NFPA®

2010

Standard for Fixed Aerosol Fire-Extinguishing Systems

2020

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NFPA® 2010

Standard for

Fixed Aerosol Fire-Extinguishing Systems

2020 Edition

This edition of NFPA 2010, *Standard for Fixed Aerosol Fire-Extinguishing Systems*, was prepared by the Technical Committee on Aerosol Extinguishing Technology. It was issued by the Standards Council on November 4, 2019, with an effective date of November 24, 2019, and supersedes all previous editions.

This edition of NFPA 2010 was approved as an American National Standard on November 24, 2019.

Origin and Development of NFPA 2010

In 1995, at the request of the Technical Committee on Alternative Protection Options to Halon, the NFPA Standards Council voted to proceed with a new project to provide guidance on the subject of fine-aerosol extinguishing technology. In 1996 the Standards Council reviewed the status of that project and voted to postpone the appointment of a startup roster for a fine-aerosol technology project until the technology had actual field use and experience. Over the next 5 years, field use and experience support material was accumulated, and in 2001 the Standards Council, responding to a public request, established a new project on fine-aerosol extinguishing technology. In 2003 the Technical Committee on Aerosol Extinguishing Technology submitted a draft document titled Fixed Aerosol Extinguishing Systems for inclusion in the Annual 2005 cycle. That document became NFPA 2010, *Standard for Fixed Aerosol Fire-Extinguishing Systems.*

The 2010 edition of NFPA 2010 featured a reorganization of Chapters 8 and 9 to separate the requirements for systems into categories, which include general requirements applicable to all systems, condensed aerosol system requirements, and dispersed aerosol system requirements. Several clarifications were made throughout the document as well.

The 2015 edition revised the frequency of system inspections and added references to third-party approval standards.

For the 2020 edition, the committee removed dispersed aerosol systems from the document scope and deleted all requirements that are not relevant to condensed aerosol systems. The lack of clear separation between the two system types created confusion, and the committee was unaware of any current manufacturers of dispersed aerosol systems.

New requirements address the use of aerosol extinguishing systems in normally occupied spaces. Revised text clarifies that an enclosure integrity test is not required and addresses compensation for leakage and enclosure ceiling height when determining the aerosol agent quantity. General improvements of readability and clarity are incorporated throughout.

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Committee Scope: This committee shall have primary responsibility for documents on design, installation, operation, testing, maintenance, and use of fire extinguishing systems that utilize aerosol extinguishing agents. It shall not address documents on safeguarding against the fire and explosion hazards associated with the manufacturing, handling, and storage of combustible or flammable aerosol products covered by other committees.

Contents

Chapter 1 Administration **2010–** 4
1.1 Scope. **2010–** 4
1.2 Purpose. **2010–** 4
1.3 Retroactivity. **2010–** 4
1.4 Equivalency. **2010–** 4
1.5 Units and Formulas. **2010–** 4
1.6 New Technology. **2010–** 4

Chapter 2 Referenced Publications **2010–** 4
2.1 General. **2010–** 4
2.2 NFPA Publications. **2010–** 4
2.3 Other Publications. **2010–** 4
2.4 References for Extracts in Mandatory Sections. **2010–** 5

Chapter 3 Definitions **2010–** 5
3.1 General. **2010–** 5
3.2 NFPA Official Definitions. **2010–** 5
3.3 General Definitions. **2010–** 5
3.4 Special Definitions for Marine Systems. **2010–** 6

Chapter 4 General **2010–** 6
4.1 General Information. **2010–** 6
4.2 Use and Limitations. **2010–** 6
4.3 Environmental Factors. **2010–** 7
4.4 Compatibility with Other Agents. **2010–** 7

Chapter 5 Safety Requirements **2010–** 7
5.1 Review Requirement. **2010–** 7
5.2 Hazards to Personnel. **2010–** 7
5.3 Electrical Clearances. **2010–** 8

Chapter 6 Components **2010–** 8
6.1 Aerosol System Agent Supply. **2010–** 8
6.2 Detection, Actuation, Alarm, and Control Systems. **2010–** 9

Chapter 7 System Design and Installation **2010–** 10
7.1 Specifications, Plans, and Approvals. **2010–** 10
7.2 Enclosure. **2010–** 11
7.3 Design Application Density. **2010–** 11
7.4 Total Flooding Quantity. **2010–** 12
7.5 Duration of Protection. **2010–** 12
7.6 Rate of Application. **2010–** 12
7.7 Generator Choice and Location. **2010–** 12

Chapter 8 Approval of Installations **2010–** 12
8.1 General. **2010–** 12
8.2 Inspection of Aerosol Generators. **2010–** 14

Chapter 9 Inspection, Testing, and Maintenance ... **2010–** 14
9.1 General. **2010–** 14
9.2 Interfaced Systems and Equipment. **2010–** 14
9.3 Inspection. **2010–** 14
9.4 Maintenance. **2010–** 14
9.5 Testing. **2010–** 15
9.6 Record Keeping. **2010–** 15
9.7 Disposal of Components and Agents. **2010–** 15

Chapter 10 Marine Systems **2010–** 15
10.1 Scope. **2010–** 15
10.2 General. **2010–** 15
10.3 Special Definitions. **2010–** 15
10.4 Inspected Vessels. **2010–** 15
10.5 Uninspected Vessels and Pleasure Craft. **2010–** 16

Annex A Explanatory Material **2010–** 17

Annex B Toxicity Information **2010–** 20

Annex C Reduced Visibility Information **2010–** 21

Annex D Informational References **2010–** 24

Index **2010–** 25

NFPA 2010

Standard for

Fixed Aerosol Fire-Extinguishing Systems

2020 Edition

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A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

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

Chapter 1 Administration

1.1 Scope.

1.1.1 This standard applies to aerosol fire-extinguishing systems consisting of one or more generators.

1.1.2 This standard contains the requirements for the design, installation, operation, testing, and maintenance of aerosol fire-extinguishing systems for total flooding applications.

1.2 Purpose. This standard is prepared for the use by and guidance of those charged with purchasing, designing, installing, testing, inspecting, approving, listing, operating, and maintaining fixed aerosol fire-extinguishing systems, so that such equipment will function as intended throughout its life.

1.3 Retroactivity.

1.3.1 The provisions of this document are considered necessary to provide a reasonable level of protection from loss of life and property from fire. They reflect situations and the state of the art at the time the standard was issued.

1.3.2 Unless otherwise noted, it is not intended that the provisions of this document be applied to facilities, equipment, structures, or installations that were existing or approved for construction or installation prior to the effective date of this document.

1.4 Equivalency. Nothing in this standard is intended to prevent the use of new methods or devices, provided sufficient technical data are submitted to the authority having jurisdiction to demonstrate that the new method or device is equivalent in quality, effectiveness, durability, and safety to that prescribed by this standard.

1.5 Units and Formulas.

1.5.1* Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI).

1.5.2 If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated is to be regarded as the requirement. A given equivalent value could be approximate.

1.6 New Technology.

1.6.1 Nothing in this standard shall be intended to restrict new technologies or alternate arrangements, provided the level of safety prescribed by this standard is not lowered.

1.6.2 Materials or devices not specifically designated by this standard shall be utilized in complete accord with all conditions, requirements, and limitations of their listings.

Chapter 2 Referenced Publications

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

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

NFPA 70®, National Electrical Code®, 2020 edition.
NFPA 72®, National Fire Alarm and Signaling Code®, 2019 edition.

2.3 Other Publications.

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

ASME *Boiler and Pressure Vessel Code*, 2017.

•

2.3.2 IEEE Publications. IEEE, Three Park Avenue, 17th Floor, New York, NY 10016–5997.

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

•

Δ **2.3.4 UL Publications.** Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 2775, *Standard for Fixed Condensed Aerosol Extinguishing System Units*, 2017.

Δ **2.3.5 U.S. Government Publications.** U.S. Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001.

U.S. Occupational Safety and Health Administration, Title 29, Code of Federal Regulations.

U.S Coast Guard, Title 46, Code of Federal Regulations.

U.S. Department of Transportation, Title 49, Code of Federal Regulations.

2.3.6 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2018 edition.
NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2019 edition.
NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 2019 edition.
NFPA 68, *Standard on Explosion Protection by Deflagration Venting,* 2018 edition.
NFPA 72®, National Fire Alarm and Signaling Code®, 2019 edition.
NFPA *101®*, *Life Safety Code®*, 2018 edition.
NFPA 820, *Standard for Fire Protection in Wastewater Treatment and Collection Facilities,* 2020 edition.

Chapter 3 Definitions

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

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

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

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

3.2.4 Shall. Indicates a mandatory requirement.

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

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

3.3 General Definitions.

N **3.3.1* Abort Switch.** A system control that, when operated during the releasing panel's release delay countdown, extends the delay in accordance with a predetermined effect.

3.3.2 Actuating Mechanism. A mechanism whose automatic or manual operation leads to the discharge of extinguishing agent.

•

3.3.3 Aerosol, Condensed. An extinguishing medium consisting of finely divided solid particles, generally less than 10 microns in diameter, and gaseous matter, generated by a combustion process of a solid aerosol-forming compound.

•

Δ **3.3.4 Agent Quantity.** Mass of aerosol-forming compound required to achieve the design application density within the protected volume within the specified discharge time.

3.3.5 Automatic. Capable of performing a function without the necessity of human intervention. [***101***, 2018]

3.3.6* Automatic/Manual Switch. Means of converting the system from automatic to manual actuation.

3.3.7 Classifications for Fires.

3.3.7.1 ***Class A Fires.*** Fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics. [**10,** 2018]

3.3.7.2 ***Class B Fires.*** Fires in flammable liquids, combustible liquids, petroleum greases, tars, oils, oil-based paints, solvents, lacquers, alcohols, and flammable gases. [**10,** 2018]

3.3.7.3 ***Class C Fires.*** Fires that involve energized electrical equipment. [**10,** 2018]

3.3.8 Clearance.

3.3.8.1 ***Electrical Clearance.*** The unobstructed air distance between extinguishing system equipment and unenclosed or uninsulated live electrical components not at ground potential.

3.3.8.2 ***Thermal Clearance.*** The air distance between a condensed aerosol generator and any structure or components sensitive to the temperature developed by the generator.

3.3.9 Coolant. A heat-absorbing medium or process.

3.3.10 Density.

3.3.10.1* ***Design Application Density (g/m^3).*** Extinguishing application density, including a safety factor, required for system design purposes.

3.3.10.2* ***Extinguishing Application Density (g/m^3).*** Minimum mass of a specific aerosol-forming compound per cubic meter of enclosure volume required to extinguish fire involving particular fuel under defined experimental conditions excluding any safety factor.

Δ **3.3.10.3* *Particulate Density.*** The density of solid particulate in grams per cubic meter after discharge of the aerosol system at the design application density.

3.3.11 Discharge Port. A passage such as nozzles or openings on an aerosol generator where aerosol is released when the generator is actuated.

3.3.12 Disconnect Switch. A manually operated switch, electrically supervised and secured from unauthorized use, that prevents the automatic or manual electrical actuation of the aerosol generators during maintenance by electrically opening the releasing circuit.

3.3.13 Enclosure. A confined or partially confined volume. [**68,** 2018]

3.3.14 Generator. A device for creating an aerosol fire-extinguishing medium by pyrotechnical means.

3.3.15 Generator Casing. The surface of the generator, excluding the surface containing the discharge ports.

•

3.3.16 Hot Work. Work involving burning, welding, or a similar operation that is capable of initiating fires or explosions. [**51B,** 2019]

3.3.17* Inspection. A visual examination of a system or portion thereof to verify that it appears to be in operating condition and is free of physical damage. [**820,** 2020]

3.3.18* Maintenance. Work performed to ensure that equipment operates as directed by the manufacturer.

3.3.19 Manual. Requiring intentional intervention to accomplish a function.

3.3.20* Mass Median Aerodynamic Diameter (MMAD). The measurement, with the geometric standard deviation, used to describe the particle size distribution of any aerosol statistically, based on the weight and size of the particles.

3.3.21 Normally Occupied. An area or space where, under normal circumstances, persons are present.

3.3.22 Normally Unoccupied. An area or space not normally occupied by people but that can be entered occasionally for brief periods.

•

3.3.23 Protected Volume. Volume enclosed by the building elements around the protected enclosure, minus the volume of any permanent impermeable building elements within the enclosure.

3.3.24 Release. The physical discharge or emission of aerosol as a consequence of the generator's actuation.

3.3.25 Solid Aerosol-Forming Compound. A solid mixture of oxidant, combustible component and technical admixtures that produces a condensed aerosol upon actuation.

3.3.26 Supervisory Condition. An abnormal condition in connection with the supervision of other systems, processes, or equipment. [**72,** 2019]

3.3.27 Supervisory Signal. A signal that results from the detection of a supervisory condition. [**72,** 2019]

3.3.28 Total Flooding Extinguishing System. A system arranged to discharge an extinguishant into an enclosure to achieve a uniform distribution of that extinguishant, at or above the design application density, throughout the enclosure volume.

3.3.29* Unoccupiable. An area or space that cannot be occupied due to dimensional or other physical constraints.

3.4 Special Definitions for Marine Systems. The following definitions shall be applicable to marine aerosol extinguishing systems.

3.4.1 Heat-Sensitive Material. A material whose melting point is below 1700°F (927°C). [**13,** 2019]

3.4.2 Marine System. An aerosol system installed on a merchant vessel, ship, barge, boat, pleasure craft, offshore platform, or other floating structure.

3.4.3 Space.

3.4.3.1 *Cargo Space.* A space for the carriage or storage of items or products that are transported by the vessel.

3.4.3.2 *Machinery Space.* A space protected by an aerosol system containing an internal combustion engine or mechanical equipment for handling, pumping, or transferring flammable or combustible liquids as a fuel to internal combustion engines.

3.4.4 Vessel.

3.4.4.1 *Inspected Vessel.* A vessel operated on the navigable waterways of the United States that is subject to the regulations in 46 CFR, which require it to be certificated and inspected as a passenger ship, cargo ship, oceanographic ship, or tank vessel.

