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NFPA 40 Storage and Handling of Cellulose Nitrate Motion Picture Film 1988 Edition

National Fire Protection Association Batterymarch Park, Quincy, MA 02269

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Policy Adopted by NFPA Board of Directors on December 3, 1982

The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

Statement on NFPA Procedures

This material has been developed under the published procedures of the National Fire Protection Association, which are designed to assure the appointment of technically competent Committees having balanced representation. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accepts any liability resulting from compliance or noncompliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

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NATIONAL FIRE PROTECTION ASSOCIATION

NFPA 40

Standard for the Storage and Handling of

Cellulose Nitrate Motion Picture Film

1988 Edition

This edition of NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Motion Picture Film,* was prepared by the Technical Committee on Hazardous Chemicals, and acted on by the National Fire Protection Association, Inc. at its Fall Meeting held November 9-11, 1987 in Portland, Oregon. It was issued by the Standards Council on December 2, 1987, with an effective date of December 22, 1987, and supersedes all previous editions.

The 1988 edition of this standard has been approved by the American National Standards Institute.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

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 the motion picture film manufacturers.

With 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 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 NFPA standard until these archive collections are reprinted onto safety film or destroyed. (The Library of Congress, the Smithsonian Institute, the U.S. Military Services, and others have great quantities of such film that is slowly being reprinted.)

The 1982 edition of NFPA 40 was a complete editorial revision of the 1974 edition. The 1988 edition of NFPA 40 is a reconfirmation of the 1982 edition.

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

NOTE: Membership on a Committee shall not in and of itself constitute an endorsement of the Association or any document developed by the Committee on which the member serves.

Contents

Foreword

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, actual use of cellulose nitrate film in theaters has virtually ceased. However, large quantities of cellulose nitrate film for archival or other purposes still exist in storage. This storage will continue for many years.

Nitrate motion picture film is required to be stored in vaults. Film cabinets are for temporary overnight storage only. All nitrate film is to be inspected on a hand rewind machine annually. Film showing signs of deterioration, i.e., discoloration, blistering, tackiness, etc., is to be either destroyed in a safe manner or sent to a laboratory with proper facilities for handling nitrate film for possible salvage by printing it onto safety film prior to its disposal. Since exposure to temperatures in excess of 185 °F (85 °C) accelerates decomposition, certain provisions of this standard are intended to limit the potential for such exposure. Nitrate film in good condition may be returned to the vault after inspection. Film in good condition that has been placed into projection equipment for observation and determination of its suitability for use in a film production may be projected only in a projection machine approved for nitrate film and projected from a booth meeting the requirements of this standard. Film selected for use should not be returned to the vault but should be reprinted onto safety film. It is intended that, over a period of years, the nitrate film currently in existence will gradually be reprinted onto safety film. In summary: existing nitrate film is to be stored in approved vaults, all nitrate film should be hand inspected annually, and deteriorating film should be destroyed or salvaged by printing onto safety film prior to destruction. Nitrate film should be found only in approved vaults, approved sprinklered film cabinets, in a projection booth approved for the projection of nitrate film, in that portion of a film laboratory designed for the handling of nitrate film, or in a workroom designed for the inspection of nitrate film and located near the vault from which it was removed.

Since 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 a similar manner, 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 whether or not such booths were originally designed for the projection of nitrate film.

The only projection booths that should be permitted to project nitrate film are those used in conjunction with screening rooms in a motion picture studio having nitrate film vaults on the premises, and in film laboratory screening rooms where the laboratory is approved for handling nitrate film.

It is acknowledged that there may be some nitrate film in the possession of individuals and those individuals may have private projection rooms. Due to the hazard of nitrate film, it is particularly important that such nitrate film not be projected until it has been reprinted onto safety film.

It is recognized that there may be some particular desire to retain nitrate film for its historical value. While that film cannot be preserved indefinitely, when the incentive for such preservation is insurmountable, the amount saved should be very limited and must be stored in individually air-conditioned and sprinklered archival vaults.

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 may be produced so rapidly as to create dangerous pressures in building structures and severe hazard to life. Free burning 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 6,000 to 8,000 Btu per lb (13 944 to 18 921 kJ/kg), compared with 7,000 to 8,000 Btu per lb (16 268 to 18 921 kJ/kg) for wood. However, the rate of combustion is about fifteen times that of wood in similar form.

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 required to destroy paper records. For this reason, safety film requires special protection to prevent damage by heat from an exposing fire. (*See NFPA 232, Standard for the Protection of Records.*)

While past experience in the storage and handling of cellulose nitrate film has been good, 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.

NFPA 40

Standard for the Storage and Handling of

Cellulose Nitrate Motion Picture Film

1988 Edition

NOTICE An asterisk (*) following the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A.
Additional information on cellulose nitrate film can be found in Appendix B. Information on referenced publications can be found in Chapter 8 and Appendix C.

Chapter 1 General

1-1 Scope.

1-1.1 This standard shall apply to all facilities involving the storage and handling of cellulose nitrate motion picture film.

1-1.2 This standard shall not apply to facilities involving the manufacture of cellulose nitrate film.

1-1.3 This standard shall not apply to the storage and handling of film having a base other than cellulose nitrate.

1-1.4 This standard shall not apply to photographs or X-ray film.

1-2 Purpose. This standard provides reasonable provisions for the storage and handling of cellulose nitrate motion picture film, based on minimum requirements for safety to life and property from fire.

1-3 Retroactivity. Since nitrate film deteriorates with age, the provisions of this standard are retroactive. Where improvements have been made over previous editions of this standard, the incorporation of these changes in existing facilities is required particularly where cellulose nitrate film storage will continue.

Exception: As otherwise allowed by this standard.

1-4 Arrangement and Applicability.

