NFPA 40

Standard for the Storage and Handling of Cellulose Nitrate Film

2007 Edition



NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

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NFPA 40

Standard for the

Storage and Handling of Cellulose Nitrate Film

2007 Edition

This edition of NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film*, was prepared by the Technical Committee on Hazardous Chemicals. It was issued by the Standards Council on July 28, 2006, with an effective date of August 17, 2006, and supersedes all previous editions.

This edition of NFPA 40 was approved as an American National Standard on August 17, 2006.

Origin and Development of NFPA 40

NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Motion Picture Film,* was developed by the Committee on Hazardous Chemicals and Explosives and was first adopted by NFPA in 1919. Amendments were adopted in 1921 and 1926. A complete revision was adopted in 1931, with further amendments in 1939, 1946, and 1947. Extensive revisions were also made in 1953. The technical requirements of these early editions of NFPA 40 were based on extensive fire tests conducted by motion picture film manufacturers.

With the reorganization of the committee in 1960, the Technical Committee on Explosives was given responsibility for NFPA 40. However, in 1970, responsibility was transferred to the Technical Committee on Storage, Handling, and Transportation of Hazardous Chemicals. The 1953 edition of NFPA 40 was reconfirmed in 1962. Amendments were adopted in 1967, and the 1967 edition was reconfirmed in 1974.

In 1979, the Technical Committee on Storage, Handling, and Transportation of Hazardous Chemicals debated whether to withdraw the document since cellulose nitrate motion picture film had not been manufactured for more than 20 years. However, due to the large quantities of cellulose nitrate motion picture film in various archives, the Committee decided to revise NFPA 40 and to maintain it as an active NFPA standard until the archive collections are reprinted onto safety film or destroyed. (The Library of Congress, the Smithsonian Institution, the U.S. military services, and others have great quantities of such film that is slowly being reprinted.)

The 1994 edition of NFPA 40 reflected a partial revision of the standard to improve its usability, adoptability, and enforceability and to update old terminology. In addition, the Technical Committee on Hazardous Chemicals clarified the requirements relating to protection of film cabinets and vaults with automatic sprinkler protection, as well as clarifying the requirements for decomposition vents.

For the 1997 edition, the terminology and provisions relating to long-term storage of cellulose nitrate motion picture film were updated to be consistent with the terminology used in the film storage industry. This was done in response to new storage facilities for cellulose nitrate films that were being built, and clarification was needed for consistency between the standard's provisions for vault construction and various building code requirements. These changes were reflected throughout the standard. Provisions for handling cellulose nitrate motion picture films also were updated within the safety limits previously established by the Hazardous Chemicals Committee. However, the Committee reduced the number of rolls of cellulose nitrate motion picture film allowed to be present in a shipping room, to reduce the potential hazard to persons working in the area. Other changes were editorial in nature to bring the document into conformance with the NFPA *Manual of Style*, 1986 edition.

The 2001 edition expanded the scope of the document to include flat film, making NFPA 40 the single document that addressed cellulose nitrate film storage. Prior to that change, flat film storage had been covered by NFPA 42, *Standard for the Storage of Pyroxylin Plastic*. Additionally, the requirements located in NFPA 42 did not adequately address flat cellulose nitrate film storage. Several changes were made to the storage chapter to reflect the safety concerns with flat film. Restructuring changes also were made to make the document conform to the *Manual of Style for NFPA Technical Committee Documents,* 2000 edition, including eliminating several exceptions, changing the chapter order, and moving nonmandatory material to annexes.

The 2007 edition of NFPA 40 is essentially a reconfirmation of the 2001 edition of the document.

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Committee Scope: This Committee shall have primary responsibility for documents on, and maintain current codes for, classes of hazardous chemicals and codes for specific chemicals where these are warranted by virtue of widespread distribution or special hazards.

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NFPA 40

Standard for the

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Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

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

Chapter 1 Administration

1.1* Scope.

1.1.1* This standard shall apply to all facilities that are involved with the storage and handling of cellulose nitrate–based film.

1.1.2 This standard shall not apply to the storage and handling of film having a base other than cellulose nitrate.

1.2 Purpose. Based on minimum requirements for safety to life and property from fire, this standard shall provide for the storage and handling of cellulose nitrate film.

1.3 Application.

1.3.1 This standard gives general provisions regarding the storage and handling of cellulose nitrate film and special provisions for such occupancies as motion picture projection booths, nitrate film vaults, and laboratories handling nitrate film. These special provisions shall apply in addition to any and all general provisions that are applicable.

1.3.2* The grouping of the special provisions under the heading of special occupancies is merely for convenience in the application of this standard. Any particular process or operation in any type of occupancy shall be governed by the provisions that are given for that process or operation, whether under the heading of that occupancy or any other heading, unless otherwise specifically provided herein.

1.4 Retroactivity. Because nitrate film deteriorates with age, the provisions of this standard shall be retroactive. Where improvements have been made over previous editions of this standard, the incorporation of these changes in existing facilities shall be required particularly where cellulose nitrate film storage will continue.

1.5 Equivalency.

1.5.1 Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed in this standard, provided that technical documentation is submitted to the authority having jurisdiction to demonstrate equivalency and that the system, method, or device is approved for the intended purpose.

1.5.2 The specific requirements of this standard for existing buildings shall be permitted to be modified by the authority having jurisdiction to allow alternative arrangements that will secure, as nearly as practical, equivalent safety to life and protection of film collections from fire. However, in no case shall the modification afford less safety to life than compliance with the corresponding provisions contained in this standard for existing buildings. *(See also 1.5.1.)*

1.6 Approval of Plans. Before any building is constructed for use as a cellulose nitrate film occupancy, any nitrate film vault is built, any enclosure for motion picture projection is installed, or any screening room is installed, complete plans for the proposed construction or installation shall be submitted for approval to the authority having jurisdiction. These plans shall show in detail all proposed construction and structural changes, means of protection to be provided, the heating system and its protection, electrical equipment, and the character and location of exposures. The plans also shall indicate the maximum amount and types of film to be handled or stored in each area.

Chapter 2 Referenced Publications

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

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

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2007 edition.

NFPA 70, *National Electrical Code®,* 2005 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2007 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems,* 2002 edition.

NFPA *101®, Life Safety Code®,* 2006 edition.

NFPA 220, *Standard on Types of Building Construction,* 2006 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls,* 2006 edition.

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

2.4 References for Extracts in Mandatory Sections. (Reserved)

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall

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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 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* 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.

3.2.5 Shall. Indicates a mandatory requirement.

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

3.3 General Definitions.

3.3.1* Cellulose Nitrate Film. Motion picture sound recording, still, or flat film that is coated on a support or base consisting essentially of cellulose nitrate.

3.3.2* Extended Term Storage. Storage having an indefinite duration (i.e., for the functional life of the film element and intended to protect and conserve the useful life of the film as long as possible).

3.3.3 Extended Term Storage Cabinet. A specially constructed and equipped enclosure that is used for the extended term storage of cellulose nitrate motion picture film.

3.3.4 Extended Term Storage Film. Film of value for record purposes that will be kept in permanent storage.

3.3.5* Extended Term Storage Rack. A rack that is intended for use in extended term storage of high value or permanent record film.

3.3.6* Extended Term Storage Vault. A specially constructed and equipped storage room with both a 4-hour fire rating and an inside volume that does not exceed 28 m^3 (1000 ft^3).

3.3.7 Film Cabinet. A specially constructed and equipped enclosure for the storage of up to 170 kg (375 lb) of cellulose nitrate motion picture film.

3.3.8* Standard Roll. A roll of film that is 35 mm (1⅜ in.) wide, 305 m (1000 ft) long, and approximately 2.3 kg (5 lb) in weight.

3.3.9* Vault. A specially constructed and equipped storage room with both a 4-hour fire rating and an inside volume that does not exceed 21 m^3 (750 ft^3).

3.3.10 Vent.

3.3.10.1 ***Decomposition Vent.*** A vent to permit the escape of gases resulting from partial burning or decomposition of nitrate film.

3.3.10.2 ***Explosion Vent.*** A vent to relieve explosion pressures resulting from ignition of a mixture of decomposition gases and air.

Chapter 4 Construction Requirements and Arrangements of Buildings

4.1 Construction.

4.1.1* Nitrate film shall be stored or handled only in buildings of Type I construction as defined in NFPA 220, *Standard on Types of Building Construction.*

4.1.1.1 Decomposition vents and explosion vents shall be of noncombustible construction.

4.1.2 All rooms where nitrate film is stored or handled shall be separated from each other and from all other parts of the building by partitions having a fire resistance rating of at least 1 hour.

