ_S = assembly load factor (γ) from Table D1

Compliance with the requirement shall be confirmed if LTL > UTL.