1-4.1 This standard gives general provisions regarding the storage and handling of cellulose nitrate motion picture film and special provisions for such occupancies as motion picture projection booths, nitrate film vaults, and laboratories handling nitrate film. These special provisions apply in addition to any and all general provisions that may be applicable.

1-4.2* 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 given for that process or operation, whether under the heading of that occupancy or any other heading, unless otherwise specifically provided herein.

1-5 Approval of Plans. Before constructing any building for use as a cellulose nitrate motion picture film occupancy, or building any nitrate film vault, or installing any enclosure for motion picture projection, or installing any screening room, 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 shall also indicate the maximum amount and types of film to be handled or stored in each area.

1-6 Definitions. For the purpose of this standard, the following terms shall have the meanings given below.

Approved. Acceptable to the "authority having jurisdiction."

NOTE: 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 or 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 concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Archival Film. Film of value for record purposes that will be kept in permanent storage.

Archival Rack. Racks intended for use in archival vaults for the storage of high-value or permanent record film. Such racks are constructed so that individual rolls or groups of two rolls are placed in insulated compartments. In certain cases, a maximum of three rolls in a single container may be placed in an insulated compartment.

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

NOTE: The phrase "authority having jurisdiction" 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, 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 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."

Cabinet. A cabinet constructed and equipped in accordance with Section 4-2 or 4-4 of this standard.

Cellulose Nitrate Film. Motion picture or sound recording film coated on a support or base consisting essentially of cellulose nitrate. The terms "cellulose nitrate film" or "nitrate film" are preferable to

"nitrocellulose"; however, for practical purposes, the terms are synonymous. The film may be in the form of unexposed film, positive prints, negatives, or used film. (*See Appendix B for additional information.*)

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

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

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization 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.

Listed. Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which 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.

Partition. A partition constructed in accordance with 2-1.3.

Exception: Where some other type of construction is specified.

Standard Roll.* A roll of film 35 mm (1⅜ in.) wide and 1000 ft (305 m) long, weighing approximately 5 lb (2.3 kg). The term is used in calculating the weight of film.

Vault. A vault constructed and equipped in accordance with Section 4-3 or 4-5 of this standard.

1-7 Equivalency Concepts.

1-7.1 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 to those prescribed by this standard, providing technical documentation is submitted to the authority having jurisdiction to demonstrate equivalency, and the system, method, or device is approved for the intended purpose.

1-7.2 The specific requirements of this standard for existing buildings may be modified by the authority having jurisdiction to allow alternative arrangements that will secure as nearly equivalent safety to life and protection of film collections from fire as practical, but 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 1-7.1.*)

Chapter 2 Construction Requirements and Arrangements of Buildings

2-1 Construction.

2-1.1 Nitrate motion picture film shall be stored or handled only in buildings of Type I construction. (*See NFPA 220, Standard on Types of Building Construction.*)

2-1.2 Nitrate film laboratories shall be located in buildings of Type I construction. (*See NFPA 220, Standard on Types of Building Construction.*)

2-1.3 All rooms in which nitrate film is stored or handled shall be separated from each other and from all other parts of the building by partitions of adequate stability having a fire resistance rating of at least 1 hour, as determined by NFPA 251, *Standard Methods of Fire Tests of Building Construction and Materials.*

Exception: Film vaults shall meet the requirements of Sections 4-3 and 4-5 of this standard.

2-1.3.1 Partitions shall be continuous from floor to ceiling and shall be securely anchored to walls, floors, and ceilings.

2-1.4 Openings in partitions shall be protected by approved fire doors suitable for use in Class C openings and having a 1-hour fire resistance rating and installed according to NFPA 80, *Standard for Fire Doors and Windows.*

2-2 Exits.

2-2.1 All rooms in which nitrate film is handled shall be provided with adequate aisles of minimum 30-in. (0.76-m) width.

2-2.2 Rooms in which nitrate film is handled shall have two or more exits, remote from each other.

Exception: Film vaults need not comply with this requirement.

2-2.3 Doors shall swing in the direction of exit travel. When not clearly identifiable, exits shall be marked by an "EXIT" sign meeting the requirements of NFPA *101®, Life Safety Code®*. (*For illuminated exit signs, see Section 2-6 of the Life Safety Code.*)

2-3 Explosion Venting.

2-3.1* Explosion venting shall be provided in new construction for rooms or vaults used for storing and handling nitrate film.

Exception: Projection rooms, rewind rooms, and rooms where the total quantity of film not stored in vented cabinets will not exceed 20 standard rolls need not comply with this requirement.

2-3.2 Explosion vents shall consist of approved explosion venting sash or equally effective vent construction or assemblies approved by the authority having jurisdiction. Vents shall be provided in the ratio of 1 sq ft of free vent area for each 50 cu ft of room or vault volume (1 m^2 per 15 m^3). (*See NFPA 68, Guide for Venting of Deflagrations.*)

2-4* Space for Workers.

2-4.1 There shall be at least 35 sq ft (3.25 m^2) of floor area for each worker in every inspection room.

2-4.2 Not more than 15 persons shall work at any one time in any one room in which nitrate film is handled.

2-5 Tables and Racks.

2-5.1 Tables and racks 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 1½ in. (3.8 cm) in least dimension.

2-5.2 Tables shall not have racks or shelves beneath them.

2-5.3 Tables and racks shall be kept at least 4 in. (10 cm) away from any radiator or heating apparatus.

2-6 Electrical Equipment.

2-6.1 All electrical wiring and equipment shall comply with NFPA 70, *National Electrical Code®*, for Class I, Division 2 locations. The temperature rating of electrical equipment shall be Class T6.

2-6.2 In any room or vault in which nitrate film is handled or stored, artifical illumination shall be restricted to incandescent or fluorescent light fixtures.

2-6.3 Motors shall be located or arranged so that film cannot come in contact with them.