4.1.2.1 The partitions shall be constructed in accordance with NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls.*

Exception: Film vaults shall meet the requirements of Section 6.3 or Section 6.5.

4.1.2.2 Partitions shall be continuous from floor to ceiling and shall be anchored securely to walls, floors, and ceilings.

4.1.3 Openings in partitions shall be protected by approved fire doors having a 1-hour fire resistance rating and installed according to NFPA 80, *Standard for Fire Doors and Other Opening Protectives.*

4.2 Exits.

4.2.1 All new rooms where nitrate film is handled, except film vaults, shall be provided with aisles having a minimum width of 910 mm (36 in.).

4.2.1.1 For existing rooms, the minimum aisle width shall be 760 mm (30 in.).

4.2.1.2 The minimum aisle width for film vaults shall be 760 mm (30 in.).

4.2.2 Rooms where nitrate film is handled shall have two or more exits that are remote from each other.

Exception: Film vaults shall not be required to comply with this provision.

4.2.3* Doors shall swing in the direction of exit travel. Where not clearly identifiable, exits shall be marked by an "EXIT" sign meeting the requirements of NFPA *101, Life Safety Code.*

4.3 Explosion Venting.

4.3.1* Explosion venting shall be provided in new construction for rooms or vaults that are used for the storing and handling of nitrate film.

Exception: Rooms where the total quantity of film not stored in vented cabinets is less than 20 standard rolls or 6100 m (20,000 ft).

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4.3.2 Explosion venting shall be provided in the ratio of 0.09 m^2 of free vent area per each 1.4 m^3 of room or vault volume (1 ft^2 per 50 ft^3).

4.4* Space for Workers.

4.4.1 There shall be at least 3.3 m^2 (35 ft^2) of floor area for each worker in every inspection room.

4.4.2 Not more than 15 persons shall work at any one time in any one room where nitrate film is handled.

4.5 Tables and Racks.

4.5.1 Tables and racks that are used in connection with the handling of film (e.g., joining, inspection, and assembly tables) shall be noncombustible or of wood construction with no member less than 38 mm (1½ in.) in least dimension.

4.5.2 Tables shall not have racks or shelves beneath them.

4.5.3 Tables and racks shall be kept at least 100 mm (4 in.) away from any radiator or heating apparatus.

4.6 Electrical Equipment.

4.6.1 All electrical wiring and equipment shall comply with NFPA 70, *National Electrical Code,* for Class I, Group D, Division 2 locations. The temperature rating of electrical equipment shall be Class T6.

4.6.2 Motors shall be located or arranged so that film cannot come in contact with them.

4.7 Heating, Cooling, and Refrigeration Equipment.

4.7.1 Artificial heating in any building or room in which nitrate film is handled or stored, other than a vault, shall be restricted to hot water or steam not exceeding gauge pressure of 103 kPa (15 psi).

4.7.1.1 Approved electric steam radiators operating at pressures not exceeding gauge pressure of 103 kPa (15 psi) and protected with wire mesh guards shall be permitted to be used if they are of the fixed (nonportable) type.

4.7.1.2 If the radiators or heating coils of an indirect heating system that uses high-pressure steam are not located in the room or rooms being heated, then the requirements of 4.7.1 shall not be interpreted as prohibiting the installation of such a system. Heat-generating equipment shall be located in a separate room.

4.7.2 All steam pipes within 1.8 m (6 ft) of the floor and where passing through walls, partitions, or racks or near woodwork shall be protected by insulation.

4.7.3 All radiators, heating coils, pipes, and returns that are near the floor or so located as to permit contact with any combustible material, waste, or dirt shall be guarded and protected with 6.4 mm (¼ in.) mesh, galvanized steel wire cloth (hardware cloth, No. 20 B&S gauge or equivalent). The guards shall be arranged so that they can be lifted for cleaning. The tops of such guards shall be sloped so that they cannot be used as shelves. Guards shall be constructed so that no film can come within 100 mm (4 in.) of the heating surface. Guards shall be constructed with a substantial metal framework that will prevent the wire mesh from being forced against the radiator or pipes.

4.7.4* Extended term storage vaults shall be permitted to have refrigeration from air-conditioning systems installed where necessary to provide temperature and humidity control.

4.8 Duct Systems.

4.8.1 Air-conditioning, warm-air-heating, air-cooling, and ventilating systems that employ ducts shall be installed in accordance with NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems.*

4.8.2 Any duct system used for air that is conditioning a film vault or room where nitrate film is handled shall be entirely independent with no duct connecting to any other vault unless backdraft dampers and fire dampers capable of withstanding a gauge pressure of 7 kPa (1 psi) overpressure are used.

4.8.3 Air shall not be recirculated between vaults.

Chapter 5 Fire Protection

5.1* Automatic Sprinklers.

5.1.1 The purpose of this protection is to prevent fire or heat from affecting storage that is not initially involved in a fire.

5.1.2 Every room, except projection booths and rewinding rooms, where nitrate film is stored or handled in quantities greater than 23 kg (51 lb), or 10 standard rolls, shall be protected by an automatic sprinkler system that is installed in accordance with the requirements for Group II extra hazard occupancies of NFPA 13, *Standard for the Installation of Sprinkler Systems.*

5.1.3 Protection for areas other than film cabinets and vaults shall utilize automatic sprinklers. Protection for film cabinets and vaults, extended term storage or other than extended term storage, shall be permitted to utilize an automatic sprinkler system or a deluge system using fixed spray nozzles or open sprinklers.

5.1.4 In areas or rooms where nitrate film is handled, the area that is protected per sprinkler head shall not exceed 6 m^2(64 ft^2) with sprinklers not being more than 2.4 m (8 ft) apart.

5.2 Water Supplies.

5.2.1 Water supplies that are acceptable to the authority having jurisdiction shall be provided.

5.2.2 Water supplies for automatic sprinklers shall be based on 1.26 L/sec (20 gpm) per sprinkler for 20 minutes for the total number of sprinklers in one vault plus 25 percent of the sprinklers in the communicating fire area.

5.3* Portable Fire Extinguishers. Every room in which nitrate film is stored or handled shall be provided with portable fire extinguishers of types using water or water solutions.

Exception: Film vaults shall not be required to comply with this provision.

Chapter 6 Storage of Nitrate Film

6.1 General. Nitrate film that is not in process or being worked on shall be stored as follows:

(1) Amounts exceeding 11 kg (25 lb), or 5 standard rolls, but not exceeding 340 kg (750 lb), or 150 standard rolls, shall be stored in approved cabinets or in vaults. *(See Sections 6.2 and 6.3.)*
(2) Amounts exceeding 340 kg (750 lb), or 150 standard rolls, shall be stored in vaults. *(See Section 6.3.)*

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(3) Extended term storage film shall be stored in extended term storage cabinets or extended term storage vaults, which are subject to the limitations of Section 6.1(1) and (2). *(See Sections 6.4 and 6.5.)*

6.2 Film Cabinets.

6.2.1 Film cabinets shall be constructed in the following manner:

(1) The bottom, top, door, and sides of the cabinet shall be at least No. 18 U.S. gauge sheet steel and double walled with 38 mm (1½ in.) air space.
(2) Joints shall be riveted, welded, or made tight by some equally effective means.
(3) The door shall be provided with a three-point latch arrangement, and the door sill shall be raised at least 50 mm (2 in.) above the bottom of the cabinet to retain spilled liquid within the cabinet, as shown in Figure 6.2.1.

6.2.2 Cabinets shall have a capacity not exceeding 170 kg (375 lb), or 75 standard rolls.

6.2.3 Shelves shall be made of noncombustible insulating material not less than 9.5 mm (⅜ in.) thick or of hardwood that is not less than 25 mm (1 in.) thick.

6.2.3.1 Shelves shall fit tightly to the back and sides of the cabinet. There shall be a clearance of at least 25 mm (1 in.) between the front of the shelf and the inside of the door.

6.2.3.2 Shelves for motion picture film storage shall be 25 mm (1 in.) wider, with a tolerance of 6.4 mm (¼ in.), than the diameter of the largest roll that is stored in the cabinet. Stops or bars shall be provided so that film cans cannot be stored with the front edge less than 19 mm (¾ in.) from the front edge of the shelf. There shall be no thumbholes or indentations in the shelves that will allow any part of the containers to project forward from the front edge of the shelf.

6.2.4* Each cabinet having a capacity of more than 23 kg (50 lb), or 10 standard rolls, of nitrate film shall be provided with a vent to the outside of the building. The vent shall have a minimum effective cross-sectional area of 90 cm^2 per 45 kg (14 $in.^2$ per 100 lb) of film capacity.