3.4.4.2 *Uninspected Vessel.* A vessel operated on the navigable waterways of the United States that is subject to the regulations in 46 CFR Subchapter C, Parts 24–28, including pleasure craft, tugboats, towing vessels, and certain fishing vessels.

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Chapter 4 General

4.1 General Information.

4.1.1 The fire extinguishing agents addressed in this standard shall be electrically nonconductive.

4.1.2 The design, installation, service, and maintenance of aerosol systems shall be performed by persons skilled in aerosol fire-extinguishing system technology.

N **4.1.3** Aerosol systems shall be designed, installed, inspected, tested, and maintained in accordance with the manufacturer's listed manual and this standard.

4.2 Use and Limitations.

4.2.1 Aerosol Systems.

4.2.1.1* All aerosol systems and automatic extinguishing units shall be installed and used to protect hazards within the limitations of and in accordance with their listing.

Δ **4.2.1.2** Aerosol systems and automatic extinguishing units referenced in 4.2.1.1 shall comply with UL 2775, or equivalent listing standard.

4.2.2 Aerosol fire-extinguishing agents shall not be used on fires involving the following materials unless the agents have been tested to the satisfaction of the authority having jurisdiction:

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

4.2.3 Aerosol generators shall not be used to protect classified hazards or similar spaces containing flammable liquids or dusts that can be present in explosive air–fuel mixtures unless the generators are specifically listed for use in those environments.

4.2.4 The aerosol generators shall not be employed at less than the minimum safe distances specified in the listing of the product.

Δ **4.2.4.1** The minimum safe distance between the aerosol generator discharge ports and personnel shall be based on an aerosol agent discharge temperature, at that distance, not exceeding 75°C (167°F).

Δ **4.2.4.2** The minimum safe distance between the aerosol generator discharge ports and combustible materials shall be based on an aerosol agent discharge temperature, at that distance, not exceeding 200°C (392°F).

4.2.4.3 In addition to the requirements in 4.2.4.1 and 4.2.4.2, the minimum safe distance requirements in 6.1.4.2.2 addressing the generator casing temperature shall apply.

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4.2.5 Where a total flooding system is used, a fixed enclosure shall be provided about the hazard that allows a specified agent design application density to be achieved and maintained for a specified period of time.

4.2.6 The potential adverse effects of agent particulate residue on sensitive equipment and other objects shall be considered where aerosol extinguishing agents are used in spaces containing that type of equipment.

4.2.7 Temperatures for use of aerosol extinguishing agents shall be within the manufacturer's listed limits.

4.3 Environmental Factors. When a type of agent is being selected to protect a hazard area, the potential adverse effects of the agent on the environment shall be considered.

4.4 Compatibility with Other Agents.

4.4.1 Unless specifically approved as an agent blend or mixture, systems employing the simultaneous discharge of different agents to protect the same enclosed space shall not be permitted.

4.4.2 Where unrelated extinguishing or suppression systems are provided and can operate simultaneously with the aerosol system, the combination of systems shall not compromise the overall level of suppression effectiveness.

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Chapter 5 Safety Requirements

5.1* Review Requirement.

5.1.1* Any agent that is to be recognized by this standard, or proposed for inclusion in this standard, shall first be evaluated in a manner equivalent to the process used by the U.S. Environmental Protection Agency's (EPA) Significant New Alternatives Policy (SNAP) Program.

5.1.2 Health Effects.

5.1.2.1 Determination for use of an agent in spaces that are normally occupied or normally unoccupied shall include a thorough evaluation of the potential adverse health effect(s) of the agent.

5.1.2.2 Potential adverse health effects shall be assessed for the particulate density, the size of the particulates (i.e., mean mass aerodynamic diameter), and the concentration of gases expected after actuation of the aerosol extinguishing system at the design application density.

5.2 Hazards to Personnel.

Δ **5.2.1* Potential Hazards.** The following potential hazards shall be considered for individual systems: noise, turbulence, reduced visibility, potential toxicity, thermal hazard, and irritation to persons in the protected space and other areas where the aerosol agent can migrate.

5.2.2 Unnecessary Exposure. Unnecessary exposure to aerosol agent, even at concentrations below an adverse-effect level, and to their decomposition products shall be avoided.

5.2.3 Pre-discharge Alarms and Time Delays.

5.2.3.1* A pre-discharge alarm and time delay shall be provided in accordance with the requirements of 6.2.5.7.

5.2.3.2 Alarm Failure.

5.2.3.2.1 In the event of failure of the pre-discharge alarm and time delay, means shall be provided to limit exposure to agents approved for use in normally occupied spaces to no longer than 5 minutes.

5.2.3.2.2 The effect of reduced visibility on egress time shall be considered.

5.2.4* Toxicity.

5.2.4.1 General. No fire suppression system shall be used that is carcinogenic, mutagenic, or teratogenic at application densities expected during use.

5.2.4.2* Normally Occupied Spaces. Aerosol extinguishing systems approved for normally occupied spaces shall be permitted in amounts where the aerosol particulate density does not exceed the level deemed acceptable by the U.S. EPA SNAP Program and where any aerosol agent produced does not exceed the excursion limit for the critical toxic effect.

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5.2.5* Reduced Visibility. Safety measures shall be used such that occupants can evacuate under conditions of low visibility caused by the discharged agent.

5.2.6 Thermal Hazards.

5.2.6.1 Aerosol generators shall not be employed at less than the minimum safe distance from personnel and combustible materials as specified in the listing of the product.

Δ **5.2.6.2** Protective gloves shall be worn by personnel removing discharged aerosol generators.

5.2.7 Safety Requirements.

5.2.7.1 Personnel shall not enter a protected space during or after agent discharge.

N **5.2.7.2** All persons who can at any time enter a space protected by an aerosol extinguishing system shall be warned of the hazards involved and provided with safe evacuation procedures.

N **5.2.7.3** Provisions shall be made to prevent entry of unprotected personnel to the protected space following the discharge of an aerosol extinguishing system until the space is ventilated.

N **5.2.7.4** Safety items, such as personnel training, warning signs, discharge alarms, self-contained breathing apparatus (SCBA), evacuation plans, and fire drills, shall be considered.

N **5.2.7.5** Operating alarms and indicators shall be provided in accordance with 6.2.5.

5.2.7.6* Safeguards shall be provided to ensure prompt evacuation of and prevent entry into post–system discharge atmospheres and also to provide means for prompt rescue of any trapped personnel.

5.2.7.7* Consideration shall be given to the possibility of an aerosol agent migrating to adjacent areas outside of the protected space.

5.3 Electrical Clearances.

5.3.1 All system components shall be located to maintain no less than minimum clearances from energized electrical parts.

5.3.1.1 The following references shall be considered as the minimum electrical clearance requirements for the installation of aerosol extinguishing systems:

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

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

5.3.3 The selected clearance to ground shall satisfy the greater of the switching surge or BIL duty, rather than being based on nominal voltage.

5.3.4 The clearance between uninsulated, energized parts of the electrical system equipment and any portion of the aerosol extinguishing system shall not be less than the minimum clearance provided elsewhere for electrical system insulations on any individual component.

Chapter 6 Components

Δ **6.1 Aerosol System Agent Supply.**

6.1.1 Quantity.

Δ **6.1.1.1 Primary Agent Supply.** The primary agent supply shall be determined by calculating the required mass of the aerosol-forming compound needed to meet the design application density.

6.1.1.2 Reserve Agent Supply. Where required, a reserve agent supply shall consist of as many multiples of the primary agent supply as the authority having jurisdiction considers necessary.

6.1.2 Quality. Agent properties shall meet the standards of quality of the agent's listing.

6.1.2.1 Each batch of agent manufactured shall be tested and certified to the specifications of its listing.

6.1.2.2 Agents shall maintain their integrity for the useful life limits established by the listing within the approved temperature range and conditions of service that they will encounter.

6.1.3 Aerosol Generator Arrangement.

6.1.3.1 Aerosol generators and accessories shall be located and arranged so that inspection, testing, and other maintenance activities are facilitated and interruption of protection is held to a minimum.

6.1.3.2 Aerosol generators shall be located within or as close as possible to the hazard or hazards they protect.

6.1.3.3 Aerosol generators shall not be located where they can be rendered inoperable or unreliable due to mechanical damage or exposure to chemicals or harsh weather conditions unless enclosures or protective measures are employed.

6.1.3.4 Aerosol generators shall be securely installed according to the manufacturer's listed installation manual.

Δ **6.1.4 Aerosol Generators.**

6.1.4.1 Safety.

6.1.4.1.1 The aerosol-forming compound shall be stored in aerosol generators designed to safely contain the pyrotechnic reaction required to produce the aerosol agent.

6.1.4.1.2 The aerosol generators shall discharge aerosol within the temperature and minimum safe distance parameters from personnel and combustibles established in the listing tests.

6.1.4.2 Minimum Safe Distance.

6.1.4.2.1 The generator shall not be installed at less than the minimum safe distances as specified in the manufacturer's installation instructions.

6.1.4.2.2 In addition to the requirements of 6.1.4.2.1, the minimum safe distance requirements in 4.2.4 addressing the agent stream temperature shall apply.

6.1.4.2.2.1 The minimum safe distance between the generator casing and personnel shall be the distance from the generator casing to where the temperature does not exceed 75°C (167°F) during and after discharge.

6.1.4.2.2.2 The minimum safe distance between the generator casing and combustible materials shall be the distance from the generator casing to where the temperature does not exceed 200°C (392°F) during and after discharge.

6.1.4.3 Listing. Aerosol generators shall be listed for the intended use.

6.1.4.3.1 Listing criteria shall include area coverage, height limits, placement, storage temperature limits, useful lifetime limits, thermal safety parameters, and orientation.

6.1.4.3.2 Aerosol generators shall be sealed in a manner that is corrosion resistant to the atmosphere in the intended application.

6.1.4.3.3 Sealing methods shall provide an unobstructed opening upon system operation.

6.1.4.4 Nameplate. Each aerosol generator shall have a permanent nameplate or other permanent marking that indicates the mass of aerosol-forming compound contained within, the manufacturer, date of manufacture, and date of mandatory replacement of the generator based on useful life limits established in the listing.

6.1.4.5 Transportation. The aerosol generators used in these systems shall comply with the requirements of the U.S. Department of Transportation (DOT) or the Canadian Transport Commission and shall be classified in accordance with 49 CFR 172.101, Subpart B, or the Canadian equivalent.

6.1.4.6 Temperature Limitations. Storage and use temperatures shall be within the manufacturer's listed limits.

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6.2 Detection, Actuation, Alarm, and Control Systems.

6.2.1 General.

6.2.1.1* Detection, actuation, alarm, and control systems shall be installed, tested, and maintained in accordance with *NFPA 70* and *NFPA 72*.

6.2.1.2 Automatic detection and automatic actuation shall be used unless manual-only actuation is approved by the authority having jurisdiction.

6.2.1.3 Raceways.

6.2.1.3.1 Initiating and releasing circuits shall be installed in raceways.

6.2.1.3.2 Unless shielded and grounded, alternating current (ac) and direct current (dc) wiring shall not be combined in a common conduit or raceway.

6.2.2 Automatic Detection.

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

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

6.2.3 Operating Devices.

Δ **6.2.3.1** Operating devices shall include agent-releasing devices, discharge controls, and shutdown equipment necessary for successful performance of the system.

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6.2.3.2 Operation shall be by listed mechanical, electrical, or pneumatic means.

6.2.3.3 A reliable source of energy shall be used.

6.2.3.4 Operating devices shall be designed for the service they will encounter and shall not readily be rendered inoperative or susceptible to accidental operation.

6.2.3.5 Operating devices shall be designed to function within their listed temperature ranges.

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

6.2.3.7 Manual Release. A means of manual release of the system shall be provided.

Δ **6.2.3.7.1** Manual release shall be accomplished by a mechanical manual release or by an electrical manual release when the control equipment monitors the battery condition.

6.2.3.7.2 The manual release shall cause simultaneous operation of actuators that control agent release and distribution.

6.2.3.7.3 Manual control(s) for actuation shall be located for easy accessibility at all times, including at the time of a fire.

6.2.3.7.4 The manual control(s) shall be of distinct appearance and clearly recognizable for the purpose intended.

6.2.3.7.5 Operation of any manual control station shall cause the complete system to operate.

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6.2.3.7.6 Manual controls shall not require a pull of more than 178 N (40 lb) or a movement of more than 356 mm (14 in.) to secure operation.

6.2.3.7.7 At least one manual control station for activation shall be installed.

N **6.2.3.7.8** Manual control stations shall be located not more than 1.2 m (4 ft) above the floor.

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

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

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

6.2.4 Control Equipment.

6.2.4.1 Electric Control Equipment.

6.2.4.1.1 The control equipment shall supervise the actuating devices and associated wiring and, as required, cause actuation.

6.2.4.1.2 The control equipment shall be specifically listed for the number and type of actuating devices utilized, and their compatibility shall be listed.

6.2.4.2 Pneumatic Control Equipment.

6.2.4.2.1 Where pneumatic control equipment is used, the lines shall be protected against crimping and mechanical damage.

6.2.4.2.2 Where installations could be exposed to conditions that could lead to loss of integrity of the pneumatic lines, special precautions shall be taken to ensure that no loss of integrity will occur.

6.2.4.2.3 The control equipment shall be specifically listed for the number and type of actuating devices utilized, and their compatibility shall be listed.

6.2.4.2.4 Pilot containers shall be designed to meet the requirements of the DOT or the Canadian Transport Commission, if used as shipping containers.

N **6.2.4.2.4.1*** If not used as shipping containers, the pilot containers shall be designed, fabricated, inspected, certified, and stamped in accordance with Section VIII of the ASME *Boiler and Pressure Vessel Code.*

N **6.2.4.2.4.2** The design pressure shall be suitable for the maximum pressure developed at 55°C (130°F) or at the maximum controlled temperature limit.

6.2.5 Operating Alarms and Indicators. Alarms or indicators or both shall be used to indicate the operation of the system, hazards to personnel, or failure of any supervised device.

6.2.5.1 General. The type (audible or visual), number, and location of the alarms or indicators shall be such that their purpose is satisfactorily accomplished.