2-6.4 Motion picture projectors and other associated electrical equipment shall be of approved type and safeguarded in accordance with NFPA 70, *National Electrical Code*.

2-7 Heating Equipment.

2-7.1 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 15 psig (103 kPa).

Exception: Approved electric steam radiators operating at pressures not exceeding 15 psig (103 kPa) and protected with wire mesh guards may be used if of the fixed (nonportable) type.

2-7.1.1 The requirements of 2-7.1 shall not be interpreted as prohibiting the installation of an indirect heating system using high-pressure steam when the radiators or heating coils of such a system are not located in the room or rooms being heated. Heat-generating equipment shall be located in a separate room.

2-7.2 All steam pipes within 6 ft (1.8 m) of the floor and where passing through partitions or racks or near woodwork shall be adequately protected by approved pipe covering.

2-7.3 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 ¼-in. (0.6-cm) mesh galvanized steel wire cloth (hardware cloth, No. 20 B & S gage or equivalent). The bottoms of such 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 4 in. (10 cm) 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.

2-8 Duct Systems.

2-8.1 Air conditioning, warm air heating, air cooling, and ventilating systems employing ducts shall be installed in accordance with NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems.*

2-8.2 Any duct system used for air conditioning a film vault or room in which nitrate film is handled shall be entirely independent, with no duct connecting to any other vault.

Chapter 3 Fire Protection

3-1* Automatic Sprinklers.

3-1.1 The purpose of this protection is to prevent fire or heat from affecting storage not initially involved.

3-1.2 Every room in which nitrate film is stored or handled in quantities greater than 50 lb (22.7 kg) (10 standard rolls) shall be protected by an approved automatic sprinkler system installed in accordance with the requirements for extra hazard occupancies of NFPA 13, *Standard for the Installation of Sprinkler Systems.*

Exception: Motion picture projection booths or rooms and rewinding rooms.

3-1.3 Protection for areas other than film cabinets and vaults may utilize regular automatic sprinklers or automatic spray sprinklers. Protection for film cabinets and vaults (archival or other than archival) may utilize an automatic sprinkler system or a deluge system using fixed spray nozzles or open sprinklers.

3-1.3.1 The requirements of Section 5-3 of NFPA 13, *Standard for the Installation of Sprinkler Systems,* shall apply where sealed sprinklers or open sprinklers are used with pre-action or deluge systems.

3-1.3.2 The requirements of NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection,* shall apply where fixed spray nozzles are used.

3-1.4 In areas or rooms where nitrate film is handled, the area protected per sprinkler head shall not exceed 64 sq ft (6.0 m²), with sprinklers and branch lines not over 8 ft (2.4 m) apart.

3-2 Water Supplies.

3-2.1 Water supplies acceptable to the authority having jurisdiction shall be provided.

3-2.2 Water supplies for automatic sprinklers shall be based on 20 gpm (1.26 L/sec) 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.

3-3* Portable Fire Extinguishers.

3-3.1 Every room in which nitrate film is stored or handled shall be provided with portable fire extinguishers of types using water or water solutions. (*See NFPA 10, Standard for Portable Fire Extinguishers.*)

Exception: Film vaults need not comply with this requirement.

Chapter 4 Storage of Nitrate Film

4-1 General.

4-1.1 Nitrate motion picture film not in process or being worked on shall be stored as follows:

(a) Amounts exceeding 25 lb (11.4 kg) (5 standard rolls) but not exceeding 750 lb (340 kg) (150 standard rolls) shall be stored in approved cabinets or in vaults. (*See Sections 4-2 and 4-3 of this standard.*)

(b) Amounts exceeding 750 lb (340 kg) shall be stored in vaults. (*See Section 4-3.*)

(c) Archival film shall be stored in archival cabinets or archival vaults, subject to the limitations of (a) and (b) above. (*See Sections 4-4 and 4-5.*)

4-2 Film Cabinets.

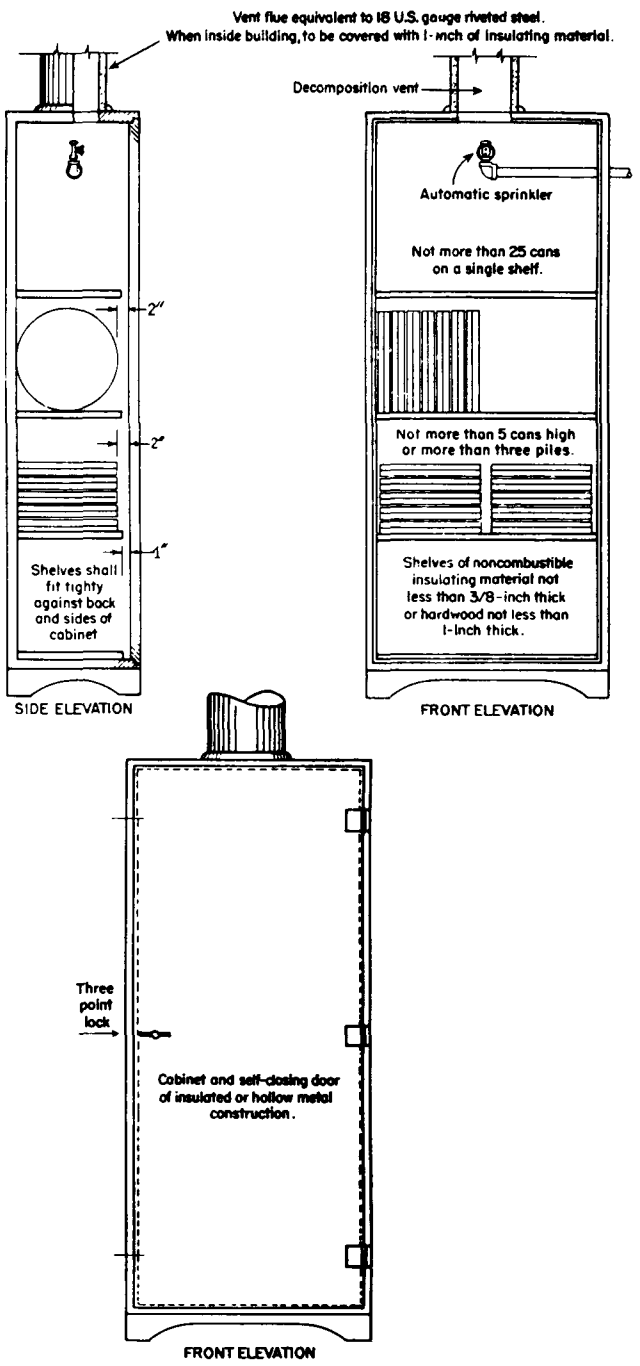
4-2.1 Film cabinets shall be constructed as shown in Figure 4-2.