6.2.4.1 Vent flues shall be of a construction that is equivalent to No. 18 U.S. gauge riveted sheet steel, and, where inside the building, it shall be covered with 25 mm (1 in.) of noncombustible thermal-insulating material.

6.2.5 Cabinet Protection.

6.2.5.1 Cabinets having a capacity of more than 34 kg (75 lb), or 15 standard rolls, of film shall be provided with at least one automatic sprinkler head.

6.2.5.2 Where cans are stored on more than one shelf, as shown in Figure 6.2.1 and as described in 6.2.6.2 or 6.2.6.3, one sprinkler head shall be provided for each shelf.

6.2.6 Motion Picture Film. Paragraphs 6.2.6.1 through 6.2.6.3 shall apply only to motion picture film.

6.2.6.1 Film in cabinets shall be in individual roll containers or in U.S. Department of Transportation (DOT) shipping containers. Materials other than film shall not be stored in the same cabinet with nitrate film. Where cabinets are provided with individual insulated compartments for each roll, the individual rolls shall not be required to be in cans or other containers.

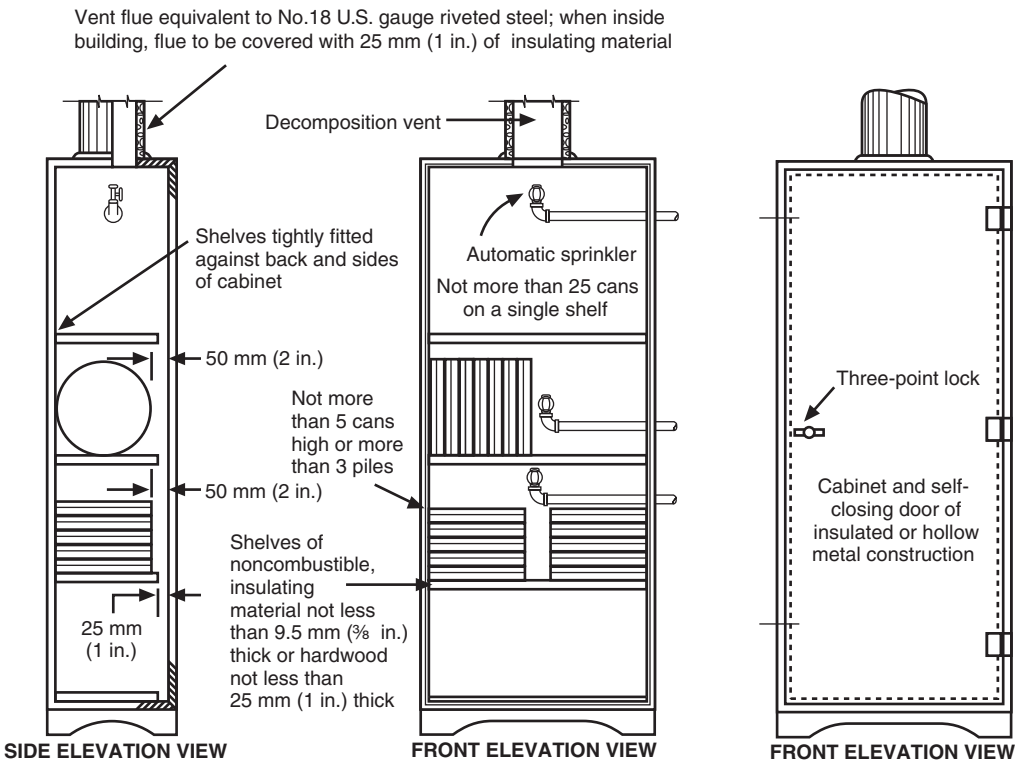


FIGURE 6.2.1 Standard Film Cabinet (for Other Than Extended Term Storage Film).

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6.2.6.2 Film cans, if placed on edge, shall be limited to not more than 25 cans per shelf.

6.2.6.3 Film cans, if placed flat, shall be stacked no more than five cans high with not more than three stacks per shelf.

6.3* Vaults Other than Extended Term Storage Vaults.

6.3.1 Vaults shall be constructed in accordance with plans that have been submitted to and approved by the authority having jurisdiction.

6.3.1.1 Vaults shall not exceed 21 m^3 (750 ft^3) in inside volume. Where the height of the vault ceiling results in a vault having a volume greater than 21 m^3 (750 ft^3), a heavy wire screen of at least 50 mm (2 in.) mesh or equivalent shall be installed below the ceiling to limit the interior vault space to 21 m^3 (750 ft^3). *(See Figure A.6.3.)*

6.3.1.2* Walls and floors of vaults shall be of Type I construction and shall have not less than 4-hour fire resistance. Where masonry units have cracks or holes, the surface shall be plastered on both sides with a cement plaster to a minimum thickness of 13 mm (½ in.) to prevent escape of gases through wall cracks.

6.3.1.3 Where the ceiling of a vault is a bearing floor, it shall have a fire resistance of at least 4 hours.

6.3.1.4 Where the vault walls extend 0.9 m (3 ft) or more above the roof, the vault roof and ceiling shall be permitted to be constructed of noncombustible materials and shall be permitted to serve as an explosion vent.

6.3.1.5 Vaults shall be provided with drains or scuppers to carry automatic sprinkler discharge directly to the outside of the building.

Exception: Existing vaults shall not be required to drain directly to the outside.

6.3.2* Door openings shall be protected with automatic, self-closing fire door assemblies having a fire protection rating of 3 hours. Such doors shall be installed in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, and, if held open, shall be arranged to close automatically upon actuation of an approved smoke detector that is located in the vault.

Exception: Existing heavy steel doors or combinations of one swinging and one sliding door, both of steel construction, shall be permitted to be accepted at the discretion of the authority having jurisdiction.

6.3.3* Vaults shall be temperature controlled to maintain temperature at 21°C (70°F) or less.

6.3.4 Each vault shall be provided with an independent decomposition vent having a minimum effective cross-sectional area of 1290 cm^2 per 454 kg (200 $in.^2$ per 1000 lb), or 200 standard rolls, of film capacity.

Exception: In vaults that are provided with explosion venting, the decomposition vent shall be permitted to be omitted.

6.3.4.1 Existing vaults shall be provided with independent vents having an effective minimum cross-sectional area of at least 903 cm^2 per 454 kg (140 $in.^2$ per 1000 lb), or 200 standard rolls, of film capacity.

6.3.4.2* The vent area for a standard 21 m^3 (750 ft^3) vault of new construction shall be not less than 1.3 m^2 (2000 $in.^2$).

6.3.4.3* Vent flues within the building shall be of Type I construction having a fire resistance of 4 hours.

6.3.4.4 The outlet of each vent shall be above the roof, and where vents discharge horizontally, a deflector wall or other device shall be provided to deflect gases upward. Vents shall be located at least 15 m (50 ft) horizontally from any window or other opening exposed thereby and at least 7.6 m (25 ft) from any fire escape on the same or a higher level.

6.3.4.5* Vaults, especially those having a window for a vent, shall be arranged so that the nitrate film in the vault is protected against ignition from the following:

(1) Rays of the sun, wherever the film in the vault is exposed to direct sunlight entering through the vent
(2) Radiated heat entering through the vent opening, as from an exposure fire, wherever the vent is severely exposed by buildings or storage of combustible material or by other openings in the same wall

6.3.4.6* Each vent shall be protected against the weather by either single-thickness [4.2 mm (⅙ in.)] glass in a sash arranged to open automatically in case of fire or a hinged hollow metal or insulated vent panel. Either of them shall be equipped with an approved releasing device that is placed inside the vault. The vents shall be arranged to open by either temperature or internal pressure of 24.4 kg/m^2 (5 lb/ft^2). No pane of glass shall be smaller than 1290 cm^2 (200 $in.^2$).

6.3.4.7 A light wire screen that is not coarser than 3.2 mm (⅛ in.) mesh shall be permitted to be placed in each vent. No bars or screens other than this insect screen shall be placed in vent openings.

6.3.5* Where there is a possibility of fire being transmitted from one vault to another or to another building through open skylights, glass windows, light roof panels, or venting devices, provisions shall be made to prevent that possibility.

6.3.6 Film. Paragraphs 6.3.6.1 through 6.3.6.5 shall apply only to film.

6.3.6.1 Racks in new film vaults shall be of hardwood or of noncombustible insulating material and shall consist of shelves tightly fitted to walls and vertical baffles.