6.2.5.2 Approval. The extent and type of alarms or indicator equipment or both shall be approved.

6.2.5.3 Warning Devices.

6.2.5.3.1 Audible and visual pre-discharge alarms shall be provided within the protected area to give positive warning of impending discharge.

6.2.5.3.2 The operation of the warning devices shall continue after agent discharge until positive action has been taken to acknowledge the alarm and proceed with appropriate action.

6.2.5.4* Abort Switches. Where provided, the abort switches shall be located within the protected area and shall be located near the means of egress for the area.

6.2.5.4.1 The abort switch shall be of a type that requires constant manual pressure to cause abort.

6.2.5.4.2 The abort switch shall not be of a type that would allow the system to be left in an aborted mode without personnel present.

Δ **6.2.5.4.3** In all cases, the manual control shall override the abort function.

6.2.5.4.4 Operation of the abort function shall result in both audible and distinct visual indication of system impairment.

6.2.5.4.5 The abort switch shall be clearly recognizable for the purpose intended.

6.2.5.5 Supervisory Conditions. Alarms indicating failure of supervised devices or equipment shall give prompt and positive indication of any failure and shall be distinct from alarms indicating operation or hazardous conditions.

6.2.5.6 Warning and Instruction Signs. Warning and instruction signs at entrances to and inside protected areas shall be provided.

6.2.5.7 Pre-discharge Alarms and Time Delays.

6.2.5.7.1 For aerosol extinguishing systems, a pre-discharge alarm and time delay, sufficient to allow personnel evacuation prior to discharge, shall be provided.

6.2.5.7.2* For hazard areas subject to fast-growth fires, where the provision of a time delay would seriously increase the threat to life and property, a time delay shall be permitted to be eliminated.

6.2.5.7.3 Time delays shall be used only for personnel evacuation or to prepare the hazard area for discharge.

6.2.5.7.4 Time delays shall not be used as a means of confirming operation of a detection device before automatic actuation occurs.

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

6.2.6.1 To avoid unwanted discharge of an aerosol system during maintenance, a supervised disconnect switch shall be provided.

6.2.6.2 The disconnect switch shall interrupt the releasing circuit to the aerosol system.

Chapter 7 System Design and Installation

7.1 Specifications, Plans, and Approvals.

7.1.1 Specifications.

7.1.1.1 Specifications for total flooding aerosol fire-extinguishing systems shall be prepared under the supervision of a person fully experienced and qualified in the design of such systems and with the advice of the authority having jurisdiction.

7.1.1.2 The specifications shall include all pertinent items necessary for the design of the system, such as the designation of the authority having jurisdiction, variances from the standard to be permitted by the authority having jurisdiction, design criteria, system sequence of operations, the type and extent of the approval testing to be performed after installation of the system, and owner training requirements.

7.1.2 Working Plans.

7.1.2.1 Working plans and calculations shall be submitted for approval to the authority having jurisdiction before system installation or remodeling begins.

Δ **7.1.2.1.1** These documents shall be prepared by persons experienced and qualified in the design of aerosol extinguishing systems.

7.1.2.1.2 Deviation from these documents shall require permission of the authority having jurisdiction.

Δ **7.1.2.2** Working plans shall be drawn to an indicated scale and shall show the following items that pertain to the design of the system:

(1) Name of owner and occupant
(2) Location, including street address
(3) Point of compass and symbol legend
(4) Location and construction of protected enclosure walls and partitions
(5) Location of fire walls
(6) Enclosure cross-section, full-height or schematic diagram, including location and construction of building floor/ceiling assemblies above and below, raised access floor, and suspended ceiling
(7) Aerosol agent being used
(8) Design application density

(9) For total flooding normally occupied spaces, the maximum allowable design application density, as specified in the manufacturer's listed manual
(10) Description of exposures surrounding the enclosure
(11) A description of the generator used, including nominal capacity expressed in units of aerosol-forming compound mass
(12) Description of wire or cable used, including classification, gauge [American Wire Gauge (AWG)], shielding, number of strands in conductor, conductor material, and color coding schedule, with the segregation requirements of various system conductors clearly indicated and the required method of making wire terminations detailed
(13) Description of the method of detector mounting
(14) Equipment schedule or bill of materials for each piece of equipment or device showing device name, manufacturer, model or part number, quantity, and description
(15) Plan view of protected area showing enclosure partitions (full and partial height); detection, alarm, and control system, including all devices and schematic of wiring interconnection; end-of-line device locations; location of controlled devices such as dampers and shutters; location of instructional signage; and the location(s) of the aerosol generator(s)
(16) Scale drawing showing the layout of the annunciator panel graphics if required by the authority having jurisdiction
(17) Details of the method of generator securement showing method of securement to the generator and to the building structure
(18) Complete step-by-step description of the system sequence of operations, including functioning of abort and maintenance disconnect switches, delay timers, and emergency power shutdown
(19) Point-to-point wiring schematic diagrams showing all circuit connections to the system control panel, to the graphic annunciator panel, and to external or add-on relays
(20) Complete calculations to determine enclosure volume, quantity of agent, and size of backup batteries and method used to determine number and location of audible and visual indicating devices and number and location of detectors
(21) The minimum clearances from the generator(s) to combustible materials and the means of egress
(22) Details of any special features

7.1.2.3 Information shall be submitted for approval to the authority having jurisdiction pertaining to the location and function of the detection devices, operating devices, auxiliary equipment, and electrical circuitry, if used.

7.1.2.3.1 Apparatus and devices used shall be identified.

7.1.2.3.2 Any special features shall be explained.

7.1.2.3.3 The details on the system shall include information and calculations on the amount of agent.

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7.1.2.4 An as-built instruction and maintenance manual that includes a full sequence of operations and a full set of drawings and calculations shall be maintained on site.

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7.1.3 Approval of Plans.

7.1.3.1 Plans and calculations shall be approved prior to installation.

7.1.3.2 Where field conditions necessitate any change from approved plans, the change shall be approved prior to implementation.

7.1.3.3 When such changes from approved plans are made, the working plans shall be updated to accurately represent the system as installed.

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7.2 Enclosure.

7.2.1 Unclosable Openings. In the design of a total flooding system, the integrity of the protected enclosure shall be considered.

7.2.1.1 The area of unclosable openings in the protected enclosure shall be kept to a minimum.

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7.2.1.2 To prevent loss of agent through openings to adjacent hazards or work areas, openings shall be permanently sealed or equipped with automatic closures.

7.2.1.3 Where reasonable confinement of agent is not practicable, protection shall be expanded to include the adjacent connected hazards or work areas, or additional agent shall be introduced into the protected enclosure using an extended discharge configuration.

7.2.2 Forced-Air Ventilating Systems. Forced-air ventilating systems shall be shut down or closed automatically where their continued operation would adversely affect the performance of the fire-extinguishing system or result in propagation of the fire.

7.2.2.1 Completely self-contained recirculating ventilation systems shall not be required to be shut down.

7.2.2.2 The volume of the ventilation system and associated ductwork shall be considered part of the total hazard volume when determining the quantity of agent.

7.2.3 Enclosure Strength and Pressure Venting. The protected enclosure shall have the structural strength and integrity necessary to contain the agent discharge.

7.2.3.1 If the developed pressures present a threat to the structural strength of the enclosure, venting shall be provided to prevent excessive pressures.

7.2.3.2 Designers shall consult the system manufacturer's recommended procedures relative to enclosure venting.

7.3 Design Application Density.

7.3.1 Determining Design Application Density.

7.3.1.1 The extinguishing application density shall be used in determining the agent design application density for a particular fuel.

7.3.1.2 For combinations of fuels, the extinguishment value for the fuel requiring the greatest design application density shall be used unless tests are made on the actual mixture.

7.3.2 Extinguishment.

7.3.2.1 Class B Fuels. The extinguishing application density for Class B fuels shall be determined by test as part of a listing program.

7.3.2.1.1 The minimum design application density for a Class B fuel hazard shall be the extinguishing application density, as determined in 7.3.2.1, multiplied by a safety factor of 1.3.

7.3.2.2 Class A Fuels. The extinguishing application density for Class A fuels shall be determined by test as part of a listing program.

7.3.2.2.1 The minimum design application density for a Class A surface fire hazard shall be the extinguishing application density, as determined in 7.3.2.2, multiplied by a safety factor of 1.3.

7.3.2.3 Class C Fuels. The minimum design application density for Class C hazards shall be at least that for the class of fire hazard being protected as defined in 3.3.7.1 and 3.3.7.2.

7.3.2.4 Fuel Combinations. For combinations of Class A and Class B fuels, the design application density shall be the value for the fuel requiring the greater design application density.

7.4 Total Flooding Quantity.

7.4.1 Quantity Calculation. The mass of aerosol-forming compound required shall be calculated from the following formula:

[7.4.1]

$$m = d_a \times f_a \times V$$

where:

m = total flooding quantity [g (lb)]
d_a = design application density [g/m^3 (lb/ft^3)] *(see Section 7.4)*
f_a = product of all additional design factors, as applicable *(see 7.5.2)*
V = protected volume [m^3 (ft^3)]

7.4.2* Additional Design Factors. In addition to the agent quantity determined by the design application density, additional quantities of agent shall be provided through the use of additional design factors to compensate for any special conditions that would affect the extinguishing efficiency.

N **7.4.2.1 Minimum Design Factor Considerations.** The product of all additional design factors, f_a, in Equation 7.4.1, as a minimum, shall include the following:

(1) Aerosol agent quantity compensation for leakage
(2) Aerosol agent quantity compensation for room ceiling height

N **7.4.2.2* Design Factor Determination Method.** Due to the unique characteristics of individual aerosol agents, each listed manufacturer shall provide detailed, specific calculations in its design manual to determine additional agent requirements based on the height of the enclosure, as well as open areas and placement of unclosable openings throughout the protected enclosure.

Δ **7.4.2.3 Other Design Factors.** The designer shall assign and document other design factors for each of the following:

(1) Re-ignition from heated surfaces
(2) Fuel type, configurations, scenarios not fully accounted for in the extinguishing application density, enclosure geometry, and obstructions and their effects on distribution
(3) Ambient pressures that vary more than 11 percent [equivalent to approximately 915 m (3000 ft) of elevation change] from standard sea level pressures

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7.5* Duration of Protection. The agent design application density shall be maintained for the specified period of time to prevent re-ignition of the fire before effective emergency action can be taken by trained personnel.

7.6 Rate of Application.

7.6.1 Initial Discharge.

7.6.1.1 The minimum design rate of application shall be based on the quantity of agent required for the desired design application density and the time allotted to achieve that desired design application density within the protected space.

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7.6.1.2 The discharge time required to achieve 95 percent of the design application density shall not exceed 60 seconds or as otherwise required by the authority having jurisdiction.

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7.6.2 Extended Discharge. When an extended discharge is necessary to maintain the design application density for the specified period of time, additional agent quantities shall be applied.

7.6.2.1 The initial discharge shall be completed within the limits specified in 7.6.1.2.

7.6.2.2 The performance of the extended discharge system shall be confirmed by test.

Δ **7.7 Generator Choice and Location.**

7.7.1 Aerosol generators shall be of the type listed for the intended purpose and shall be placed within the protected enclosure in compliance with listed limitations with regard to spacing, floor coverage, thermal clearances, and alignment.

Δ **7.7.2** The type of generators selected, their number, and their placement shall be such that the design application density will be established in all parts of the hazard enclosure.

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Chapter 8 Approval of Installations

8.1* General.

8.1.1 The completed system shall be reviewed and tested by qualified personnel to meet the approval of the authority having jurisdiction.

8.1.2 Only listed equipment and devices shall be used in the systems.

8.1.3 Where field conditions necessitate any change from approved plans, the change shall be approved prior to implementation.

8.1.4 When such changes from approved plans are made, the working plans shall be updated to accurately represent the system as installed.

8.1.5 Installing contractor shall verify that fans and/or the dampers operate in accordance with the approved design.

8.1.6* Agent shall not directly impinge on areas where personnel could be found in the work area.

8.1.7* Agent shall not directly impinge on any loose objects or shelves, cabinet tops, or other surfaces.

8.1.8 Adequate quantity of agent to produce the desired specified design application density shall be provided.

8.1.8.1 The actual room volumes shall be checked against those indicated on the system drawings to ensure the proper quantity of agent.

8.1.8.2 Fan coastdown and damper closure time shall be taken into consideration.

Δ **8.1.9*** All systems shall have the enclosure examined to locate and then seal any air leaks (other than those included in the approved plans) that could result in a failure of the enclosure to hold the specified agent design application density for the specified holding period.

• **8.1.10 Review Electrical Components.**

8.1.10.1 Wiring. All wiring systems shall be installed in accordance with *NFPA 72*.

8.1.10.2 Functional Testing.

Δ **8.1.10.2.1 Preliminary Functional Tests.** The following preliminary functional tests shall be provided:

(1) If the system is connected to an alarm-receiving office, notify the alarm-receiving office that the fire system test is to be conducted and that an emergency response by the fire department or alarm station personnel is not desired.
(2) Notify all concerned personnel at the end user's facility that a test is to be conducted and instruct personnel as to the sequence of operation.
(3) Disable each generator so that activation of the release circuit will not release agent.
(4)* Reconnect the release circuit with a functional device in lieu of each generator.
(5) Check each detector for response.
(6) Check that polarity has been observed on all polarized alarm devices and auxiliary relays.
(7) Check that all end-of-line resistors have been installed across the detection and alarm bell circuits where required.
(8) Check all supervised circuits for trouble response.

Δ **8.1.10.2.2 System Functional Operational Test.** The following system functional operational tests shall be performed:

(1) Operate detection initiating circuit(s).
(2) Verify that all alarm functions occur according to design specification.
(3) Operate the necessary circuit to initiate a second alarm circuit if present.
(4) Verify that all second alarm functions occur according to design specifications.
(5) Operate manual release.
(6) Verify that manual release functions occur according to design specifications.
(7) Operate abort switch circuit if supplied.
(8) Verify that abort functions occur according to design specifications.
(9) Confirm that visual and audible supervisory signals are received at the control panel.
(10) Check pneumatic equipment, where required, for integrity.