4-2.2 Cabinets shall have a capacity not exceeding 375 lb (170 kg) (75 standard rolls).

4-2.3 Shelves shall be of noncombustible insulating material not less than ⅜ in. (1.0 cm) thick or of hardwood not less than 1 in. (2.54 cm) thick.

4-2.3.1 Shelves shall fit tightly to the back and sides of the cabinet. There shall be a clearance of at least 1 in. (2.54 cm) between the front of the shelf and the inside of the door.

4-2.3.2 Shelves shall be 1 in. (2.54 cm) wider, with a tolerance of ¼ in. (0.6 cm), than the diameter of the largest roll stored in the cabinet. Stops or bars shall be provided so that film cans cannot be stored with the front edge less than ¾ in. (1.9 cm) 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.



For SI Units: 1 in. = 2.54 cm.

Figure 4-2 Standard Film Cabinet (for other than archival film).

4-2.4* Each cabinet having a capacity of more than 50 lb (22.7 kg) (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 14 sq in. per 100 lb (2.0 cm per kg) of film capacity.

4-2.4.1 Vent flues shall be of construction equivalent to 18 US gage riveted sheet steel and, where inside the building, shall be covered with 1 in. (2.54 cm) of approved thermal insulating material.

4-2.5 Cabinets having a capacity of more than 75 lb (34 kg) (15 standard rolls) of film shall be provided with at least one automatic sprinkler head or one sprinkler head for each shelf meeting the description of 4-2.6.1 or 4-2.6.2 of this standard, whichever is applicable.

4-2.6 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 need not be in cans or other containers.

4-2.6.1 Film cans, if placed on edge, shall be limited to not more than 25 cans per shelf.

4-2.6.2 Film cans, if placed flat, shall be stacked no more than three cans high, with not more than three stacks per shelf.

4-3 Vaults — Other than Archival Vaults. (*See Figure 4-3.*)

4-3.1 Vaults shall be constructed in accordance with plans submitted to and approved by the authority having jurisdiction.

4-3.1.1 Vaults shall not exceed 750 cu ft (21.3 m^3) in inside volume. Where the height of the vault ceiling results in a vault having a volume greater than 750 cu ft (21.3 m^3), a heavy wire screen of at least 2-in. (5.0-cm) mesh or equivalent shall be installed below the ceiling to limit the interior vault space to 750 cu ft (21.3 m^3). (*See Figure 4-3.*)

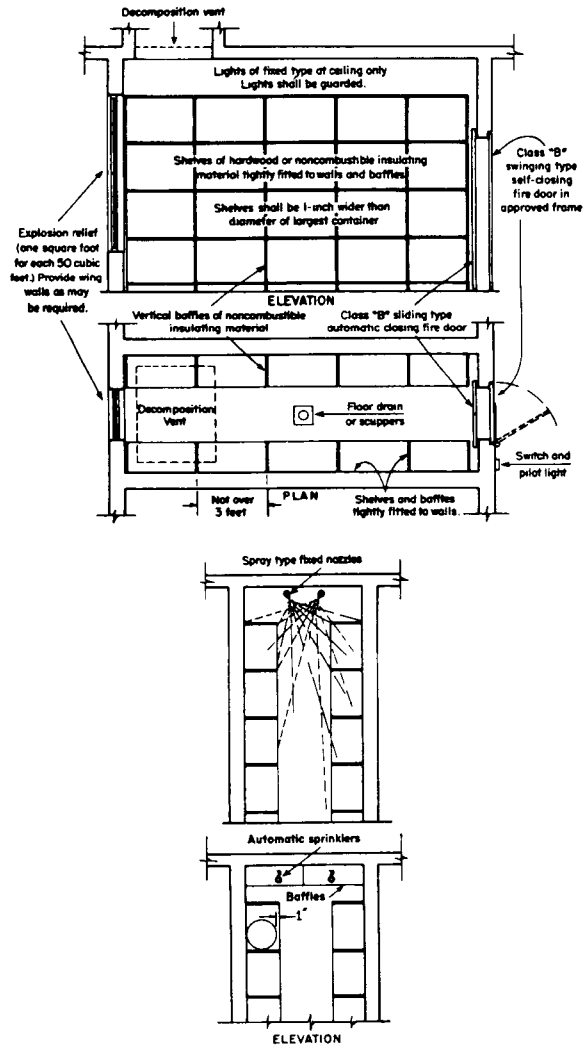
4-3.1.2 Walls and floors of vaults shall be of Type I construction, as defined in NFPA 220, *Standard on Types of Building Construction*, and shall have not less than 4-hour fire resistance. Where masonry units may have cracks or holes, the surface shall be plastered on both sides with a cement plaster to a minimum thickness of ½ in. (1.25 cm) to prevent escape of gases through wall cracks.