6.3.6.2 Vertical barriers shall be of noncombustible insulating material that is at least 9.5 mm (⅜ in.) thick. They shall be spaced to divide the racks into sections of not more than 0.9 m (3 ft) in width.

6.3.6.3 Shelves shall be at least 25 mm (1 in.) wider than the diameter of the largest stored container.

6.3.6.4 Metal supports shall be permitted to be used to keep containers in place.

6.3.6.5 Open racks in new construction shall be used only for storage of film in standard DOT containers or in insulated boxes.

6.3.7 In new vaults, fire protection shall be provided by a wet pipe automatic sprinkler system or, where speed of operation is important, a deluge system.

6.3.7.1 Sprinkler protection utilizing regular automatic sprinklers or open sprinklers shall be calculated on the basis of one sprinkler for each 1.8 m^3 (62.5 ft^3) of the interior vault volume.

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6.3.7.2 The minimum number of sprinklers for a standard 21 m^3 (750 ft^3) vault shall be not less than 12.

6.3.7.3* Sprinklers or nozzles shall be arranged to provide coverage over the tops and fronts of shelves.

6.3.7.4 Where automatic sprinklers are used, barriers made of No. 24 U.S. gauge sheet steel or other acceptable noncombustible material shall be installed between each sprinkler. Barriers shall be fastened rigidly in place and shall extend from the ceiling down to 100 mm (4 in.) below the sprinkler deflectors.

6.3.7.5 The authority having jurisdiction shall be consulted for water and arrangement requirements for either automatic sprinklers or fixed spray nozzles.

6.3.8 Light fixtures shall comply with the requirements of 4.6.1. All switches shall be outside the vault and provided with pilot lights to indicate whether vault lights are on or off.

6.3.9 Where heat is required to prevent freezing of the sprinkler system, it shall be provided by hot water or low-pressure steam that is limited to gauge pressure of 69 kPa (10 psi) maximum pressure. Vault temperature shall not exceed 21°C (70°F) *(see 6.3.3)*. Radiators shall be placed at the ceiling, over aisle spaces, and with pipes. Also, radiators shall be protected by wire guards that are arranged so that film cannot be placed within 300 mm (12 in.) of them.

6.3.10 All motion picture film that is stored in vaults shall be in single- or double-roll containers or in DOT-approved shipping containers.

6.4 Extended Term Storage Cabinets.

6.4.1 Extended term storage cabinets shall be provided with individual drawers or compartments, each holding not more than 610 m (2000 ft) of film. Individual compartments shall be separated by 9.5 mm (⅜ in.) of noncombustible insulating material. Each compartment shall be provided with a hinged damper or similar device to allow release of decomposition gases into the cabinet vent.

6.4.2 Extended term storage cabinets shall be provided with automatic sprinklers when holding more than 23 kg (51 lb) of nitrate film.

6.4.3* Each extended term storage cabinet having a capacity of more than 23 kg (51 lb), or 10 standard rolls, of film shall be provided with a vent to the outside of the building. The vent shall have a minimum cross-sectional area of 90 cm^2 per 45 kg (14 $in.^2$ per 100 lb), or 200 standard rolls of film capacity.

6.4.3.1 Decomposition vent pipes shall be of No. 18 U.S. gauge riveted steel or equivalent. Where located within the building, decomposition vent pipes shall be covered with 25 mm (1 in.) of noncombustible insulating material.

6.5* Extended Term Storage Vaults.

6.5.1 Extended term storage vaults shall not exceed 28 m^3 (1000 ft^3) in interior volume. Where the height of the vault ceiling results in a vault having an interior volume greater than 28 m^3 (1000 ft^3) or greater than the volume that is agreed upon by the authority having jurisdiction, then the interior vault space shall be permitted to be limited as described in 6.3.1.1. *(See Figure A.6.5.)*

6.5.1.1 Walls and floors shall be of Type I construction, having a fire resistance of 4 hours. Where masonry units have cracks or holes, the surface shall be plastered on both sides with a cement plaster to a thickness of at least 13 mm (½ in.). Equivalent construction that will provide equal fire resistance and prevent escape of gases through wall cracks shall be permitted to be used.

6.5.1.2 Extended term storage vaults shall comply with 6.3.1.3, 6.3.1.4, and 6.3.1.5.

6.5.2 Door openings in extended term storage vaults shall be protected in accordance with the requirements of 6.3.4, except as modified by 6.3.5 and 6.3.6.

6.5.3 Maximum temperature control shall be provided in accordance with 6.3.4.

6.5.4 Extended term storage vaults shall be provided with decomposition vents meeting the requirements of 6.3.4, except as modified by 6.3.5 and 6.3.6.

Exception: In vaults provided with explosion venting, the decomposition vent shall be permitted to be omitted.

6.5.4.1 The vent area for a standard 28 m^3 (1000 ft^3) extended term storage vault shall be not less than 1.72 m^2 (2670 $in.^2$). *(See Figure A.6.3.4.2.)*

6.5.5 Film. Paragraphs 6.5.5.1 through 6.5.5.5 shall apply only to film.

6.5.5.1 Extended term storage vaults shall be provided with horizontal shelves and vertical barriers that are spaced so that not more than two containers, each containing 305 m (1000 ft) of film, shall be permitted to be placed in each compartment.

6.5.5.2 The spacing between shelves shall be such that the container covers can be lifted approximately 13 mm (½ in.) but cannot be lifted completely off the container.

6.5.5.3 The shelves shall be separated by vertical barriers so that not more than one container can be placed between vertical barriers. The vertical barriers and the shelves shall be of noncombustible insulating material that is at least 9.5 mm (⅜ in.) thick or of hardwood construction that is at least 25 mm (1 in.) thick.

6.5.5.4 Containers shall be placed on shelves in contact with the back wall.

6.5.5.5 Racks shall be designed in relation to the sprinkler system so that the open face of each rack structure shall be protected by the sprinkler system.

6.5.6 In new extended term storage vaults, fire protection shall be provided in accordance with 6.3.7.

Exception: As modified in 6.5.6.1 through 6.5.6.3.

6.5.6.1 Sprinklers shall be provided in a ratio of one head for each 1.8 m^3 (63.6 ft^3) of vault volume.

Exception: Sprinkler systems in existing extended term storage vaults that were in compliance with the provisions of this standard at the time of installation shall be permitted to be continued in use.

6.5.6.2 The minimum number of sprinkler heads for a 28 m^3 (1000 ft^3) vault shall be 15 sprinklers.

Exception: Sprinkler systems in existing extended term storage vaults that were in compliance with the provisions of this standard at the time of installation shall be permitted to be continued in use.

6.5.6.3 Directional sprinkler heads that provide coverage into the face of the shelves shall be provided.

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6.5.7 Interior lighting for extended term storage vaults shall comply with 6.3.8.

6.5.8 Where heat is required to prevent freezing of the sprinkler system, the heating system shall comply with 6.3.9.

6.5.9 All film that is stored in extended term storage vaults shall be in single- or double-roll containers or in DOT-approved shipping containers. The cover of the container that is used shall not lift off when the container is placed properly in the rack.

Chapter 7 Handling of Nitrate Film

7.1 General Conditions. All procedures for handling nitrate film shall be conducted only with the appropriate safeguards to protect against possible hazards. Specialized operations such as printing, video transfer, sound transfer, cleaning, splicing, repairing, marking, and cataloging that are necessary for the maintenance and use of nitrate film shall be permitted to be grouped together in common work areas and shall be done in a manner that is consistent with this standard.

7.2* Containers Required. All nitrate film shall be kept in closed, individual metal cans or DOT-approved containers unless actually being worked on or examined.

7.3 Shielding. Nitrate film shall not be placed or kept under benches, tables, or other surfaces that would shield it from sprinkler discharge.

7.4* Scrap and Discarded Film.

7.4.1 Scrap nitrate film shall be kept separate from waste paper, scrap safety film, and other rubbish.

7.4.2 Scrap nitrate film shall be collected from workrooms at least once daily and removed to a room used for no other purpose. It shall be kept under water in steel drums or metal containers with tight-fitting covers.

7.4.3 Discarded film in full or partial rolls shall be kept in containers in vaults until disposal.

7.4.4 Scrap and discarded film shall be disposed of at frequent intervals. Scrap film shall not be baled or burned.

7.5 Transportation.

7.5.1 Nitrate film shall not be transported in any vehicle, aircraft, or other public conveyance that is used for the transportation of passengers unless it complies with DOT shipping regulations and other applicable regulations.