8.1.10.2.3 Remote Monitoring Operations. The following testing of remote monitoring operations, if applicable, shall be performed:

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

8.1.10.2.4 Control panel primary power source shall be in accordance with *NFPA 72*.

Δ **8.1.10.2.5 Return of System to Operational Condition.** When all functional testing has been completed, each generator shall be reconnected so that activation of the release circuit will release the agent.

8.1.10.2.5.1* The system shall be returned to its fully operational design condition, as specified in the approved plans.

8.1.11 Alternating current (ac) and direct current (dc) wiring shall not be combined in a common conduit or raceway unless shielded and grounded.

8.1.11.1 All field circuits shall be free of ground faults and short circuits.

8.1.11.1.1 Where field circuitry is being measured, all electronic components, such as smoke and flame detectors or special electronic equipment for other detectors or their mounting bases, shall be removed, and jumpers shall be installed to prevent the possibility of damage within these devices.

8.1.11.1.2 Components shall be replaced after measuring.

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

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

8.1.12 Auxiliary Functions.

8.1.12.1 All auxiliary functions such as alarm sounding or alarm-displaying devices, remote annunciators, air-handling shutdown, and power shutdown shall be checked for operation in accordance with system requirements and design specifications.

8.1.12.2 If possible, all air-handling and power cutoff controls shall be of the type that, once interrupted, requires manual restart to restore power.

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

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

8.1.15 Location.

8.1.15.1 Detectors shall not be located near obstructions or air ventilation and cooling equipment that would appreciably affect their response characteristics.

8.1.15.2 Where applicable, air changes for the protected area shall be taken into consideration.

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

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

8.1.18 All manual stations used to release agents shall require two separate and distinct actions for operation.

8.1.18.1 All manual stations used to release agents shall be identified.

8.1.18.2 Particular care shall be taken where manual release devices for more than one system are in close proximity and could be confused or the wrong system actuated.

8.1.18.3 Manual stations in this instance shall be clearly identified as to which zone or suppression area they affect.

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

8.1.20 For systems using abort switches, the switches shall be of the dead man type requiring constant manual pressure, installed, readily accessible within the hazard area, and clearly identified.

8.1.20.1 Switches that remain in the abort position when released shall not be used for this purpose.

8.1.20.2 Manual pull stations shall always override abort switches.

8.1.21 The control unit shall be installed and readily accessible.

8.1.22 Control Panel Primary Power Source.

8.1.22.1 The following testing of the control panel primary power source shall be performed:

(1) Verify that the control panel is connected to a dedicated circuit and labeled.
(2) Test a primary power failure in accordance with the manufacturer's specification with the system fully operated on standby power.

8.1.22.2 The control panel shall be readily accessible, yet restricted from unauthorized personnel.

8.1.23 The alarm-receiving office and all concerned personnel at the end user's facility shall be notified that the fire system test is complete and that the system has been returned to full service condition.

8.2 Inspection of Aerosol Generators.

8.2.1 Aerosol generators shall be securely fastened to limit vertical or lateral movement during discharge in accordance with the manufacturer's specifications.

8.2.2 Aerosol generators and any associated equipment shall be securely fastened to prevent vertical or lateral movement during discharge that is not included in the design.

Δ **8.2.3** All aerosol generators shall be located in accordance with an approved set of system drawings.

Δ **8.2.4** All aerosol generator mounting brackets shall be fastened securely in accordance with the manufacturer's requirements.

8.2.5 Aerosol generators and mounting brackets shall be installed in such a manner that they will not cause injury to personnel.

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Chapter 9 Inspection, Testing, and Maintenance

9.1 General.

Δ **9.1.1** Testing, impairment, and restoration of aerosol systems shall be reported promptly to the authority having jurisdiction.

9.1.2 Any impairments that will have a detrimental effect on system performance shall be corrected in a timely manner consistent with the hazard protected.

9.2* Interfaced Systems and Equipment. Any interfaced system installed in accordance with other installation standards shall be maintained as required by those other standards.

9.3 Inspection.

9.3.1 At least semiannually, a visual inspection shall be conducted to assess the aerosol system's operational condition.

N **9.3.2** Where external visual inspection indicates that the generator has been damaged, it shall be replaced.

Δ **9.3.3** At least every 12 months, the enclosure protected by the aerosol system shall be thoroughly inspected to determine if penetrations or other changes have occurred that could adversely affect agent leakage or change volume of hazard or both.

9.3.4 At least annually, all systems shall be thoroughly inspected for proper operation by qualified personnel.

9.3.5 At least semiannually, the pressure or weight of pilot containers shall be inspected.

Δ **9.3.6 Flexible Connectors.**

N **9.3.6.1** All flexible connectors shall be inspected annually for damage.

9.3.6.2 If the inspection shows any deficiency, the flexible connector shall be immediately replaced or tested as specified in 9.5.

9.4 Maintenance.

9.4.1 Systems shall be maintained in full operating condition at all times.

9.4.2 All systems shall be subjected to the manufacturer's maintenance procedures by qualified personnel.

9.4.3 Where the inspection indicates conditions that result in an inability to maintain the aerosol design application density, they shall be corrected.

9.4.4 Any penetrations made through the enclosure protected by the aerosol system shall be sealed immediately with an approved material that will restore the original fire resistance rating of the enclosure.

9.4.5 Carbon dioxide pilot cylinders with loss of weight of more than 5 percent shall require refilling or replacement of the container.

9.4.6 A loss of pressure (adjusted for temperature) of more than 5 percent for any pilot cylinder shall require refilling or replacement of the pilot cylinder.

9.5 Testing.

9.5.1 If a condition that affects system performance exists, the enclosures shall be evaluated for integrity in accordance with Chapter 8.

9.5.2 At least annually, all systems shall be subjected to the manufacturer's test procedures by qualified personnel.

9.5.3* Pressurized containers used for aerosol fire extinguishing systems shall be hydrostatically tested or replaced according to the requirements of DOT or TC, or similar requirements acceptable to the authority having jurisdiction.

9.5.4 All flexible connectors shall be tested every 5 years at 150 percent of the maximum container pressure at 55°C (130°F).

9.5.5 The testing procedure shall be as follows:

(1) The flexible connector is removed from any attachment.
(2) The flexible connector is then placed in a protective enclosure designed to permit visual observation of the test.
(3) The flexible connector is completely filled with water before testing.
(4) Pressure then is applied at a rate-of-pressure rise to reach the test pressure within a minimum of 1 minute.
(5) The test pressure is maintained for 1 full minute.
(6) Observations are made to note any distortion or leakage.
(7) If the test pressure has not dropped or if the couplings have not moved, the pressure is released.
(8) The flexible connector is considered to have passed the hydrostatic test if no permanent distortion has taken place.
(9) Flexible connectors passing the test must be completely dried internally.
(10) If heat is used for drying, the temperature must not exceed the manufacturer's specifications.
(11)* Flexible connectors failing a hydrostatic test must be marked, destroyed, and then replaced with new flexible connectors.
(12) Each flexible connector passing the hydrostatic test is marked to show the date of test.

9.6 Record Keeping.

9.6.1 A completed copy of the inspection, testing, and maintenance reports performed on these systems in accordance with this standard shall be furnished to the owner of the system or an authorized representative, and the records shall be retained for the life of the system.

9.6.2 Inspections required for pressurized containers shall be recorded on both of the following:

(1) A record tag permanently attached to each pressurized container
(2) An inspection report

9.7 Disposal of Components and Agents. All generators removed from useful service shall be returned to the manufacturer, or their designee, for recycling or disposal in an environmentally sound manner and in accordance with existing laws and regulations.

Caution

Improper discharge of an aerosol generator can cause personal injury.

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Chapter 10 Marine Systems

10.1 Scope. This chapter shall be limited to applications using marine systems with aerosol fire extinguishing agents on commercial vessels and pleasure craft.

10.2 General.

10.2.1 Chapter 10 outlines the deletions, modifications, and additions that shall be required for marine applications.

10.2.2 All other requirements of this standard shall apply to marine systems except as modified by this chapter.

10.3 Special Definitions. See Section 3.4.

10.4 Inspected Vessels.

10.4.1 Use and Limitations.

10.4.1.1 Aerosol fire-extinguishing systems used to protect hazards that are partially or totally enclosed or equipment that is partially or totally enclosed on inspected vessels shall comply with the requirements of this section.

10.4.1.2 Aerosol fire-extinguishing systems used to protect normally occupied spaces shall have a time delay and audible and visual pre-discharge alarms that sound in the protected space for at least 20 seconds prior to discharge.

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10.4.2 Detection, Alarm, and Control.

Δ **10.4.2.1** All circuits essential for the release of the system located within the protected space shall be fire-resistive cable systems compliant with Article 728 of *NFPA 70*.

10.4.2.2 System discharge shall be indicated on the navigating bridge.

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10.4.3 System Component Requirements.

10.4.3.1 System components shall be specifically listed or approved for marine applications.

10.4.3.2 The system and equipment shall be designed to withstand ambient temperature changes, vibrations, humidity, shock, impact, clogging, and corrosion normally encountered in ships.

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10.4.3.3 Heat-sensitive materials shall not be used for mounting brackets.

10.4.3.4 Aluminum components shall not be used for manually operated systems.

Δ **10.4.3.5** High-pressure cylinders shall comply with the requirements of the U.S. Department of Transportation (DOT), 49 CFR or other approved international standards.

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10.4.4 Detection, Actuation, and Control Systems.

10.4.4.1 Automatic detection systems shall initiate audible and visual alarms in the protected space and on the navigating bridge upon detection of fire.

10.4.4.2 Detection and alarm system components shall be electrically supervised for fault conditions.

10.4.4.3 Detection system trouble signals shall initiate audible and visual alarms on the navigating bridge.

10.4.4.4 Power Supplies.

10.4.4.4.1 Automatic detection, signaling, control, and actuation systems shall have at least two independent power supplies with automatic changeover.

10.4.4.4.2 One of the sources of power described in 10.4.4.4.1 shall be wholly provided from outside the protected space.

10.4.4.5 The backup power supply shall be sized to operate the system for at least 24 hours.

10.4.4.6 Automatic release of the extinguishing system shall not be permitted in spaces over 170 m^3 (6000 ft^3) where actuation of the system would interfere with the safe navigation of the vessel.

10.4.4.7 Every system shall have a remote manual actuation station located in the main egress route outside the protected space.

Δ **10.4.4.8** Instructions for the operation of the system shall be located in a conspicuous place at or near all manual actuation stations.

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10.4.4.9 Manual actuation of the system shall require two separate actions, except for systems protecting spaces less than 170 m^3 (6000 ft^3).

10.4.4.10 Interlocks shall be provided to shut down any pressurized fuel systems and power-operated ventilation systems serving the protected space prior to agent discharge.

10.4.5 Enclosure.

10.4.5.1 All openings in the protected space shall be permanently sealed to prevent the loss of agent or shall comply with 10.4.5.2 or 10.4.5.3.

10.4.5.2 Openings in the protected space that cannot be permanently sealed to prevent the loss of agent shall be arranged to be automatically closed prior to the release of agent.

10.4.5.3 Additional quantities of agent shall be provided to compensate for any openings in the protected space that cannot be permanently sealed or equipped with automatic closures to prevent the loss of agent.

10.4.6 Agent Design Application Density.

10.4.6.1 For combinations of fuels, the agent design application density shall be determined for the fuel requiring the greatest design application density.

10.4.6.2 The agent design application density shall be determined at the lowest expected ambient temperature in the protected space.

10.4.6.2.1 The agent design application density for machinery spaces shall be determined at 0°C (32°F).

10.4.6.2.2 The agent design application density for cargo pump rooms shall be determined at −18°C (0°F).

10.4.6.3 The agent design application density shall be calculated based on the net volume of the protected space.

10.4.6.4 If the protected space includes a bilge or a machinery casing area, the volume of these areas shall be included in the net volume calculation.

10.4.6.5 If the protected space includes pressurized air receivers, their equivalent free air volume shall be included in the net volume calculation.

10.4.6.6 For flammable and combustible liquid hazards, the minimum agent design application density shall be determined by full-scale testing in accordance with IMO MSC/Circular 1270.

10.4.6.7 For ordinary combustible hazards, including electrical components, the minimum agent design application density shall be determined by testing acceptable to the authority having jurisdiction.

Δ **10.4.6.8** The spacing, area of coverage, ceiling height, and location of generators shall be within the limits determined by full-scale fire tests in accordance with IMO MSC/Circular 1270 for flammable and combustible liquids or in accordance with the testing required by 10.4.6.7 for ordinary combustibles.

10.4.7 Duration of Protection. The quantity of agent provided shall be sufficient to maintain the minimum agent design application density in the protected space for at least 15 minutes.

10.4.8 Compliance. Electrical systems shall comply with 46 CFR, Subchapter J, "Electrical Engineering."

10.5 Uninspected Vessels and Pleasure Craft.

10.5.1 Use and Limitations.

10.5.1.1 Aerosol fire-extinguishing systems used to protect unoccupied spaces on uninspected vessels and pleasure craft shall comply with the requirements of Section 10.5.

10.5.1.2 Aerosol fire-extinguishing systems used to protect normally occupied spaces and spaces larger than 57 m^3 (2000 ft^3) shall comply with the requirements of Section 10.4.

10.5.2 System Component Requirements.

Δ **10.5.2.1** Aerosol fire-extinguishing system components shall be specifically listed or approved for use on uninspected vessels and pleasure craft.

10.5.2.2 The equipment shall be designed to withstand ambient temperature changes, vibrations, humidity, shock, impact, clogging, and corrosion normally encountered in marine applications.

10.5.3 Installation.

10.5.3.1 Aerosol fire-extinguishing systems shall be installed in accordance with the manufacturer's listed instructions with approved brackets and mounting hardware.

10.5.3.2 Aerosol fire-extinguishing systems shall be installed within volume and spacing limits determined by testing acceptable to the authority having jurisdiction.

10.5.4 Detection, Actuation, and Control Systems.

10.5.4.1 Aerosol fire-extinguishing systems shall be automatically actuated.

10.5.4.2 Aerosol fire-extinguishing systems installed in spaces larger than 28 m^3 (1000 ft^3) shall have a manual actuator in addition to the automatic means of actuation.