4-3.1.3 Where the ceiling of a vault is a bearing floor, it shall have a fire resistance of at least 4 hours. When the vault walls extend 3 ft (0.9 m) or more above the roof, the vault roof and ceiling may be constructed of noncombustible materials and may serve as an explosion vent.

4-3.1.4 Vaults shall be provided with suitable drains or scuppers to carry automatic sprinkler discharge directly to the outside of the building.

Exception: Existing vaults need not drain directly to the outside.

4-3.2* Door openings shall be protected with automatic, self-closing fire door assemblies, suitable for Class A openings and having a fire protection rating of 3 hours. Such doors shall be installed in accordance with NFPA 80, *Standard for Fire Doors and Windows*, and, if held open, shall be arranged to close automatically upon actuation of an approved smoke detector located in the vault.



For SI Units: 1 in. = 2.54 cm; 1 ft = 0.3 m; 1 cu ft = 0.028 m^3.

Figure 4-3 Standard Film Vault (for other than archival film).

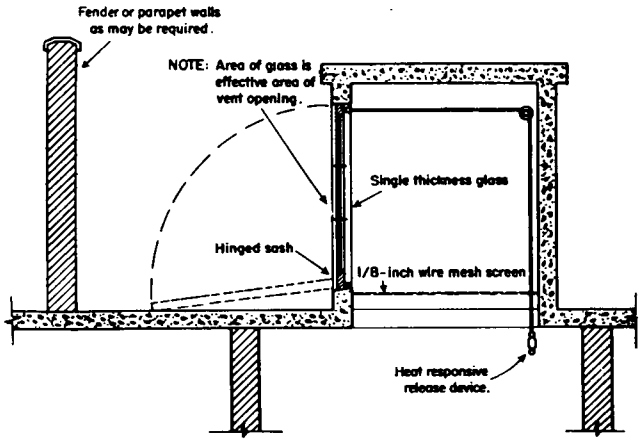
Exception: Existing heavy steel doors, or combinations of one swinging and one sliding door, both of steel construction, may be accepted at the discretion of the authority having jurisdiction.

4-3.3* Each vault shall be provided with an independent decomposition vent having a minimum effective cross-sectional area of 200 sq in. per 1000 lb (2.8 cm^2 per kg) (200 standard rolls) of film capacity.

Exception: In vaults provided with explosion venting, the decomposition vent may be omitted.

4-3.3.1 Existing vaults shall be provided with independent vents having an effective minimum cross-sectional area of at least 140 sq in. per 1000 lb (2.0 cm^2 per kg) (200 standard rolls) of film capacity.

4-3.3.2 The vent area for a standard 750 cu ft (21.3-m³) vault of new construction shall be not less than 2000 sq in. (1.3 m²). (*See Figure 4-3.3.*)



For SI Units: 1 in. = 2.54 cm.

Figure 4-3.3 Decomposition Vent.

4-3.3.3* Vent flues within the building shall be of Type I construction having a fire resistance of 4 hours.

4-3.3.4 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 50 ft (15 m) horizontally from any window or other opening exposed thereby and at least 25 ft (7.6 m) from any fire escape on the same or a higher level.

4-3.3.5* Vaults, especially those having a window for a vent, shall be arranged so that the nitrate film in the vault is protected against ignition by:

(a) Rays of the sun, whenever the film in the vault is exposed to direct sunlight entering through the vent.

(b) Radiated heat entering through the vent opening, as from an exposure fire, whenever the vent is severely exposed by buildings or storage of combustible material or by other openings in the same wall.

4-3.3.6* Each vent shall be protected against the weather by either single thickness [⅛-in. (0.16-cm.)] glass in a sash arranged to open automatically in case of fire or a hinged hollow metal or insulated vent panel, either of the above to be equipped with an approved releasing device placed inside the vault. The vents shall be arranged to open by both temperature or internal pressure of 5 lb per sq ft (25 kg/m²). No pane of glass shall be smaller than 200 sq in. (0.13 m²).

Exception: Protection equivalent to the above may be acceptable in lieu thereof.

4-3.3.7 A light wire screen not coarser than ⅛-in. (0.3-cm) mesh may be placed in each vent. No bars or screens other than this insect screen shall be placed in vent openings.

4-3.4* 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, adequate provisions shall be made to prevent this possibility.

4-3.5 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.

4-3.5.1 Vertical baffles shall be of noncombustible insulating material at least ⅜ in. (1.0 cm) thick, spaced to divide the racks into sections of not more than 3 ft (0.9 m) in width.

4-3.5.2 Shelves shall be at least 1 in. (2.54 cm) wider than the diameter of the largest container stored.

4-3.5.3 Metal supports may be used to keep containers in place.

4-3.5.4 Open racks in new construction shall be used only for storage of film in standard DOT containers or in insulated boxes.

4-3.6 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.

4-3.6.1 Sprinkler protection utilizing regular automatic sprinklers or open sprinklers shall be calculated on the basis of one sprinkler for each 62.5 cu ft (1.8 m³) of the interior vault volume.

4-3.6.2 The minimum number of sprinklers for a standard 750-cu ft (21.3-m³) vault shall be not less than 12.

4-3.6.3* Sprinklers or nozzles shall be arranged to provide adequate coverage over the tops and fronts of shelves.

4-3.6.4 Where automatic sprinklers are used, baffles made of 24 gage sheet steel or other acceptable noncombustible material shall be installed between each sprinkler. Baffles shall be rigidly fastened in place and shall extend from the ceiling down to 4 in. (10 cm) below the sprinkler deflectors.

4-3.6.5 The authority having jurisdiction shall be consulted for water and arrangement requirements for either automatic sprinklers or fixed spray nozzles.