7.5.2 Nitrate film shall not be allowed in any underground subway train or station unless under the jurisdiction of the U.S. Department of Transportation and conforming to DOT regulations.

Chapter 8 Motion Picture Projection and Special Processes

8.1 Enclosures for Motion Picture Projectors.

8.1.1* In new installations, motion picture projectors using nitrate film shall be operated or set up for operations only within an approved enclosure, not less than 3.7 m^2 (40 ft^2) in area for each projector and 2.3 m (7½ ft) high. Not more than two machines shall be located in each enclosure.

8.1.2 No more than 34 kg (75 lb) of nitrate film shall be allowed in the projection booth unless stored in an approved cabinet in accordance with Chapter 6.

8.1.3 The projection room shall have a fire resistance of not less than 1 hour. The interior finish shall have a flame spread index that is no greater than 25.

8.1.4* Exit doors shall be outward-swinging, self-closing, approved fire doors that have a fire protection rating of not less than 1 hour. They shall be installed according to NFPA 80, *Standard for Fire Doors and Other Opening Protectives.* Doors shall be kept closed at all times when they are not actually in use.

8.1.5 Two openings shall be provided for each motion picture projection room or booth: the one for the projectionist's view shall be not larger than 1290 cm^2 (200 $in.^2$); the other, for the projector itself, shall be not larger than 774 cm^2 (120 $in.^2$).

8.1.5.1 Where separate slide projection, spotlight, or floodlight machines are installed in the same enclosure with motion picture projectors, not more than one opening for each such machine shall be provided for both the operator's view and for the projection of light.

8.1.5.2 Two or more projectors shall be permitted to be operated through the same opening. Such openings shall be as small as practical and shall be capable of being protected by approved automatic shutters.

8.1.6 Each opening in accordance with 8.1.5 shall be provided with an approved gravity shutter set into guides that are not less than 25 mm (1 in.) at the sides and bottom and are overlapping the top of the opening by not less than 25 mm (1 in.) when closed. Shutters shall be not less than No. 10 U.S. gauge iron or equivalent. Shutters shall be suspended, arranged, and interconnected so that all openings close upon operation of a fusible or mechanical releasing device that is designed to operate automatically in case of fire.

8.1.6.1 Each shutter shall have a fusible link above it, and there shall also be a fusible link over each upper magazine that, upon operating, closes all shutters.

8.1.6.2 Means shall be provided for manually closing all shutters simultaneously from the projector head and from a point within the projection enclosure near each exit door.

8.1.7 All shelves, furniture, and fixtures within the enclosure shall be constructed of noncombustible materials.

Exception: Tables shall comply with Section 4.5.

8.1.8 No combustible material of any sort shall be permitted in the projection enclosure other than the film, film cleaner, lubricants, and film cement.

8.1.9 Ventilation shall be provided by one or more mechanical exhaust systems that draw air from each lamp housing and from one or more points near the ceiling.

8.1.9.1 Exhaust systems shall exhaust to the outdoors either directly or through a noncombustible flue that is used for no other purpose.

8.1.9.2 Exhaust capacity shall be neither less than 0.43 m^3/min (15 ft^3/min) nor more than 1.4 m^3/min (50 ft^3/min) for each lamp, plus 5.7 m^3/min (200 ft^3/min) for the room itself.

8.1.9.3 Exhaust systems shall be controlled from within the enclosure and shall have pilot lights to indicate operation.

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8.1.9.4 The exhaust system serving the projection room shall be permitted to be extended to cover rooms that are associated with the projection enclosure, such as rewind rooms, but shall not be connected in any way with ventilating or air-conditioning systems serving other portions of the building.

8.1.9.5 No dampers shall be installed in exhaust systems associated with the projection enclosure.

8.1.9.6 Exhaust ducts shall be of noncombustible material and shall either be kept 25 mm (1 in.) from combustible material or be covered with 13 mm (½ in.) of noncombustible thermal-insulating material.

8.1.9.7 Fresh air intakes, other than those direct to the outside, shall be protected by approved fire dampers or shutters that are arranged to operate automatically with the shutters described in 8.1.6.

8.1.10 Provision shall be made so that auditorium lights can be turned on from within the projection enclosure and from at least one other convenient point in the building.

Chapter 9 Special Occupancies

9.1 Motion Picture Film Exchanges. Nitrate film shall not be stored or handled in film exchanges.

9.2 Motion Picture Film Laboratories.

9.2.1 The requirements of Chapter 4 also shall apply to nitrate motion picture film laboratories.

9.2.2 All buildings housing a nitrate motion picture film laboratory shall be protected throughout with an approved automatic sprinkler system.

9.2.3 The total quantity of nitrate film outside of storage cabinets or vaults shall be limited to one motion picture feature or subject per work station, not to exceed 12,192 m (40,000 ft), or 40 standard rolls, in rooms where film is prepared for printing.

9.2.4 The total quantity of nitrate film that is not in containers in all workrooms shall not exceed 610 m (2000 ft), or two standard rolls, per person handling film.

Exception No. 1: This requirement shall not apply to film that is in process on cleaning or printing machines.

Exception No. 2: Five standard rolls, or 1524 m (5000 ft), per cleaning or printing machine work station shall be permitted, provided that the total does not exceed 10 standard rolls, or 3050 m (10,000 ft), at any time.

9.2.5 For new installations, printing machines shall be separated from each other by noncombustible partitions unless they are spaced so that there is a 1.8 m (6 ft) distance between the film on one machine and the film on an adjacent machine.

9.2.5.1 Partitions separating one nitrate film–handling room from another shall be of Type I construction and shall have a fire resistance of not less than 1 hour.

9.2.5.2 In all cases, sprinklers shall be arranged so that not more than two machines are protected by any one sprinkler head.

9.2.6 Cabinet-type drying machines shall be listed.

9.2.7 Waxing of film shall be done in a separate room. Waxing processes that require the waxed film to be left exposed to dry shall be in a room used solely for that purpose. Not more than five machines shall be located in any one room. Not more than 3050 m (10,000 ft), or 10 standard rolls of film, shall be exposed at any one time.

9.2.8 Not more than two projectors for nitrate film shall be located in any one room.

9.2.9 The shipping room shall be separated from the rest of the building by partitions complying with 4.1.2. No process other than the inspection and packing of film shall be conducted in the shipping room. Not more than 30,480 m (100,000 ft), or 100 standard rolls, of film shall be in a shipping room at one time. Of this quantity, no fewer than 50 standard rolls, or 15,240 m (50,000 ft), shall be in shipping cases.

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.1.1 Although the storage and handling of cellulose nitrate film have a good safety record, fire tests conducted prior to 1967 indicated the desirability of a modification of existing standards. The requirements of this standard, therefore, apply strictly to long-term storage of cellulose nitrate film.

A.1.1.1 Cellulose nitrate–based film includes, but is not limited to, original negative, duplicate negative, interpositive (fine grain), color separation master (YCM), successive exposure master (SEN), optical soundtrack negative or master, mattes, title bands, and release prints.

A.1.3.2 For example, any process in a studio that, in the opinion of the authority having jurisdiction, is similar to some process covered under laboratories would be covered by the requirements for that process given under laboratories.

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

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

A.3.3.1 Cellulose Nitrate Film. The terms *cellulose nitrate film* and *nitrate film* are preferable to *nitrocellulose*; however, for practical purposes, the terms are synonymous. The film can be in the form of unexposed film, positive prints, negatives, or used film.

Cellulose nitrate contains chemically combined oxygen, sufficient in amount so that it can partially burn or decompose without the presence of air. The gases formed during burning or decomposition are both toxic and flammable and can be produced so rapidly as to create dangerous pressures in building structures and severe hazard to life. Free burning of the material results in the production of less toxic gases, but, due to the rapid burning, such fires are intense and still represent a serious life hazard. The actual heat of combustion of cellulose nitrate film is 13,944 kJ/kg to 18,921 kJ/kg (6000 Btu/lb to 8000 Btu/lb), compared with 16,268 kJ/kg to 18,921 kJ/kg (7000 Btu/lb to 8000 Btu/lb) for wood. However, the rate of combustion is about 15 times greater than the combustion rate of wood in similar form. *(See Table B.1.)*

For many years, motion picture film was manufactured with a supporting film base of cellulose nitrate, commonly called nitrocellulose. Since 1951, no cellulose nitrate film base of any kind has been manufactured in the United States. Also, the use of cellulose nitrate film in theaters has virtually ceased. However, large quantities of cellulose nitrate film still exist and will remain in storage for many years. *(See Annex B for additional information.)*

A.3.3.2 Extended Term Storage. *Extended term storage* is synonymous with *archival storage*.