10.5.4.3 The discharge of an aerosol fire-extinguishing system shall be indicated by a visual signal at the operator's console.

10.5.4.4 Aerosol fire-extinguishing systems with the capability to automatically shut down the vessel's engines shall have a means to permit restart of the engines from the operator's console.

10.5.4.5 Aerosol fire-extinguishing systems without the capability to automatically shut down the vessel's engines must be supplemented with a warning label posted at the operator's console that states:

IF FIXED FIRE-EXTINGUISHING SYSTEM DISCHARGES, SHUT DOWN ENGINES, GENERATORS, AND BLOWERS.

Annex A Explanatory Material

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

A.1.5.1 See IEEE/ASTM SI 10, *American National Standard for Metric Practice*.

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

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

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

N **A.3.3.1 Abort Switch.** The effect of an abort switch is typically a programmable configuration of the releasing panel, such that any of several modes of operation can be used. Typical options include the following:

(1) Engaging the abort switch pauses the countdown for as long as the switch remains engaged. The countdown resumes when the switch is released.
(2) Engaging the abort switch resets the timer to a predetermined value (e.g., the initial value or 30 seconds) and pauses the countdown for as long as the switch remains engaged. The countdown restarts when the switch is released.
(3) Engaging the switch permits the timer to continue counting down until it reaches a predetermined value (e.g., 10 seconds), then it pauses for as long as the switch remains engaged. The countdown resumes from the predetermined value when the switch is released.

Where an abort switch is installed, the selected mode should be approved by the authority having jurisdiction. *(See 6.2.5.4.)*

A.3.3.6 Automatic/Manual Switch. The means can be in the form of a manual switch on the control panel or other units or a personnel door interlock. In all cases, the switch changes the actuation mode of the system from automatic and manual to manual only and vice versa.

A.3.3.10.1 Design Application Density (g/m^3). Measuring the amount of solid aerosol particulate in the atmosphere after discharge of a system is technically difficult and resource intensive. Therefore, manufacturers use the extinguishing application density *(see 3.3.10.2)* and the design application density *(see 3.3.10.1)* as convenient proxies that can be used by system designers to calculate the amount of aerosol-forming compound that is necessary to protect a given space.

Extinguishing application density is calculated by taking the mass of solid aerosol-forming compound necessary to extinguish the fire over the volume of the protected space in a test fire. For example, in a 5 m^3 (176.6 ft^3) room, a hypothetical powdered aerosol could require 2 kg (4.4 lb) of solid aerosol-forming compound to extinguish a flame. Therefore, the extinguishing concentration in this example would be 400 g/m^3 (0.025 lb/ft^3). The design application density is calculated by adding 30 percent to the extinguishing design density. Therefore, for this example, the design application density would be 520 g/m^3 (0.032 lb/ft^3). Additional safety factors can be required depending on the specific characteristics of the hazard as specified by this standard. The system designer can then calculate the amount of solid aerosol-forming material needed to achieve the design application density and thus protect a given space by applying the formula in 7.4.1.

However, to assess the potential human health effects, manufacturers must conduct additional toxicity testing for use in normally occupied spaces. Such testing requires direct measurement of the particulates after discharge of the systems at the maximum design application density. The measurement is defined by this standard as the particulate density *(see 3.3.10.3)*.

A.3.3.10.2 Extinguishing Application Density (g/m^3). See A.3.3.10.1.

N **A.3.3.10.3 Particulate Density.** This information is used to assess the degrees of visibility obscuration and the potential health effects of accidental exposure to the agent.

A.3.3.17 Inspection. This is done by seeing that the system is in place, that it has not been actuated or tampered with, and that there is no obvious physical damage or condition to prevent operation.

A.3.3.18 Maintenance. It includes a thorough examination and any necessary repair or replacement of system components.

A.3.3.20 Mass Median Aerodynamic Diameter (MMAD). Fifty percent of the particles by weight will be smaller than the median diameter and fifty percent of the particles will be larger. (For more information, see EPA Health Effects Test Guidelines, OPPTS 870.1300, Acute Inhalation Toxicity.)

A.3.3.29 Unoccupiable. Examples of unoccupiable areas include shallow void spaces and cabinets.

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A.4.2.1.1 Aerosols can include systems incorporating discharge devices, methods of application, generator placement, actuation techniques, discharge times, and mounting techniques that could differ from those detailed elsewhere in this standard.

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Δ **A.5.1** The discharge of aerosol extinguishing systems to extinguish a fire could create a hazard to personnel from the natural form of the aerosol or from certain products of aerosol generation (including combustion products and trace gases from condensed aerosols). Unnecessary exposure of personnel to either the natural agent or the decomposition products should be avoided.

A.5.1.1 The SNAP Program was originally outlined in 59 FR 13044. There could be other national standards that need to be addressed for the country where the system is being installed.

Δ **A.5.2.1** Potential hazards to be considered for individual systems are the following:

(1) *Noise.* Discharge of a system can cause noise loud enough to be startling but ordinarily insufficient to cause traumatic injury.
(2) *Turbulence.* High-velocity discharge could be sufficient to dislodge substantial objects directly in their path. System discharge can cause enough general turbulence in the enclosures to move unsecured paper and light objects.
(3) *Reduced Visibility.* When activated, aerosol generators reduce visibility both during and after discharge period. This particular consideration is further addressed in A.5.2.5.
(4) *Potential Toxicity.* When activated, aerosol generators may produce toxic levels of gases such as carbon monoxide, nitrogen oxides, and ammonia, which are typical by-products of the aerosol-generating reaction. Actual concentrations of these by-products depend on the chemical composition of the aerosol-forming compound and coolant, engineering design of the aerosol generators, and conditions in the enclosure under protection. This particular consideration is further addressed in Annex C.
(5) *Thermal Hazard.* A condensed aerosol discharges at elevated temperatures. Depending on the intended application(s) of the aerosol system, the temperature and minimum clearance from the discharge outlet are specified by the manufacturers of the aerosol generators. Immediately after discharge, aerosol generators can be hot; therefore, protective gloves should be worn by personnel handling generators after discharge.
(6) *Eye Irritation.* Direct contact with the particles being discharged from a system can result in irritation, tearing, and burning of the eyes. Exposure of the powdered aerosol to the eyes should be avoided. This particular consideration is addressed in Annex C.

A.5.2.3.1 The intent of the pre-discharge alarm and time delay is to prevent human exposure to the aerosol agents by providing a warning of a pending discharge and allowing personnel to exit the protected space before the start of discharge.

A.5.2.4 See Annex B for toxicity information regarding the toxic effects of aerosols.

The design application density for occupied spaces should not exceed the values in Table A.5.2.4 for the specific aerosol.

A.5.2.4.2 Reference is made to EPA/600/8-90/066F.

A.5.2.5 Such safety measures can include but are not limited to personnel training, goggles, audio devices, floor-mounted directional lighting, evacuation plans, and exit drills.

See Annex C for reduced visibility information.

A.5.2.7.6 The steps and safeguards necessary to prevent injury or death to personnel in areas whose atmospheres will be made hazardous by the discharge or thermal decomposition of aerosol agents can include the following:

(1) Provision of adequate aisleways and routes of exit and procedures to keep them clear at all times.
(2) Provision of emergency lighting and directional signs as necessary to ensure quick, safe evacuation.
(3) Provision of alarms in such areas that will operate immediately on detection of the fire.
(4) Provision of only outward-swinging, self-closing doors at exits from hazardous areas and, where such doors are latched, provision of panic hardware.

N **Table A.5.2.4 Typical Maximum Allowable Design Application Densities for Normally Occupied Spaces**

Aerosol Agent Designation	Maximum Allowable Design Application Density [g/m^3]
Inert gas/powdered aerosol blend	*
Powdered aerosol A	*
Powdered aerosol C	*
Powdered aerosol D	100
Powdered aerosol E	109.2
Powdered aerosol F	*
Powdered aerosol G	*

*A maximum allowable design application density for occupied spaces has not been determined. The aerosol agent is approved by the U.S. EPA SNAP Program for normally unoccupied areas only. If determined at a later date, a value could be added.

(5) Provision of continuous alarms at entrances to such areas until the atmosphere has been restored to normal.
(6) Provision of warning and instruction signs at entrances to and inside such areas. These signs should inform persons in or entering the protected area that an aerosol system is installed and should contain additional instructions pertinent to the conditions of the hazard.
(7) Provision for the prompt discovery and rescue of persons rendered unconscious in such areas. This should be accomplished by having such areas searched immediately by trained personnel equipped with proper breathing equipment. Self-contained breathing equipment and personnel trained in its use and in rescue practices, including cardiopulmonary resuscitation (CPR), should be readily available.
(8) Provision of instruction and drills for all personnel in or in the vicinity of such areas, including maintenance or construction people who could be brought into the area, to ensure their correct action when an aerosol system operates.
(9) Provision of means for prompt ventilation of such areas. Forced ventilation will often be necessary. Care should be taken to readily dissipate hazardous atmospheres and not merely move them to another location.
(10) Prohibition against smoking until the atmosphere has been determined to be free of the aerosol agent.
(11) Following a system discharge, removal, in accordance with the manufacturer's recommendations, of the aerosol that has settled. Protective clothing, including gloves and goggles, should be worn. A respirator or mask can be required.
(12) Provision of such other steps and safeguards that a careful study of each particular situation indicates is necessary to prevent injury or death.

A.5.2.7.7 A certain amount of leakage from a protected space to adjacent areas is anticipated during and following agent discharge. Consideration should be given to agent density, decomposition products, products of combustion, and relative size of adjacent spaces. Additional consideration should be given to exhaust paths when the enclosure is opened or vented after a discharge.

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A.6.2.1.1 In Canada, refer to CAN/ULC S524-06 and CAN/ULC S529-09.

N **A.6.2.4.2.4.1** Independent inspection and certification are recommended.

A.6.2.5.4 A telephone should be located near the abort switch. An abort switch should not be operated unless the cause of the alarm condition is known and corrective action can be taken.

A.6.2.5.7.2 Hazards associated with fast-growth fires would include but not be limited to flammable liquid storage or transfer and aerosol filling areas.

A.6.2.6 Accidental discharge can be a significant factor in unwanted aerosol agent emissions. Equipment lockout or service disconnects can be instrumental in preventing false discharges when the aerosol agent system is being tested or serviced. In addition, servicing of air-conditioning systems with the release of refrigerant aerosols, soldering, or turning electric plenum heaters on for the first time after a long period of being idle could trip the aerosol system. Where used, an equipment service disconnect switch should be of the keyed-access type if external to the control panel, or it can be a toggle type if it is within the locked control panel. Either type should annunciate at the panel when in the out-of-service mode. Written procedures should be established for taking the aerosol system out of service.

A.7.4.2 Fan coastdown and damper closure time should be taken into consideration.

N **A.7.4.2.2** Aerosol fire suppression agents are discharged as warm or hot ultrafine particulates and effluent propellant gases. While the aerosol self-contained device is discharging, the propelled aerosol immediately mixes with the room ambient air, which typically is cooler than the aerosol airborne particulates and gases. The warm aerosol gases are also discharged as a low-pressure compressed gas, which expands as soon as the gases are discharged from the aerosol unit. The result is that the aerosol/enclosure air mechanical mixture is buoyant or exhibits lighter-than-air characteristics causing the bulk of the aerosol to float in the upper half of the enclosure. The leakage calculation method described in the Russian standard NPB 88-2001 highlights this phenomena, such that leakage areas located at mid-level to ceiling level in the enclosure will require a higher compensation factor than leakage areas in the lower half of the enclosure. Consequently, in determination of factor f_a in Equation 7.4.1, the location of the leakage area in the enclosure does impact the aerosol quantity compensation calculation. Further details can be found in NPB 88-2001.

A.7.5 Because measuring the concentration of the actual aerosol presents certain difficulties, other physical properties proportional to the aerosol, such as optical transmittance, can be measured, provided adequate calibration between such properties and aerosol concentration can be effected. The measuring technique, procedure, and calibration method shall be endorsed by an appropriate authority.

Δ **A.8.1** Safe practices include preventing injury to personnel in the area. The generators and mounting brackets should be installed in such a manner that they will not potentially cause injury to personnel.

Δ **A.8.1.6** Suitable clearances below and around all discharge ports should be a concern to all installations to prevent discharge of aerosol extinguishing agents on people.

A.8.1.7 Aerosol extinguishing agent discharging on these surfaces where loose objects could be present can result in those objects becoming dislodged and causing injury to occupants, or property damage.

A.8.1.9 The extinguishing medium for condensed aerosols is the ultrafine particulate with the gas generated in the reaction serving primarily as a carrier vehicle, similar to a dry chemical system. As such, a thorough visual inspection of the area is sufficient. Observed unclosable openings must be taken into consideration in the design and detailed calculations for additional agent quantities based on the manufacturer's design manual, and this data must be provided to ensure the specified agent design application density for the specified duration of protection.

In special circumstances as determined by the AHJ, a blower door fan test could be undertaken to determine the total open area in the protected enclosure only. However, location of the leakage points in the protected enclosure is an important design factor, and this information cannot be provided by the door fan test. In the event a door fan test is conducted, the sum of the openings in the design calculation should be equal to or greater than the equivalent open area as determined by the door fan test.

A.8.1.10.2.1(4) For electrically actuated release mechanisms, these devices can include 24 V lamps, flashbulbs, or circuit breakers. Pneumatically actuated release mechanisms can include pressure gauges. Refer to the manufacturer's recommendations in all cases.

A.8.1.10.2.5.1 During maintenance of installed systems, the protected area should be examined and compared to the original design area to verify that the system as installed will still provide adequate protection.

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A.9.2 Actuation systems can be installed in accordance with either *NFPA 70* or *NFPA 72*. This standard is not detailing the inspection, testing, and maintenance requirements for these systems, since these other installation standards detail the ITM for these systems.

Δ **A.9.5.3** U.S. Department of Transportation (DOT), or Transport Canada (TC) containers should not be recharged without retesting if more than 5 years have elapsed since the date of the last test and inspection.

A.9.5.5(11) The flexible connector should be destroyed in such a manner to prevent reuse.