4-3.7 Light fixtures shall comply with the requirements of 2-6.2 of this standard. All switches shall be outside the vault and provided with pilot lights to indicate whether vault lights are on or off.

4-3.8 Where heat is required to prevent freezing of the sprinkler system, it shall be by hot water or low-pressure steam limited to 10 psig (69 kPa) maximum pressure. Vault temperature shall not exceed 70°F (21°C). Radiators shall be placed at the ceiling, over aisle spaces, with pipes and radiators protected by wire guards arranged so that film cannot be placed within 12 in. (0.3 m) of them.

4-3.9 All film stored in vaults shall be in single- or double-roll containers or in DOT-approved shipping containers.

4-4 Archival Cabinets.

4-4.1 Archival cabinets shall be provided with individual drawers or compartments, each holding not more than 2000 ft (610 m) of film. Individual compartments shall be separated by ⅜ in. (1.0 cm) 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.

4-4.2 Archival cabinets shall be provided with automatic sprinklers when holding more than 50 lb (22.7 kg) of nitrate film.

4-4.3 Each archival cabinet having a capacity of more than 50 lb (22.7 kg) (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 14 sq in. per 100 lb (2.0 cm² per kg) (200 standard rolls) of film capacity.

4-4.3.1 Vent flues shall be of 18 U.S. gage riveted steel or equivalent. Where located within the building, vent flues shall be covered with 1 in. (2.54 cm) of approved thermal insulating material.

4-4.3.2 For long lengths of vent pipe, a larger size than that indicated in 4-4.3 may be necessary to take care of friction losses and turns in pipe.

4-5 Archival Vaults. (*See Figure 4-5.*)

4-5.1 Archival vaults shall be constructed according to plans submitted to and approved by the authority having jurisdiction.

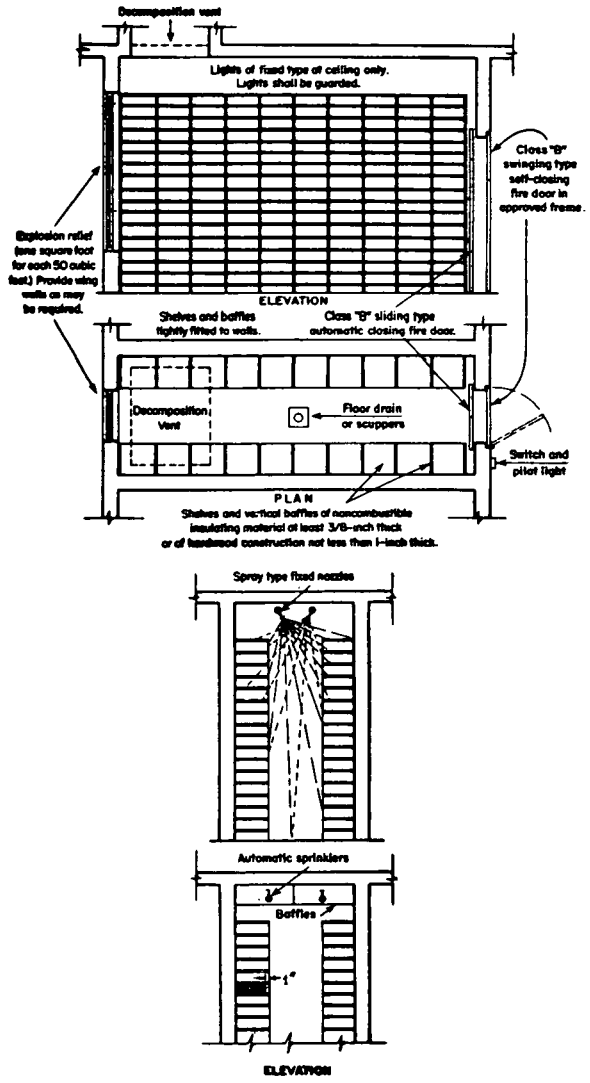
4-5.1.1 Archival vaults shall not exceed 1000 cu ft (28.4 m³) in interior volume. Where the height of the vault ceiling results in a vault having an interior volume greater than 1000 cu ft (28.4 m³) or greater than the volume agreed upon by the authority having jurisdiction, the interior vault space may be limited as described in 4-3.1.1 of this standard. (*See Figure 4-5.*)

4-5.1.2 Walls and floors shall be of Type I construction having a fire resistance of 4 hours. Where masonry units may have cracks or holes, the surface shall be plastered on both sides with a cement plaster to a thickness of at least ½ in. (1.25 cm). Equivalent construction that will provide equal fire resistance and prevent escape of gases through wall cracks may be used.

4-5.1.3 Archival vaults shall comply with 4-3.1.3 and 4-3.1.4 of this standard.

4-5.2 Door openings in archival vaults shall be protected in accordance with the requirements of 4-3.2 of this standard.

4-5.3 Archival vaults shall be provided with decomposition vents meeting the requirements of 4-3.3, except as modified by 4-5.3 and 4-3.4 of this standard.



For SI Units: 1 in. = 2.54 cm; 1 cu ft = 0.028 m³.

Figure 4-5 Archival Vault.

(a) The vent area for a standard 1000-cu ft (28.4-m³) archival vault shall be not less than 2670 sq in. (1.7 m²). (*See Figure 4-3.3.*)

(b) In no case shall the vent outlet exceed 25 ft (7.6 m) in length for a vault exceeding 1000 cu ft (28.4 m³).

Exception: In vaults provided with explosion venting, the decomposition vent may be omitted.

4-5.4 Archival vaults shall be provided with horizontal shelves and vertical baffles spaced so that not more than two containers, each containing 1000 ft (305 m) of film, may be placed in each compartment.

4-5.4.1 The spacing between shelves shall be such that the container covers may lift approximately ½ in. (1.25 cm), but cannot be lifted completely off the container.