A.3.3.5 Extended Term Storage Rack. Such racks are constructed so that individual rolls or groups of two rolls are placed in insulated compartments.

A.3.3.6 Extended Term Storage Vault. This type of vault is used for the extended term storage of cellulose nitrate motion picture film.

A.3.3.8 Standard Roll. This definition is intended to establish a measure of length and weight. It is not intended to prohibit the use of double rolls [610 m (2000 ft)] of film in theaters and exchanges. The term is used in calculating the weight of film.

A.3.3.9 Vault. This type of vault is used for the storage of cellulose nitrate motion picture film in quantities not exceeding 341 kg (750 lb).

A.4.1.1 See NFPA 220, *Standard on Types of Building Construction*.

A.4.2.3 For illuminated exit signs, see Section 7.10 of NFPA *101, Life Safety Code*.

A.4.3.1 It is suggested that, wherever practical, explosion vents be provided in existing rooms or vaults that are used for the storage and handling of nitrate film. For information on the design of explosion vents, see NFPA 68, *Guide for Venting of Deflagrations*.

A.4.4 The purpose of this section is to prevent congestion of workers in areas where large quantities of nitrate film are handled.

A.4.7.4 The following text is extracted from the Eastman Kodak publication *Hazard in the Handling and Storage of Nitrate and Safety Motion Picture Film*: "To reduce the chance of spontaneous ignition of nitrate films — even those which are not of special concern — we [Kodak] recommend that storage vaults be air conditioned where necessary to prevent temperatures in excess of 21°C (70°F), and relative humidity in excess of 60 percent." Provisions for refrigeration systems can be found in ASHRAE 15, *Safety Code for Mechanical Refrigeration*.

A.5.1 It is recommended that buildings used for the storage or handling of nitrate film, except for buildings that house small areas possessing no fire hazard and are so located that there is little opportunity for fire gases to enter the area, be protected completely by automatic sprinklers. Also, although this section does not require automatic sprinklers for projection rooms, fire experience indicates that they do provide desirable protection, and their use is advised.

A.5.3 See NFPA 10, *Standard for Portable Fire Extinguishers*. Also, small hose equipment is recommended. See NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*.

A.6.2.4 For long lengths of vent pipe, a larger size could be necessary to overcome friction loss and turns in the pipe.

A.6.3 See Figure A.6.3. The illustration shows the location of sprinkler heads and the decomposition vent.

A.6.3.1.2 See NFPA 220, *Standard on Types of Building Construction*.

A.6.3.2 Vaults can have two door openings. Such an arrangement is often a great convenience, as in laboratories, where the vault is located between rooms and is used for temporary storage of film in process. Approved, quick-operating devices for closing vault doors are recognized as having advantages over the fusible link, and their use is recommended.

A.6.3.3 The life of nitrate film retained for its historical value is maximized when it is stored in individually air-conditioned and sprinklered extended term storage vaults. Often these vaults are maintained at temperatures as low as 17°C (35°F) and a relative humidity of 30 percent. Air changes to minimize decomposition product accumulation can also be effective.

A.6.3.4.2 See Figure A.6.3.4.2. The figure shows the location of sprinkler heads, decomposition vents, and noncombustible flame barriers.

A.6.3.4.3 The extension of a vent outlet by means of flues that extend a considerable distance adds appreciably to the frictional resistance and greatly decreases the effectiveness of the vents. If it is necessary to construct vents longer than 7.6 m (25 ft), proper allowance should be made for frictional losses, and the cross-sectional area should be increased progressively to ensure venting. Such cases are regarded as special and are subject to the approval of the authority having jurisdiction.

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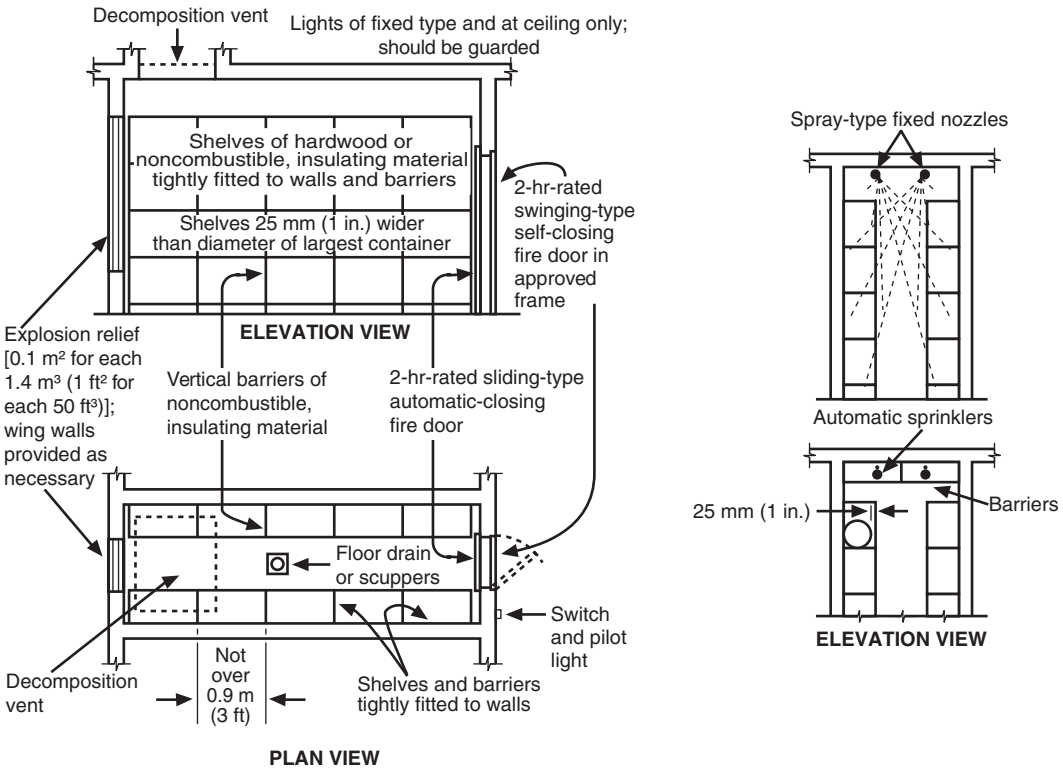


FIGURE A.6.3 Standard Film Vault (for Other Than Extended Term Storage Film).

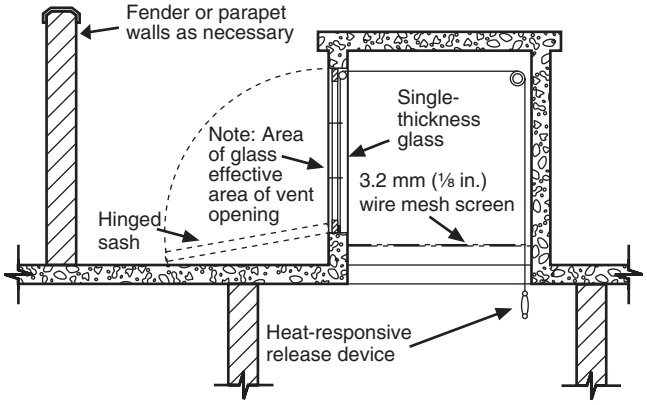


FIGURE A.6.3.4.2 Decomposition Vent.

A.6.3.4.5 Protection against sunlight can be obtained by painting the glass in the vent opening a dark color. One method of effecting protection from radiated heat is to use a hinged insulated or hollow metal panel as a vent. Another acceptable method uses two baffle walls inside the vault itself. The baffle wall closer to the vent extends down from the ceiling to within 0.9 m (3 ft) of the floor; the inner baffle wall extends up from the floor to within 0.9 m (3 ft) of the ceiling. These walls should be of substantial construction and spaced and arranged to afford the full required vent area from the film storage space to the outside.

A.6.3.4.6 The use of approved, quick-operating devices is recommended.

A.6.3.5 This protection can be achieved by providing roof parapets or extended wing walls between such openings.

A.6.3.7.3 The arrangement of sprinklers or nozzles for providing distribution over the face of shelving is important and requires knowledge of sprinkler discharge patterns and locations. This arrangement should be done only by qualified personnel.

A.6.4.3 Good engineering judgment recommends that the vent lines be no longer than 3 m (10 ft). *(See* NFPA 68, *Guide for Venting of Deflagrations.)*

A.6.5 See Figure A.6.5.

A.7.2 This requirement is essential for life safety and from the standpoint of fire hazard.