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Annex B Toxicity Information

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Design requirements of the powdered aerosol fire suppressants are such that the particles must be 10 μm for maximum effectiveness. Particles of this size are able to be inhaled, thus making potential exposure to the respiratory system (nasal passages, trachea, bronchus, and terminal bronchioles) a concern. For example, in humans, particles of size 5 μm to 30 μm are typically deposited in the nasopharyngeal (nose and throat) region due to impaction, while particles ranging from 1 μm to 5 μm will deposit by sedimentation within the trachea (windpipe) and bronchiolar (lower lung) region. Particles approximating 1 μm will diffuse into the alveolar region (gas exchange area) and can affect gas exchange and be absorbed into the bloodstream. The location of particle settling has a large effect on what happens to the particle following exposure and the types of adverse effects it might cause. For example, particles depositing in the upper nasal passages can be sneezed or breathed out, while those in the nasopharyngeal and tracheobronchial regions are removed via mucociliary transport [via the threadlike fringes (cilia) on cells lining these regions of the respiratory system]. Although the duration of exposure in an accidental release is very short (≤5 minutes), the large amounts of aerosol released by the suppressant mechanism suggests that exposures to aerosol components will be high. Further, because clearance of the deposited material does not occur rapidly (e.g., within days to weeks), the potential exists for injury even though the exposure time is very short.

Table B.1(a) shows the locations for deposition based on particle size and the clearance mechanisms and clearance times for deposited particles.

Powdered aerosols are typically composed of multiple soluble and insoluble compounds. As such, acute inhalation exposure to very high concentrations of these compounds can induce a variety of adverse effects in humans. Therefore, a limited battery of toxicity tests is required to determine the appropriateness of the powdered aerosol system for use in occupied spaces. These tests are the following:

(1) *Draize Eye Irritation Test.* This assay, using a rabbit model, is currently recommended for assaying the potential for eye irritation (reversible eye effects) and corrosion (irreversible damage to eye tissue) after exposure to a variety of toxicants.
(2) *Static Acute Inhalation Toxicity Test.* This assay is designed to determine the acute toxicity of an actual exposure to the powdered aerosol agent at its design concentration. The test assays the potential for suffocation and immediate pulmonary responses in the test animal induced by both insoluble and soluble particles in the powdered aerosol. Because exposure in this test is limited to a very short period (e.g., 15 minutes), it is necessary to model exposure to the powdered aerosol at its design concentration. Doing so ensures that the design concentration has been adequately tested with regard to immediate adverse effects (e.g., suffocation).
(3) *Additional Toxicity Tests as Needed.* In the event that a powdered aerosol comprises components with unknown toxicity, it can be appropriate to conduct a more extensive inhalation toxicity test to determine potential effects, particularly if the design concentration cannot be achieved or closely approximated in the static toxicity test. An example of an additional test is the acute inhalation limit test, which uses a 4-hour exposure duration.

It is important to have data on the aerodynamic properties of the powdered aerosol [e.g., the mass median aerodynamic diameter (MMAD) and geometric standard deviation, σg]. These values are necessary to determine where the particles can deposit within the airways of a rodent model and in a potentially exposed human. These values are important because the larger the number of particles (and thus increased total mass) capable of penetrating the lung, the greater the probability of a toxic effect. Table B.1(b) provides information regarding areas of the human respiratory tract where particulate matter can be deposited following exposure.

B.2 An appropriate protocol measures the effect in a stepwise manner such that the interval between the lowest observable adverse effect level (LOAEL) and the no observed adverse effect level (NOAEL) is sufficiently small to be acceptable to the competent regulatory authority. The EPA includes in its SNAP evaluation this aspect (of the rigor) of the test protocol. (The SNAP Program was originally outlined in 59 FR 13044.) For powdered aerosols covered in this standard, the NOAEL and LOAEL are based on acute pulmonary toxicity. The measured endpoints can include suffocation, pulmonary edema, inflammation, and a myriad of other cellular responses, such as cytokine activation.

B.3 Because pulmonary responses in animal models following inhalation exposures to high concentrations of particulate matter can differ substantially from that in humans, it is necessary to extrapolate the response in the animal model to that of a human under the same exposure conditions. In this regard, an appropriate dosimetry model, such as the Regional Deposited Dose Ratio model [1] or the Multiple Path Particle Dosim-

Table B.1(a) Locations and Mechanisms of Deposition of Particles in the Human Respiratory Tract and Postdeposition Clearance Times

Particle Size (μm)	Mechanism of Deposition	Location	Clearance Mechanism	Clearance Time
>10	Impaction	Nasopharyngeal	Mucociliary transport	Hours to days
5–10	Impaction	Nasopharyngeal	Mucociliary transport	Hours to days
1–5	Sedimentation	Tracheobronchiolar	Mucociliary transport	Hours to weeks
<1–2.5	Diffusion	Alveolar	Alveolar macrophage	Hours

etry model [2] should be used. These models allow the extrapolation between inhalation concentrations in animal models to that of a human to predict responses at particular exposure concentrations.

B.4 Some components of powdered aerosols can have the potential for inducing extrarespiratory systemic toxicity. This means that they do not cause toxicity to the respiratory system but instead result in an adverse effect to another organ (e.g., liver, kidneys, central nervous system) following uptake into the body's circulatory system. Examples of extrarespiratory toxicants are potassium carbonate, potassium bromide, and sodium bicarbonate. Exposure concentrations should be compared to known occupational limits set by appropriate governing bodies. For example, short-term exposure limits (STELs) can be available for these chemicals and should be used to determine whether individual components of the aerosol can pose a risk to human health following acute accidental exposure. Further, any available toxicity information on the aerosol components, combustion products (for condensed aerosols), or trace gases should be used to determine the potential for toxic effects following such an acute exposure. When reviewing the toxicity data, the focus should be on the target organ(s) and most sensitive effects. For those compounds with limited or no available toxicity data, a reasonable surrogate compound (i.e., structurally similar compound) should be used.

B.5 References.

(1) EPA/600/8-90/066F, Regional Deposited Dose Ratio Program in "Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry," October 1994.

(2) CIIT/RIVM, Chemical Industry Institute of Toxicology/ Dutch National Institute for Public Health and the Environment, Multiple Path Particle Dosimetry Model, MPDD V1.0, October 2002.

Annex C Reduced Visibility Information

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1 In the fire protection sector, safety and health depend on an individual's ability to escape a fire hazard. This ability could be impaired if a fire suppressant has an immediate toxic effect or decreases the visibility necessary to exit an occupied space. These factors can also pose risks in a nonfire situation. Visibility is of particular concern when powdered aerosols are used. The following discussion provides guidance to assist in the characterization of visibility. Authorities having jurisdiction might wish to consider this information when assessing powdered-aerosol fire extinguishers for occupied spaces.

Table B.1(b) Deposition of Particles in the Human Respiratory Tract as a Function of Particle Size

Particle Size (μm)	Extrathoracic (Nose and Throat)	Tracheo-bronchial	Pulmonary Region (Gas Exchange)
>10	Yes	No	No
5–10	Yes	Yes	No
2.5–5	Yes	Yes	Some
<2.5	Yes	Yes	Yes

C.2 Assessing Visibility for a Powdered Aerosol: A Model Approach. To ensure that powdered-aerosol products will meet the visibility requirements of the appropriate organizations, a brief assessment of visibility ratings as functions of concentration of agent and particle size is provided. Table C.2 provides an estimate of the distances an individual can see in a space where a powdered-aerosol fire extinguisher has been discharged in the absence of a fire. The distances are based on a standard contrast value of 0.02 for particulate matter with a given mass median aerodynamic diameter (MMAD) at varying concentrations, under sunlight conditions. If the release of the powdered aerosol restricts visibility in a room to 1 m or less, reengineering powdered-aerosol systems to improve visibility can be prudent. Manipulating particle size and concentration to increase visibility above 1 m is recommended because maneuvering around objects in a room to find an exit would be extremely problematic if vision is restricted to less than 1 m.

Table C.2 shows that visibility is a strong function of the powdered aerosol's concentration and MMAD. As the MMAD of the aerosol deviates (i.e., increases or decreases) from 0.6 μm and the concentration of the powdered aerosol remains constant, the visibility in the space improves. Additionally, as the concentration of the released powdered aerosol increases, the visibility in the space decreases.

The model is based on daylight conditions and might not precisely correspond to visibility in machinery spaces without natural light; however, the model can still be used as an approximate gauge for these circumstances. Note that if lighting is substantially below daylight conditions, then the values in Table C.2 overestimate visibility.

Table C.2 Visibility as a Function of Particle MMAD and Concentration

Particle Size MMAD (μm)	Visibility (cm) at Varying Concentrations										
	10 mg/m³	1,000 mg/m³	10,000 mg/m³	20,000 mg/m³	30,000 mg/m³	40,000 mg/m³	50,000 mg/m³	70,000 mg/m³	90,000 mg/m³	110,000 mg/m³	130,000 mg/m³
10	285,600.0	2,856.0	285.6	142.8	95.2	71.4	57.1	40.8	31.7	26.0	22.0
9	248,400.0	2,484.0	248.4	124.2	82.8	62.1	49.7	35.5	27.6	22.6	19.1
8	207,600.0	2,076.0	207.6	103.8	69.2	51.9	41.5	29.7	23.1	18.9	16.0
7	177,600.0	1,776.0	177.6	88.8	59.2	44.4	35.5	25.4	19.7	16.1	13.7
6	156,000.0	1,560.0	156.0	78.0	52.0	39.0	31.2	22.3	17.3	14.2	12.0
5	139,200.0	1,392.0	139.2	69.6	46.4	34.8	27.8	19.9	15.5	12.7	10.7
4	123,600.0	1,236.0	123.6	61.8	41.2	30.9	24.7	17.7	13.7	11.2	9.5
3	114,000.0	1,140.0	114.0	57.0	38.0	28.5	22.8	16.3	12.7	10.4	8.8
2	81,600.0	816.0	81.6	40.8	27.2	20.4	16.3	11.7	9.1	7.4	6.3
1	25,200.0	252.0	25.2	12.6	8.4	6.3	5.0	3.6	2.8	2.3	1.9
0.8	15,600.0	156.0	15.6	7.8	5.2	3.9	3.1	2.2	1.7	1.4	1.2
0.6	12,000.0	120.0	12.0	6.0	4.0	3.0	2.4	1.7	1.3	1.1	0.9
0.1	163,200.0	1,632.0	163.2	81.6	54.4	40.8	32.6	23.3	18.1	14.8	12.6

C.3 Design of the Model. This model is based on the standard visual range formula and Mie theory. (Mie theory is a mathematical-physical theory of the scattering of electromagnetic radiation by spherical particles.) [1] The following standard visual range formula is based on typical aerosol distribution in sunlight and the standard visual contrast:

[C.3]

$$L_v \approx \frac{1200}{C}$$

where:
L_v = visibility (km)
C = the concentration of the aerosol particles (μg/m³) for particles with MMAD falling in the range of 0.1 μm to 1 μm

Figure C.3 is based on Mie scattering and shows how the amount of light scattering, represented by a scattering coefficient, is dependent on particle MMAD. The figure shows how solar light at sea level, which has its peak wavelength in the range 0.4 μm to 0.6 μm, is most effectively scattered by particles with similar dimensions (i.e., 0.4 μm to 0.6 μm in diameter). Thus, light is less effectively scattered by particles whose size is larger or smaller than this optimal size range, and the resulting visibility improves. Thus, the visibility for a powdered aerosol is approximated by a function of the concentration, as shown by the standard visual range formula, and the particle MMAD for a given characteristic standard distribution of solar light is based on Mie scattering functions.

The scattering coefficient has been calculated and is shown in Figure C.3 for a given characteristic standard distribution of solar light based on Mie scattering functions over typical ground level visual wavelengths (0.36 μm to 0.68 μm) for a typical refractive index of 1.5.

C.4 Potential Settling Rates and the Effect on Visibility. The scattering model described in Section C.3 does not include any adjustment for the velocity at which the particles settle. If the particles settle quickly, the concentration of the powdered aerosol in the air decreases and visibility increases. Table C.4 shows settling velocity for spherical particles based on Stokes law and adjustments for friction and slip corrections. The table shows that over the time period of interest (<10 minutes) the vast majority of particles will remain suspended for particles with MMAD <10 μm. Fire suppressant systems tend not to use particles having MMAD >10 μm because the particles agglomerate and fall out of suspension, rendering the fire suppressant less effective. Therefore, since the settling velocities are minimal for the size particles used in fire suppressants, the settling velocity will not significantly alter the visibilities presented in Table C.2.

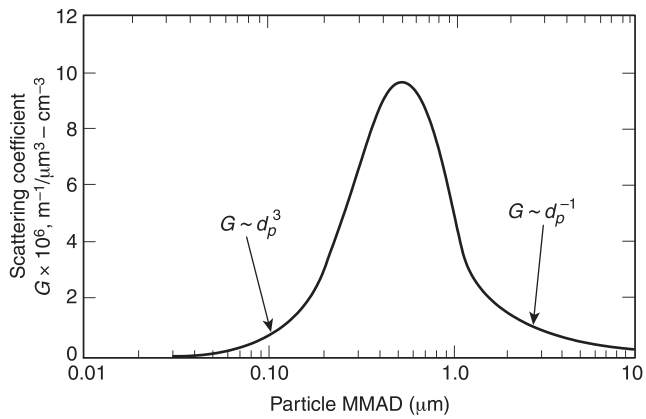

FIGURE C.3 Mie Scattering. (Source: Friedlander, *Smoke, Dust, and Haze: Fundamentals of Aerosol Dynamics*, Figure 5.8.)

C.5 Methods for Increasing Visibility and Ability to Exit Space. If the visibility resulting from use of a fire suppressant is <1 m, then mitigating activities should be performed to increase a person's ability to see the location of the exit in the protected space after the powdered aerosol extinguisher has been discharged. Methods for increasing visibility include re-engineering the powdered aerosol, designing the lighting and space to conform with physical properties of the powdered aerosol, and training the occupants to locate the exits in the event of a discharge.