4-5.4.2 The shelves shall be separated by vertical barriers so that not more than one container may be placed

between vertical baffles. The vertical baffles and the shelves shall be of noncombustible insulating material at least ⅜ in. (1.0 cm) thick, or hardwood construction at least 1 in. (2.5 cm) thick.

4-5.4.3 Containers shall be placed on shelves in contact with the back wall.

4-5.4.4 Racks shall be designed in relation to the sprinkler system so that the open face of each rack structure shall be adequately protected by the sprinkler system.

4-5.5 In new archival vaults, fire protection shall be provided in accordance with 4-3.6 of this standard, except as modified in the following paragraphs.

4-5.5.1 Sprinklers shall be provided in a ratio of one head for each 62.5 cu ft (1.5 m^3) of vault volume.

Exception: Sprinkler systems in existing archival vaults that complied with the provisions of this standard at the time of installation may be continued in use.

4-5.5.2 The minimum number of sprinkler heads for a 1000-cu ft (28.4-m^3) vault shall be 15 sprinklers.

Exception: Sprinkler systems in existing archival vaults that complied with the provisions of this standard at the time of installation may be continued in use.

4-5.5.3 Directional sprinkler heads that will provide adequate coverage into the face of the shelves shall be provided.

4-5.6 Interior lighting for archival vaults shall comply with 4-3.7 of this standard.

4-5.7 Where heat is required to prevent freezing of the sprinkler system, the heating system shall comply with 4-3.8 of this standard.

4-5.8 All film stored in archival vaults shall be in single- or double-roll containers or in DOT-approved shipping containers. The cover of the container used shall not lift off when the container is properly placed in the rack.

Chapter 5 Handling of Nitrate Film

5-1 Containers Required.

5-1.1* All nitrate film shall be kept in closed containers unless actually being worked on or examined.

5-1.2 Individual metal cans for each roll of film are acceptable. Containers approved by the U.S. Department of Transportation for shipment of nitrate film are especially suitable.

5-2 Shielding. Nitrate film shall not be placed or kept under benches, tables, or other surfaces that would shield it from sprinkler discharge.

5-3* Scrap Film.

5-3.1 Scrap nitrate film shall be kept separate from waste paper, scrap safety film, and other rubbish.

5-3.2 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.

5-3.3 Discarded film in full or partial rolls shall be kept in containers in vaults until disposal.

5-3.4 Scrap and discarded film shall be disposed of at frequent intervals. Scrap film shall not be baled or burned.

5-4 Transportation.

5-4.1 Nitrate film shall not be transported in any vehicle, aircraft, or other public conveyance used for the transportation of passengers, unless complying with DOT shipping regulations and other applicable regulations.

5-4.2 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 6 Motion Picture Projection and Special Processes

6-1 Enclosures for Motion Picture Projectors.

6-1.1* Motion picture projectors using nitrate film shall be operated or set up for operation only within an approved enclosure, not less than 80 sq ft (7.4 m^2) in area and 7 ft-6 in. (2.3 m) high. Only two machines shall be located in each such room.

6-1.2 The projection room shall have a fire resistance of not less than 1 hour. Interior finish shall have a flame spread index no greater than 25.

6-1.3* Exit doors shall be outward-swinging, self-closing, approved fire doors having a fire protection rating of not less than 1 hour. They shall be installed according to NFPA 80, *Standard for Fire Doors and Windows*. Doors shall be kept closed at all times when not actually in use.

6-1.4 Two openings shall be provided for each motion picture projection room or booth: one for the projectionist's view shall be not larger than 200 sq in. (1290 cm^2); the other for the projector itself shall be not larger than 120 sq in. (774 cm^2).

6-1.4.1 Where separate slide projection, spot- 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 projection of light. Two or more projectors may 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.

6-1.5 Each opening provided in accordance with 6-1.4 shall be provided with an approved gravity shutter, set into guides not less than 1 in. (2.54 cm) at sides and bottom and overlapping the top of the opening by not less than 1 in. (2.54 cm) when closed. Shutters shall be not less than 10-gage iron or equivalent. Shutters shall be suspended, arranged, and interconnected so that all openings will close upon operation of a suitable fusible or mechanical releasing device designed to operate automatically in case of fire.

6-1.5.1 Each shutter shall have a fusible link above it and there shall also be a fusible link over each upper magazine that, upon operating, will close all shutters.

6-1.5.2 Suitable 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.

6-1.6 All shelves, furniture, and fixtures within the enclosure shall be constructed of noncombustible materials.

Exception: Tables shall comply with Section 2-5 of this standard.

6-1.7 No combustible material of any sort shall be permitted in the projection enclosure other than the film and film cement.

6-1.8 Ventilation shall be provided by one or more mechanical exhaust systems that shall draw air from each arc lamp housing and from one or more points near the ceiling.

6-1.8.1 Exhaust systems shall exhaust to outdoors either directly or through a noncombustible flue used for no other purpose.

6-1.8.2 Exhaust capacity shall be neither less than 15 cfm (0.43 m^3 per min) nor more than 50 cfm (1.4 m^3 per min) for each arc lamp, plus 200 cfm (6.0 m^3 per min) for the room itself.

6-1.8.3 Exhaust systems shall be controlled from within the enclosure and shall have pilot lights to indicate operation.

6-1.8.4 The exhaust system serving the projection room may be extended to cover rooms 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.

6-1.8.5 No dampers shall be installed in such exhaust systems.

6-1.8.6 Exhaust ducts shall be of noncombustible material and shall either be kept 1 in. (2.54 cm) from combustible material or be covered with ½ in. (1.25 cm) of noncombustible thermal insulating material.

6-1.8.7 Fresh air intakes other than those direct to the outside shall be protected by approved fire dampers or shutters arranged to operate automatically with the shutters described in 6-1.5 of this standard.