A.7.4 Nitrate film in the form of clippings and short lengths is very hazardous. Safety precautions in the handling of such scraps are essential. Baling and burning of film are processes that present distinct fire hazards. Waste nitrate film should be disposed of in accordance with federal, state, and local statutes.

A.8.1.1 For new construction, an enclosure not less than 2.4 m (8 ft) wide, 3 m (10 ft) long, and 2.4 m (8 ft) high is recommended for one projection machine, and not less than 3 m (10 ft) wide, 4.3 m (14 ft) long, and 2.4 m (8 ft) high is recommended for two machines.

A.8.1.4 For new construction, it is recommended that at least two doors be provided, each not less than 76 cm (30 in.) wide and 183 cm (72 in.) high. In all cases, it is recommended that exit requirements of the authority having jurisdiction be complied with, particularly those regarding size and locations. At least one door should be of the conventional stairway type, having a landing at the top or opening directly into a corridor.

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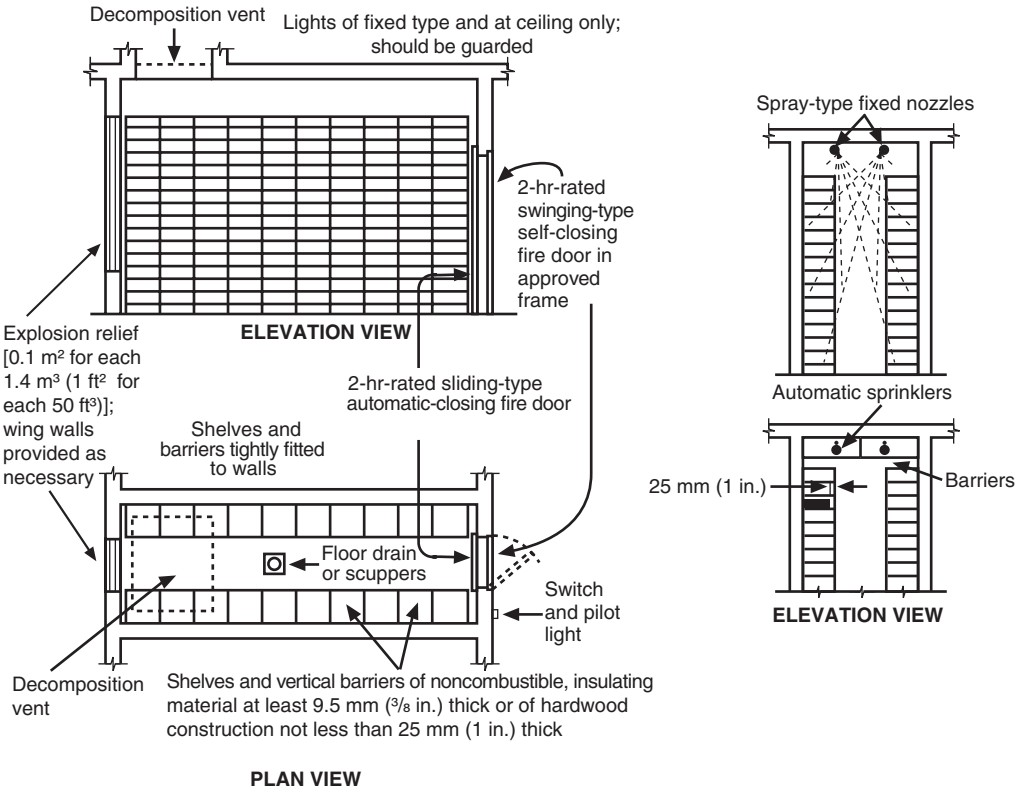


FIGURE A.6.5 Extended Term Storage Vault.

Annex B Additional Information on Cellulose Nitrate Film

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

This material has been extracted with permission of Eastman Kodak Company from Hazard in the Handling and Storage of Nitrate and Safety Motion Picture Film.

B.1 Hazards. The most dangerous aspects of cellulose nitrate motion picture film are its ease of ignition, its very high rate of combustion, and its extremely poisonous combustion gases.

Cellulose nitrate film decomposes readily when heated to temperatures above ambient but below its ignition temperature. The decomposition is both exothermic and autocatalytic. The quantity of heat produced by decomposition is such that, if not dissipated, it rapidly raises the temperature of the film to the ignition point. Even local heating can raise the temperature of the film to a dangerous level, initiating decomposition in the entire mass. Cellulose nitrate also contains enough oxygen within its molecule so that decomposition or combustion proceeds rapidly, even in a limited air supply. A fire in cellulose nitrate film, therefore, cannot be extinguished by smothering.

Cellulose nitrate film is not itself explosive and is less flammable than certain other nitrated compounds. Its ignition temperature is given generally as about 149°C (300°F), but the exact value depends on the duration of exposure, size and purity of film, and other factors. For example, in a laboratory test a sample of fresh nitrate film base ignited in air at 163°C (325°F) within 80 seconds; at 204°C (400°F), ignition occurred in 10 seconds; and at 260°C (500°F), in only 3 seconds. Residual chemicals from processing, dirt, or foreign material can lower the ignition temperature. Investigations conducted after the Cleveland Clinic fire of 1929 showed that temperatures above 93°C (200°F) were unsafe for nitrate film and that exposed steam pipes and unprotected light bulbs were dangerous in rooms containing nitrate film.

Improperly cared-for nitrate film has caused fires after several hours storage at temperatures as low as 49°C (120°F). Also, spontaneous ignition is believed to have been responsible for a number of nitrate film fires that have occurred in storage vaults in the summer, following periods of 38°C (100°F) weather. (Cummings, J. W., A. C. Hutton, and H. Silton. 1950. "Spontaneous Ignition of Decomposing Cellulose Nitrate Film." *J. Soc. Mot. Pict. and Tel. Eng.* 54: 268–274.)

The actual heat of combustion of cellulose nitrate film is low compared with that of more common fuels. *(See Table B.1.)*

Table B.1 Heat Rates of Combustion

Nitrate Film vs. Common Fuels	kJ/kg	Btu/lb
Nitrate film	13,944–18,592	6000–8000
Wood	16,268–18,592	7000–8000
Alcohol	27,005	11,620
Coal, bituminous	23,240–32,536	10,000–14,000
Gasoline	52,900	22,750

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However, the rate of combustion of nitrate film is about 15 times greater than the combustion rate of wood in any form so that the heat evolved per minute is initially much greater. This rate results in a rapid temperature increase and a very intense fire. A nitrate film fire burns so fiercely and spreads so quickly that it is virtually impossible to control or extinguish it except by automatic sprinklers.

B.2 Products of Combustion. When a single layer of cellulose nitrate film is ignited and allowed to burn freely in excess air, it burns with a bright yellow flame. The gases given off are colorless and are chiefly nitrogen, carbon dioxide, and water vapor — none of which is poisonous or explosive. If, however, the air supply is restricted, as is always the case where the nitrate film is in rolls, the film burns with or without flame, producing copious quantities of thick, yellow smoke. These gases are extremely poisonous and can form explosive mixtures with air. The relative amounts of the gases given off by burning nitrate film in a limited air supply are shown in Table B.2. Traces of hydrogen cyanide have also been detected, but not in significant amounts.

Table B.2 Gases Evolved in Flameless Combustion of Nitrate Film

Gas	Percent by Volume
Nitric oxide	1.4–8.2
Nitrogen dioxide and tetroxide	6.9–8.9
Carbon monoxide	47.7–59.1
Carbon dioxide	21.3–24.5
Oxygen	None
Hydrogen	0.9–3.2
Methane	1.0–2.7

Notes:
1. From "Proceedings of a Board of the Chemical Warfare Service Appointed for the Purpose of Investigating Conditions Incident to the Disaster at the Cleveland Hospital Clinic, Cleveland, OH, on May 15, 1929." Washington, DC: U.S. Government Printing Office, 1929.
2. Volume of combustion chamber: 0.23 m^3 to 0.76 m^3 (8 ft^3 to 27 ft^3)
3. Weight of film: 0.9 kg/m^3 (0.056 lb/ft^3)

Complete combustion of nitrate film yields 0.051 m^3 to 0.064 m^3 per kg (4 ft^3 to 5 ft^3 of gas per lb) of film at normal temperature and pressure. The proportions of the various gases will vary somewhat with such conditions as temperature, pressure, and air supply.