Table C.4 Aerosol Settling Velocity for Spherical Particles in Air

MMAD (μm)	Settling Velocity (cm/s)
0.1	0.000086
0.2	0.00023
0.5	0.0010
1.0	0.0035
2.0	0.013
5.0	0.078
10	0.31
20	1.2
50	7.6

C.6 Engineering Powdered Aerosol According to the Model. One way to increase the visibility resulting from use of a powdered aerosol is to engineer the fire suppressant so that the scattering of light is minimized. Light scattering can be reduced by manipulating particle size and concentration and by choosing chemical constituents with low refractive indexes.

C.7 Manipulating Particle Size and Concentration. Calculations resulting from the Mie scattering visibility model presented in this annex indicate that a visibility of 1 m or more can be achieved by increasing the MMAD particle size above 0.6 μm and maintaining concentrations below 30,000 mg/m^3 *(see Table C.2)*. Adjusting the particle size below 0.6 μm also increases visibility but might not be feasible for most fire suppression systems. Engineers should manipulate particle size and design concentration to maximize visibility in an occupied space while maintaining the powdered aerosol's ability to effectively extinguish the fire.

C.8 Accounting for Refractive Index. The refractive index (i.e., the change in direction of light passing through the substance) of a particle also can influence visibility. This refractive index includes both scattering and absorption of light. If the particular powdered aerosol of concern has a relatively low refractive index (e.g., 1.2), then assuming spherical particles, the particles would be approximately five times less effective in scattering light than typical atmospheric aerosols. Conversely, if a powdered aerosol has a refractive index of 1.8, then for spherical aerosols the scattering would be five times greater. Fire suppressants containing powdered aerosols with a low refractive index yield better visibility in the space than those with a higher refractive index. Therefore, choosing chemicals (i.e., powdered aerosols) with a low refractive index for use in a fire suppressant is one means of increasing the visibility resulting from these types of materials.

C.9 Designing the Lighting and Space to Conform with Physical Properties of the Powdered Aerosol. Visibility in a room where a powdered aerosol has been discharged can also be increased by careful design of the environment in which the fire extinguisher is used. Through utilization of lights with specific wavelengths, rather than white light, and a room design that provides easily accessible exits, the chances for escape from a room where a powdered aerosol has been discharged can be improved.

C.10 Utilizing Light of Specific Wavelengths and Photoluminescent Marking Systems. Light is most effectively scattered by a particle size that is the same dimension as the incident light. As the wavelength of light deviates from the size of the powdered aerosol distributed in the air, interference between the particles and the light decreases and visibility increases. Because powdered aerosol products each have their own MMAD and refractive index, each fire suppressant will have particular wavelengths of light that penetrate through its suspended particles with minimal scattering. It is therefore possible to research the different types of light that can be used in the occupied spaces and determine which type of lighting is best suited for use with a particular powdered aerosol. For example, mercury or sodium vapor lamps can improve visibility depending on particle size.

During an emergency situation in which a powdered aerosol fire extinguisher is released, electrical or battery-powered lighting systems can be unreliable. In anticipation of power failure in emergency situations, a photoluminescent floor-lighting system has been developed as an alternative to traditional lighting. Photoluminescent lights, originally used in many of Norway's hydropower plants and the underground facilities of Oslo's airport, are now considered for use in high-rise towers and in planes to provide emergency lighting. [2]

Additionally, an FAA-sponsored study tested the efficacy of a photoluminescent escape path–marking system in an airplane. During a nighttime evacuation scenario in a cabin without identifier lights or illuminated signs (to mimic smoke-obscuring conditions in the cabin environment from the ceiling to 4 ft above the cabin floor), both zinc sulfide and strontium aluminate photoluminescent marking systems were tested. These materials absorb energy from natural light and the plane's standard aircraft lighting. Then, in emergency situations, when all other lighting is extinguished, the photoluminescent system emits the energy as visible light. The FAA study concluded that the strontium aluminate system, though it charges more slowly than the zinc sulfide material, emits more light and provides adequate lighting to mark a path of egress. [3] Thus, a photoluminescent floor-marking system would potentially help in marking an exit route in a scenario involving powdered aerosol discharge. The effectiveness of such a system would depend on the powdered aerosol concentration and particle size distribution.

C.11 Decreasing Distance to Exits. The rooms in which powdered-aerosol fire extinguishers are used can be designed such that the distance to the nearest exit is as short as possible. Other designs to consider are ones in which the distance to any wall that leads to an exit is minimized. A room constructed in this manner would allow one to see well enough to get to the wall and then feel his or her way to the closest exit.

C.12 Training. Increasing the ability of an individual to exit a space where a powdered aerosol has been released can also be achieved through training of the space's occupants. Workers who occupy areas in which powdered-aerosol fire extinguishers are present should be trained on how to react in the event that there is an accidental release of the fire suppressant. Personnel should be made aware of the locations of all the exits and the distance and direction of all doorways and other means of egress, even when a view of the exits is obscured by the released powdered aerosol.

C.13 Recommended Testing Procedures. After consideration of modeling and engineering adjustments identified in this annex leads to a determination that the powdered aerosol is likely to meet visibility standards, then physical testing of visibility should be performed. A nephelometer can be used to measure visibility. Usually used to assess visual air quality or particulate matter concentrations in air, a nephelometer measures the extinction of light, which is dependent on both the scattering and the absorption of light over some distance. [4] Using the scattering coefficient provided by the nephelometer and the design concentration, the visibility resulting from the discharge of the powdered aerosol can be assessed.

C.14 References.

(1) D. Glover, Jr., ed., *Dictionary of Technical Terms for Aerospace Use.* NASA Lewis Research Center, Cleveland, Ohio.
(2) G. Jensen, "Wayfinding and Rescue in Heavy Smoke or Blackouts: Low Tech Marking Outperform Sophisticated Concepts." InterConsult Group ASA article for *Industrial Fire Journal*, GJ 9.11, 1999.
(3) DOT/FAA/AM-98/2, *Performance Demonstration of Zinc Sulfide and Strontium Aluminate Photoluminescent Floor Proximity Escape Path Marking Systems.* Office of Aviation Medicine, Washington, DC, February 1998.
(4) J. Parikh, "Nephelometer Procedure." Washington State Department of Ecology, Air Quality Program, February 2001.

Annex D Informational References

D.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

Δ **D.1.1 NFPA Publications.** National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 70®, *National Electrical Code®*, 2020 edition.

NFPA 72®, *National Fire Alarm and Signaling Code®*, 2019 edition.

D.1.2 Other Publications.

D.1.2.1 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ANSI/ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, 2018.

Δ **D.1.2.2 IEEE Publications.** IEEE, Three Park Avenue, 17th Floor, New York, NY 10016-5997.

IEEE/ASTM SI 10, *American National Standard for Metric Practice*, 2016.

Δ **D.1.2.3 ULC Publications.** Underwriters Laboratories of Canada, 7 Underwriters Road, Toronto, ON M1R 3A9, Canada.

CAN/ULC S524-06, *Standard for the Installation of Fire Alarm Systems*, 2016.

CAN/ULC S529-09, *Smoke Detectors for Fire Alarm Systems*, 2006.

Δ **D.1.2.4 U.S. Government Publications.** U.S. Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001.

EPA/600/8-90/066F, Regional Deposited Dose Ratio Program in "Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry," October 1994.

EPA Health Effects Test Guidelines, OPPTS 870.1300, Acute Inhalation Toxicity, August 1998.

59 FR 13044, *Federal Register*, 1994.

D.1.2.5 Other Publications.

CIIT/RIVM, Chemical Industry Institute of Toxicology/Dutch National Institute for Public Health and the Environment, Multiple Path Particle Dosimetry Model, MPPD V1.0, October 2002.

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NPB 88-2001, *Fire extinguishing and alarm systems. Design rules and regulations*, GUGPS and FGU VNIIPO EMERCOM of Russia, 2018.

Parikh, J., "Nephelometer Procedure." Washington State Department of Ecology, Air Quality Program, February 2001.

D.2 Informational References. (Reserved)

D.3 References for Extracts in Informational Sections. (Reserved)

Index

-A-

Abort Switch
  Definition, 3.3.1, A.3.3.1
Actuating Mechanism
  Definition, 3.3.2
Administration, Chap. 1
  Equivalency, 1.4
  New Technology, 1.6
  Purpose, 1.2
  Retroactivity, 1.3
  Scope, 1.1
  Units and Formulas, 1.5
Aerosol, Condensed
  Definition, 3.3.3
Agent Quantity
  Definition, 3.3.4
Approval of Installations, Chap. 8
  General, 8.1, A.8.1
    Auxiliary Functions, 8.1.12
    Control Panel Primary Power Source, 8.1.22
    Location, 8.1.15
    Review Electrical Components, 8.1.10
      Functional Testing, 8.1.10.2
        Preliminary Functional Tests, 8.1.10.2.1
        Remote Monitoring Operations, 8.1.10.2.3
        Return of System to Operational Condition, 8.1.10.2.5
        System Functional Operational Test, 8.1.10.2.2
      Wiring, 8.1.10.1
  Inspection of Aerosol Generators, 8.2
Approved
  Definition, 3.2.1, A.3.2.1
Authority Having Jurisdiction (AHJ)
  Definition, 3.2.2, A.3.2.2
Automatic
  Definition, 3.3.5
Automatic/Manual Switch
  Definition, 3.3.6, A.3.3.6

-C-

Classifications for Fires
  Class A Fires
    Definition, 3.3.7.1
  Class B Fires
    Definition, 3.3.7.2
  Class C Fires
    Definition, 3.3.7.3
  Definition, 3.3.7
Clearance
  Definition, 3.3.8
  Electrical Clearance
    Definition, 3.3.8.1
  Thermal Clearance
    Definition, 3.3.8.2
Components, Chap. 6
  Aerosol System Agent Supply, 6.1
    Aerosol Generator Arrangement, 6.1.3
    Aerosol Generators, 6.1.4
      Listing, 6.1.4.3
      Minimum Safe Distance, 6.1.4.2
      Nameplate, 6.1.4.4
      Safety, 6.1.4.1
      Temperature Limitations, 6.1.4.6
      Transportation, 6.1.4.5
    Quality, 6.1.2
    Quantity, 6.1.1
      Primary Agent Supply, 6.1.1.1
      Reserve Agent Supply, 6.1.1.2
  Detection, Actuation, Alarm, and Control Systems, 6.2
    Automatic Detection, 6.2.2
    Control Equipment, 6.2.4
      Electric Control Equipment, 6.2.4.1
      Pneumatic Control Equipment, 6.2.4.2
    General, 6.2.1
      Raceways, 6.2.1.3
    Operating Alarms and Indicators, 6.2.5
      Abort Switches, 6.2.5.4, A.6.2.5.4
      Approval, 6.2.5.2
      General, 6.2.5.1
      Pre-discharge Alarms and Time Delays, 6.2.5.7
      Supervisory Conditions, 6.2.5.5
      Warning and Instruction Signs, 6.2.5.6
      Warning Devices, 6.2.5.3
    Operating Devices, 6.2.3
      Manual Release, 6.2.3.7
    Unwanted System Operation, 6.2.6, A.6.2.6
Coolant
  Definition, 3.3.9

-D-

Definitions, Chap. 3
Density
  Definition, 3.3.10
  Design Application Density (g/m3)
    Definition, 3.3.10.1, A.3.3.10.1
  Extinguishing Application Density (g/m3)
    Definition, 3.3.10.2, A.3.3.10.2
  Particulate Density
    Definition, 3.3.10.3, A.3.3.10.3

Discharge Port
Definition, 3.3.11
Disconnect Switch
Definition, 3.3.12

-E-

Enclosure
Definition, 3.3.13
Explanatory Material, Annex A

-G-

General, Chap. 4
Compatibility with Other Agents, 4.4
Environmental Factors, 4.3
General Information, 4.1
Use and Limitations, 4.2
Aerosol Systems, 4.2.1
Generator
Definition, 3.3.14
Generator Casing
Definition, 3.3.15

-H-

Heat-Sensitive Material
Definition, 3.4.1
Hot Work
Definition, 3.3.16

-I-

Informational References, Annex D
Inspection
Definition, 3.3.17, A.3.3.17
Inspection, Testing, and Maintenance, Chap. 9
Disposal of Components and Agents, 9.7
General, 9.1
Inspection, 9.3
Flexible Connectors, 9.3.6
Interfaced Systems and Equipment, 9.2, A.9.2
Maintenance, 9.4
Record Keeping, 9.6
Testing, 9.5

-L-

Listed
Definition, 3.2.3, A.3.2.3

-M-

Maintenance
Definition, 3.3.18, A.3.3.18
Manual
Definition, 3.3.19
Marine System
Definition, 3.4.2
Marine Systems, Chap. 10
General, 10.2
Inspected Vessels, 10.4
Agent Design Application Density, 10.4.6
Compliance, 10.4.8
Detection, Actuation, and Control Systems, 10.4.4
Power Supplies, 10.4.4.4
Detection, Alarm, and Control, 10.4.2
Duration of Protection, 10.4.7
Enclosure, 10.4.5
System Component Requirements, 10.4.3
Use and Limitations, 10.4.1
Scope, 10.1
Special Definitions, 10.3
Uninspected Vessels and Pleasure Craft, 10.5
Detection, Actuation, and Control Systems, 10.5.4
Installation, 10.5.3
System Component Requirements, 10.5.2
Use and Limitations, 10.5.1
Mass Median Aerodynamic Diameter (MMAD)
Definition, 3.3.20, A.3.3.20

-N-

Normally Occupied
Definition, 3.3.21
Normally Unoccupied
Definition, 3.3.22

-P-

Protected Volume
Definition, 3.3.23

-R-

Reduced Visibility Information, Annex C
Accounting for Refractive Index, C.8
Assessing Visibility for a Powdered Aerosol: A Model Approach, C.2
Decreasing Distance to Exits, C.11
Design of the Model, C.3
Designing the Lighting and Space to Conform with Physical Properties of the Powdered Aerosol, C.9
Engineering Powdered Aerosol According to the Model, C.6
Manipulating Particle Size and Concentration, C.7
Methods for Increasing Visibility and Ability to Exit Space, C.5
Potential Settling Rates and the Effect on Visibility, C.4
Recommended Testing Procedures, C.13
References, C.14
Training, C.12
Utilizing Light of Specific Wavelengths and Photoluminescent Marking Systems, C.10
Referenced Publications, Chap. 2
Release
Definition, 3.3.24

-S-

Safety Requirements, Chap. 5
Electrical Clearances, 5.3
Hazards to Personnel, 5.2
Potential Hazards, 5.2.1, A.5.2.1
Pre-discharge Alarms and Time Delays, 5.2.3
Alarm Failure, 5.2.3.2
Reduced Visibility, 5.2.5, A.5.2.5

Safety Requirements, 5.2.7
Thermal Hazards, 5.2.6
Toxicity, 5.2.4, A.5.2.4
General, 5.2.4.1
Normally Occupied Spaces, 5.2.4.2, A.5.2.4.2
Unnecessary Exposure, 5.2.2
Review Requirement, 5.1, A.5.1
Health Effects, 5.1.2
Shall
Definition, 3.2.4
Should
Definition, 3.2.5
Solid Aerosol-Forming Compound
Definition, 3.3.25
Space
Cargo Space
Definition, 3.4.3.1
Definition, 3.4.3
Machinery Space
Definition, 3.4.3.2
Standard
Definition, 3.2.6
Supervisory Condition
Definition, 3.3.26
Supervisory Signal
Definition, 3.3.27
System Design and Installation, Chap. 7
Design Application Density, 7.3
Determining Design Application Density, 7.3.1
Extinguishment, 7.3.2
Class A Fuels, 7.3.2.2
Class B Fuels, 7.3.2.1
Class C Fuels, 7.3.2.3
Fuel Combinations, 7.3.2.4
Duration of Protection, 7.5, A.7.5
Enclosure, 7.2
Enclosure Strength and Pressure Venting, 7.2.3
Forced-Air Ventilating Systems, 7.2.2
Unclosable Openings, 7.2.1
Generator Choice and Location, 7.7
Rate of Application, 7.6
Extended Discharge, 7.6.2
Initial Discharge, 7.6.1
Specifications, Plans, and Approvals, 7.1
Approval of Plans, 7.1.3
Specifications, 7.1.1
Working Plans, 7.1.2
Total Flooding Quantity, 7.4
Additional Design Factors, 7.4.2, A.7.4.2
Design Factor Determination Method, 7.4.2.2, A.7.4.2.2
Minimum Design Factor Considerations, 7.4.2.1
Other Design Factors, 7.4.2.3
Quantity Calculation, 7.4.1

-T-

Total Flooding Extinguishing System
Definition, 3.3.28
Toxicity Information, Annex B
References, B.5

-U-

Unoccupiable
Definition, 3.3.29, A.3.3.29

-V-

Vessel
Definition, 3.4.4
Inspected Vessel
Definition, 3.4.4.1
Uninspected Vessel
Definition, 3.4.4.2

Sequence of Events for the Standards Development Process

Once the current edition is published, a Standard is opened for Public Input.

Step 1 – Input Stage

- Input accepted from the public or other committees for consideration to develop the First Draft
- Technical Committee holds First Draft Meeting to revise Standard (23 weeks); Technical Committee(s) with Correlating Committee (10 weeks)
- Technical Committee ballots on First Draft (12 weeks); Technical Committee(s) with Correlating Committee (11 weeks)
- Correlating Committee First Draft Meeting (9 weeks)
- Correlating Committee ballots on First Draft (5 weeks)
- First Draft Report posted on the document information page

Step 2 – Comment Stage

- Public Comments accepted on First Draft (10 weeks) following posting of First Draft Report
- If Standard does not receive Public Comments and the Technical Committee chooses not to hold a Second Draft meeting, the Standard becomes a Consent Standard and is sent directly to the Standards Council for issuance (see Step 4) or
- Technical Committee holds Second Draft Meeting (21 weeks); Technical Committee(s) with Correlating Committee (7 weeks)
- Technical Committee ballots on Second Draft (11 weeks); Technical Committee(s) with Correlating Committee (10 weeks)
- Correlating Committee Second Draft Meeting (9 weeks)
- Correlating Committee ballots on Second Draft (8 weeks)
- Second Draft Report posted on the document information page

Step 3 – NFPA Technical Meeting

- Notice of Intent to Make a Motion (NITMAM) accepted (5 weeks) following the posting of Second Draft Report
- NITMAMs are reviewed and valid motions are certified by the Motions Committee for presentation at the NFPA Technical Meeting
- NFPA membership meets each June at the NFPA Technical Meeting to act on Standards with "Certified Amending Motions" (certified NITMAMs)
- Committee(s) vote on any successful amendments to the Technical Committee Reports made by the NFPA membership at the NFPA Technical Meeting

Step 4 – Council Appeals and Issuance of Standard

- Notification of intent to file an appeal to the Standards Council on Technical Meeting action must be filed within 20 days of the NFPA Technical Meeting
- Standards Council decides, based on all evidence, whether to issue the standard or to take other action

Notes:

1. Time periods are approximate; refer to published schedules for actual dates.
2. Annual revision cycle documents with certified amending motions take approximately 101 weeks to complete.
3. Fall revision cycle documents receiving certified amending motions take approximately 141 weeks to complete.

Committee Membership Classifications[1,2,3,4]

The following classifications apply to Committee members and represent their principal interest in the activity of the Committee.

1. M *Manufacturer:* A representative of a maker or marketer of a product, assembly, or system, or portion thereof, that is affected by the standard.
2. U *User:* A representative of an entity that is subject to the provisions of the standard or that voluntarily uses the standard.
3. IM *Installer/Maintainer:* A representative of an entity that is in the business of installing or maintaining a product, assembly, or system affected by the standard.
4. L *Labor:* A labor representative or employee concerned with safety in the workplace.
5. RT *Applied Research/Testing Laboratory:* A representative of an independent testing laboratory or independent applied research organization that promulgates and/or enforces standards.
6. E *Enforcing Authority:* A representative of an agency or an organization that promulgates and/or enforces standards.
7. I *Insurance:* A representative of an insurance company, broker, agent, bureau, or inspection agency.
8. C *Consumer:* A person who is or represents the ultimate purchaser of a product, system, or service affected by the standard, but who is not included in (2).
9. SE *Special Expert:* A person not representing (1) through (8) and who has special expertise in the scope of the standard or portion thereof.

NOTE 1: "Standard" connotes code, standard, recommended practice, or guide.

NOTE 2: A representative includes an employee.

NOTE 3: While these classifications will be used by the Standards Council to achieve a balance for Technical Committees, the Standards Council may determine that new classifications of member or unique interests need representation in order to foster the best possible Committee deliberations on any project. In this connection, the Standards Council may make such appointments as it deems appropriate in the public interest, such as the classification of "Utilities" in the National Electrical Code Committee.

NOTE 4: Representatives of subsidiaries of any group are generally considered to have the same classification as the parent organization.

Submitting Public Input / Public Comment Through the Online Submission System

Following publication of the current edition of an NFPA standard, the development of the next edition begins and the standard is open for Public Input.

Submit a Public Input

NFPA accepts Public Input on documents through our online submission system at www.nfpa.org. To use the online submission system:

- Choose a document from the List of NFPA codes & standards or filter by Development Stage for "codes accepting public input."
- Once you are on the document page, select the "Next Edition" tab.
- Choose the link "The next edition of this standard is now open for Public Input." You will be asked to sign in or create a free online account with NFPA before using this system.
- Follow the online instructions to submit your Public Input (see www.nfpa.org/publicinput for detailed instructions).
- Once a Public Input is saved or submitted in the system, it can be located on the "My Profile" page by selecting the "My Public Inputs/Comments/NITMAMs" section.

Submit a Public Comment

Once the First Draft Report becomes available there is a Public Comment period. Any objections or further related changes to the content of the First Draft must be submitted at the Comment Stage. To submit a Public Comment follow the same steps as previously explained for the submission of Public Input.

Other Resources Available on the Document Information Pages

Header: View document title and scope, access to our codes and standards or NFCSS subscription, and sign up to receive email alerts.

Current & Prior Editions	Research current and previous edition information.
Next Edition	Follow the committee's progress in the processing of a standard in its next revision cycle.
Technical Committee	View current committee rosters or apply to a committee.
Ask a Technical Question	For members, officials, and AHJs to submit standards questions to NFPA staff. Our Technical Questions Service provides a convenient way to receive timely and consistent technical assistance when you need to know more about NFPA standards relevant to your work.
News	Provides links to available articles and research and statistical reports related to our standards.
Purchase Products & Training	Discover and purchase the latest products and training.
Related Products	View related publications, training, and other resources available for purchase.

Information on the NFPA Standards Development Process

I. Applicable Regulations. The primary rules governing the processing of NFPA standards (codes, standards, recommended practices, and guides) are the NFPA *Regulations Governing the Development of NFPA Standards (Regs)*. Other applicable rules include NFPA *Bylaws*, NFPA *Technical Meeting Convention Rules*, NFPA *Guide for the Conduct of Participants in the NFPA Standards Development Process*, and the NFPA *Regulations Governing Petitions to the Board of Directors from Decisions of the Standards Council*. Most of these rules and regulations are contained in the *NFPA Standards Directory*. For copies of the *Directory*, contact Codes and Standards Administration at NFPA headquarters; all these documents are also available on the NFPA website at "www.nfpa.org/regs."

The following is general information on the NFPA process. All participants, however, should refer to the actual rules and regulations for a full understanding of this process and for the criteria that govern participation.

II. Technical Committee Report. The Technical Committee Report is defined as "the Report of the responsible Committee(s), in accordance with the Regulations, in preparation of a new or revised NFPA Standard." The Technical Committee Report is in two parts and consists of the First Draft Report and the Second Draft Report. (See *Regs* at Section 1.4.)

III. Step 1: First Draft Report. The First Draft Report is defined as "Part one of the Technical Committee Report, which documents the Input Stage." The First Draft Report consists of the First Draft, Public Input, Committee Input, Committee and Correlating Committee Statements, Correlating Notes, and Ballot Statements. (See *Regs* at 4.2.5.2 and Section 4.3.) Any objection to an action in the First Draft Report must be raised through the filing of an appropriate Comment for consideration in the Second Draft Report or the objection will be considered resolved. [See *Regs* at 4.3.1(b).]

IV. Step 2: Second Draft Report. The Second Draft Report is defined as "Part two of the Technical Committee Report, which documents the Comment Stage." The Second Draft Report consists of the Second Draft, Public Comments with corresponding Committee Actions and Committee Statements, Correlating Notes and their respective Committee Statements, Committee Comments, Correlating Revisions, and Ballot Statements. (See *Regs* at 4.2.5.2 and Section 4.4.) The First Draft Report and the Second Draft Report together constitute the Technical Committee Report. Any outstanding objection following the Second Draft Report must be raised through an appropriate Amending Motion at the NFPA Technical Meeting or the objection will be considered resolved. [See *Regs* at 4.4.1(b).]

V. Step 3a: Action at NFPA Technical Meeting. Following the publication of the Second Draft Report, there is a period during which those wishing to make proper Amending Motions on the Technical Committee Reports must signal their intention by submitting a Notice of Intent to Make a Motion (NITMAM). (See *Regs* at 4.5.2.) Standards that receive notice of proper Amending Motions (Certified Amending Motions) will be presented for action at the annual June NFPA Technical Meeting. At the meeting, the NFPA membership can consider and act on these Certified Amending Motions as well as Follow-up Amending Motions, that is, motions that become necessary as a result of a previous successful Amending Motion. (See 4.5.3.2 through 4.5.3.6 and Table 1, Columns 1-3 of *Regs* for a summary of the available Amending Motions and who may make them.) Any outstanding objection following action at an NFPA Technical Meeting (and any further Technical Committee consideration following successful Amending Motions, see *Regs* at 4.5.3.7 through 4.6.5) must be raised through an appeal to the Standards Council or it will be considered to be resolved.

VI. Step 3b: Documents Forwarded Directly to the Council. Where no NITMAM is received and certified in accordance with the *Technical Meeting Convention Rules*, the standard is forwarded directly to the Standards Council for action on issuance. Objections are deemed to be resolved for these documents. (See *Regs* at 4.5.2.5.)

VII. Step 4a: Council Appeals. Anyone can appeal to the Standards Council concerning procedural or substantive matters related to the development, content, or issuance of any document of the NFPA or on matters within the purview of the authority of the Council, as established by the *Bylaws* and as determined by the Board of Directors. Such appeals must be in written form and filed with the Secretary of the Standards Council (see *Regs* at Section 1.6). Time constraints for filing an appeal must be in accordance with 1.6.2 of the *Regs*. Objections are deemed to be resolved if not pursued at this level.

VIII. Step 4b: Document Issuance. The Standards Council is the issuer of all documents (see Article 8 of *Bylaws*). The Council acts on the issuance of a document presented for action at an NFPA Technical Meeting within 75 days from the date of the recommendation from the NFPA Technical Meeting, unless this period is extended by the Council (see *Regs* at 4.7.2). For documents forwarded directly to the Standards Council, the Council acts on the issuance of the document at its next scheduled meeting, or at such other meeting as the Council may determine (see *Regs* at 4.5.2.5 and 4.7.4).

IX. Petitions to the Board of Directors. The Standards Council has been delegated the responsibility for the administration of the codes and standards development process and the issuance of documents. However, where extraordinary circumstances requiring the intervention of the Board of Directors exist, the Board of Directors may take any action necessary to fulfill its obligations to preserve the integrity of the codes and standards development process and to protect the interests of the NFPA. The rules for petitioning the Board of Directors can be found in the *Regulations Governing Petitions to the Board of Directors from Decisions of the Standards Council* and in Section 1.7 of the *Regs*.

X. For More Information. The program for the NFPA Technical Meeting (as well as the NFPA website as information becomes available) should be consulted for the date on which each report scheduled for consideration at the meeting will be presented. To view the First Draft Report and Second Draft Report as well as information on NFPA rules and for up-to-date information on schedules and deadlines for processing NFPA documents, check the NFPA website (www.nfpa.org/docinfo) or contact NFPA Codes & Standards Administration at (617) 984-7246.

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