B.3 Detection and Disposal of Unstable Nitrate Film. New nitrate film was made to be as stable as possible, and some nitrate films, which are 30 or 40 years old, still appear to be in reasonably good condition. However, all nitrate film deteriorates with age, and the deterioration can be increased by chemical contamination and improper storage conditions. Nitrate film in advanced stages of deterioration can be less stable and can ignite at lower temperatures than nitrate film in good condition. All nitrate films that are to be saved for future reprocessing or for extended term storage purposes should be examined carefully throughout their length prior to being stored in a vault. Further, they should be re-examined periodically. For moderate storage temperatures and where both temperature and humidity are controlled, inspections should be made at least once annually. Where conditions are not controlled, examinations should be made every six months. In tropical climates, inspection intervals might have to be decreased to two or three months.

Any films that, upon examination, show yellow discoloration, fading of the image, undue brittleness, stickiness of the emulsion, or any other signs of deterioration should be copied onto safety film as soon as practical. Any films in cans that are corroded on the inside should be recanned. Such corrosion can indicate an imminent deterioration problem.

The disposal of deteriorated or unstable nitrate film presents a problem. Nitrate film should not be mixed with ordinary rubbish. Such film should be kept under water in a steel drum until disposal can be arranged. Safe disposal should be arranged through proper authorities.

Annex C History of Cellulose Nitrate Film Use and Storage

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

C.1 Inspection and Storage of Film. Nitrate film that is in good condition should be returned to the vault after inspection. Film that is in good condition should be projected only in a projection machine that is approved for nitrate film and projected from a booth that meets the requirements of this standard. It is intended that, over a period of years, the nitrate film currently in existence gradually will be reprinted. In summary, existing nitrate film should be stored in approved vaults, should be hand-inspected periodically, and, if deteriorating, should be destroyed or salvaged by printing onto safety film prior to destruction. Nitrate film should be located only in approved vaults, in approved sprinklered film cabinets, in a projection booth that is approved for the projection of nitrate film, in that portion of a film laboratory that is designed for the handling of nitrate film, or in a workroom that is both designed for the inspection of nitrate film and located near the vault from which it was removed.

Due to the fact that there has been no raw nitrate film manufactured since approximately 1951, there is obviously no raw film available for photographic purposes on motion picture or television sound stages. In addition, film exchanges for theaters are no longer permitted to have nitrate film on the premises. Nitrate film should not be permitted in theater projection booths except where such booths have been constructed for the projection of nitrate film in accordance with this standard.

C.2 Projection Booths. The only projection booths that should be permitted to project nitrate film are those booths that are designed specifically to project nitrate film. These booths should meet the requirements of this standard and be approved by the local authority having jurisdiction. Once approved, the booths should project nitrate film only under the direction of trained projectionists following approved procedures. It is understood that such instances are restricted to venues, usually operating in conjunction with extended term storage programs, in libraries, museums, academic institutions, motion picture studios, or laboratory screening rooms, all of which must have facilities that are approved for handling nitrate film. It is acknowledged that there might be some nitrate film in the possession of individuals, and those individuals might have private projection rooms. The hazards of nitrate film are well known to trained, professional archivists

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and projectionists. Under the restricted conditions of this standard, nitrate film stock can be projected only in those venues approved for the purpose.

It is presently recognized that substantial amounts of nitrate film will be retained for its historical value. It is recognized that the life of the film will be maximized when it is stored in individually air-conditioned and sprinklered extended term storage vaults.

C.3 Safety Film. Since 1951, motion picture film has been produced with a "safety" base of cellulose acetate or other slow-burning esters or polyesters. The fire hazard characteristics of all these materials are roughly similar to those of ordinary paper of similar thickness and form. Unlike cellulose nitrate, they do not produce oxides of nitrogen when they burn. Safety film is damaged by heat at a lower temperature than is needed to destroy paper records. For that reason, safety film needs special protection to prevent damage by heat from an exposing fire. *(See* NFPA 232, *Standard for the Protection of Records.)*

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.

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

NFPA 10, *Standard for Portable Fire Extinguishers*, 2007 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2007 edition.

NFPA 68, *Guide for Venting of Deflagrations*, 2002 edition.

NFPA *101®*, *Life Safety Code®*, 2006 edition.

NFPA 220, *Standard on Types of Building Construction*, 2006 edition.

NFPA 232, *Standard for the Protection of Records*, 2007 edition.

D.1.2 Other Publications.

D.1.2.1 ASHRAE Publications. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329-2305.

ASHRAE 15, *Safety Code for Mechanical Refrigeration,* 1995 edition.

D.1.2.2 Cummings, J. W., A. C. Hutton, and H. Silton. "Spontaneous Ignition of Decomposing Cellulose Nitrate Film." *Journal of the Society of Motion Picture and Television Engineers,* No. 54, 1950, 268–274.

D.1.2.3 *Hazard in the Handling and Storage of Nitrate and Safety Motion Picture Film.* Rochester, NY: Eastman Kodak Company, 1951.

D.1.2.4 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

"Proceedings of a Board of the Chemical Warfare Service Appointed for the Purpose of Investigating Conditions Incident to the Disaster at the Cleveland Hospital Clinic, Cleveland, OH, on May 15, 1929."

D.2 Informational References. (Reserved)

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

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Sequence of Events Leading to Issuance of an NFPA Committee Document

Step 1: Call for Proposals

- Proposed new Document or new edition of an existing Document is entered into one of two yearly revision cycles, and a Call for Proposals is published.

Step 2: Report on Proposals (ROP)

- Committee meets to act on Proposals, to develop its own Proposals, and to prepare its Report.
- Committee votes by written ballot on Proposals. If two-thirds approve, Report goes forward. Lacking two-thirds approval, Report returns to Committee.
- Report on Proposals (ROP) is published for public review and comment.

Step 3: Report on Comments (ROC)

- Committee meets to act on Public Comments to develop its own Comments, and to prepare its report.
- Committee votes by written ballot on Comments. If two-thirds approve, Report goes forward. Lacking two-thirds approval, Report returns to Committee.
- Report on Comments (ROC) is published for public review.

Step 4: Technical Report Session

- "*Notices of intent to make a motion"* are filed, are reviewed, and valid motions are certified for presentation at the Technical Report Session. ("Consent Documents" that have no certified motions bypass the Technical Report Session and proceed to the Standards Council for issuance.)
- NFPA membership meets each June at the Annual Meeting Technical Report Session and acts on Technical Committee Reports (ROP and ROC) for Documents with "certified amending motions."
- Committee(s) vote on any amendments to Report approved at NFPA Annual Membership Meeting.

Step 5: Standards Council Issuance

- Notification of intent to file an appeal to the Standards Council on Association action must be filed within 20 days of the NFPA Annual Membership Meeting.
- Standards Council decides, based on all evidence, whether or not to issue Document or to take other action, including hearing any appeals.

Committee Membership Classifications

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

M *Manufacturer:* A representative of a maker or marketer of a product, assembly, or system, or portion thereof, that is affected by the standard.

U *User:* A representative of an entity that is subject to the provisions of the standard or that voluntarily uses the standard.

I/M *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.

L *Labor:* A labor representative or employee concerned with safety in the workplace.

R/T *Applied Research/Testing Laboratory:* A representative of an independent testing laboratory or independent applied research organization that promulgates and/or enforces standards.

E *Enforcing Authority:* A representative of an agency or an organization that promulgates and/or enforces standards.

I *Insurance:* A representative of an insurance company, broker, agent, bureau, or inspection agency.

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 the *User* classification.

SE *Special Expert:* A person not representing any of the previous classifications, but who has a special expertise in the scope of the standard or portion thereof.

NOTES;
1. "Standard" connotes code, standard, recommended practice, or guide.
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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 members 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 appointments as it deems appropriate in the public interest, such as the classification of "Utilities" in the National Electrical Code Committee.
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1. (a) NFPA Document Title National Fuel Gas Code **NFPA No. & Year** 54, 200X Edition

(**b) Section/Paragraph** 3.3

2. Proposal Recommends (check one): ☐ new text ☒ revised text ☐ deleted text

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted): [Note: Proposed text should be in legislative format, i.e., use underscore to denote wording to be inserted (inserted wording) and strike-through to denote wording to be deleted (~~deleted wording~~).]

Revise definition of effective ground-fault current path to read:

3.3.78 Effective Ground-Fault Current Path. An intentionally constructed, permanent, low impedance electrically conductive path designed and intended to carry ~~underground~~ electric fault current ~~conditions~~ from the point of a ground fault on a wiring system to the electrical supply source.

4. Statement of Problem and Substantiation for Proposal: (Note: State the problem that would be resolved by your recommendation; give the specific reason for your Proposal, including copies of tests, research papers, fire experience, etc. If more than 200 words, it may be abstracted for publication.)

Change uses proper electrical terms.

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