6-1.9 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.

6-2 Processing Nitrate Film.

6-2.1 Such operations as cleaning, splicing, repairing, marking, cataloging, etc., may be grouped together in common work areas but shall not be done in rooms where other operations are performed.

6-2.2 Special processes for treating nitrate film shall be provided with the necessary safeguards to protect against the hazards involved. The authority having jurisdiction shall be consulted to determine the necessary protection.

Chapter 7 Special Occupancies

7-1 Motion Picture Theaters. Nitrate film is prohibited from occupancies that are being used as motion picture theaters.

7-2 Motion Picture Film Exchanges. Nitrate film shall not be stored or handled in film exchanges.

7-3 Motion Picture Film Laboratories.

7-3.1 The requirements of Chapter 2 of this standard shall also apply to nitrate motion picture film laboratories.

7-3.2 All buildings housing a nitrate motion picture film laboratory shall be protected throughout with an approved automatic sprinkler system.

7-3.3 The total quantity of nitrate film not in containers in all workrooms except shipping rooms shall not exceed two standard rolls per person handling film.

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

Exception No. 2: Five standard rolls per work station may be permitted provided the total does not exceed 10 standard rolls at any time.

7-3.4 The quantity of nitrate film outside of approved storage cabinets or vaults shall be limited to one motion picture feature or subject per work station, not to exceed a total of 40 standard rolls in rooms where film is prepared for printing.

7-3.5 For new installations, printing machines shall be separated from each other by noncombustible partitions, unless they are spaced so that there is a 6-ft (1.8-m) distance between the film on one machine and the film on an adjacent machine.

7-3.5.1 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.

7-3.5.2 In all cases, sprinklers shall be arranged so that not more than two machines are protected by any one sprinkler head.

7-3.6 Cabinet-type drying machines shall be listed.

7-3.7 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 10 standard rolls or 10,000 ft (3050 m) of film shall be exposed at any one time.

7-3.8 Not more than two projectors for nitrate film shall be located in any one room.

7-3.9 The shipping room shall be separated from the rest of the building by partitions complying with 2-1.3 of this standard. No process other than the packing of film shall be conducted in the shipping room. Not more than 500 standard rolls of film shall be in a shipping room at one time. Of this quantity, no fewer than 250 standard rolls shall be in shipping cases.

Chapter 8 Referenced Publications

8-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

8-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 10-1988, *Standard for Portable Fire Extinguishers*

NFPA 13-1987, *Standard for the Installation of Sprinkler Systems*

NFPA 15-1985, *Standard for Water Spray Fixed Systems for Fire Protection*

NFPA 68-1988, *Guide for Explosion Venting*

NFPA 70-1987, *National Electrical Code*

NFPA 80-1986, *Standard for Fire Doors and Windows*

NFPA 90A-1985, *Standard for the Installation of Air Conditioning and Ventilating Systems*

NFPA *101*-1988, *Life Safety Code*

NFPA 220-1985, *Standard on Types of Building Construction*

NFPA 251-1985, *Standard Methods of Fire Tests of Building Construction and Materials*

Appendix A

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

A-1-4.2 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-1-6 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 [2000 ft (610 m)] of film in theaters and exchanges.

A-2-3.1 It is suggested that, wherever practical, explosion vents be provided in existing rooms or vaults used for the storage and handling of nitrate film.

A-2-4 The purpose of this section is to prevent congestion of workers in areas where large quantities of nitrate film are handled.

A-3-1 It is recommended that buildings used for the storage or handling of nitrate film, except for buildings housing small areas possessing no fire hazard and so located that there is little opportunity for fire gases to enter the area, be completely protected by automatic sprinklers. Also, while 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-3-3 Small hose equipment is recommended. See NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*.

A-4-2.4 For long lengths of vent pipe, a larger size may be necessary to overcome friction loss and turns in the pipe.

A-4-3.2 Vaults may have two door openings. Such an arrangement is often a great convenience, as in laboratories, where the vault is located between rooms and 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-4-3.3 The vent area requirement is equivalent to 1 sq in. (6.5 cm^2) for each standard roll. In determining the proper vent opening, allowance must be made for the window frame and sash, as the area of the glass is considered the effective cross-sectional area of the vent opening.

A-4-3.3.3 The extension of a vent outlet by means of flues extending 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 25 ft (8.7 m), proper allowance must be made for frictional losses and the cross-sectional area increased progressively to ensure adequate venting. Such cases are regarded as special and subject to the approval of the authority having jurisdiction.

A-4-3.3.5 Protection against sunlight may 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 that has been used employs two baffle walls inside the vault itself. The baffle wall nearer the vent should extend down from the ceiling to within 3 ft (0.9 m) of the floor; the inner baffle wall extends up from the floor to within 3 ft (0.9 m) 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-4-3.3.6 The use of approved quick-operating devices is recommended.

A-4-3.4 This may be done by providing roof parapets or extended wing walls between such openings.

A-4-3.6.3 The arrangement of sprinklers or nozzles to provide adequate distribution over the face of shelving is important and requires knowledge of sprinkler discharge patterns and locations. This should be done only by qualified personnel.

A-5-1.1 The requirement is essential for life safety and from the standpoint of fire hazard.

A-5-3 Nitrate film in the form of clippings and short lengths is very hazardous. Safe precautions in the handling of such scraps are most essential. Baling and burning of film are processes presenting distinct fire hazards. Sending film to a central reclaiming plant is recommended.

A-6-1.1 For new construction, an enclosure not less than 8 ft (2.4 m) wide, 10 ft (3 m) long, and 8 ft (2.4 m) high is recommended for one projection machine, and not less than 10 ft (3 m) wide, 14 ft (4.3 m) long, and 8 ft (2.4 m) high for two machines.

A-6-1.3 For new construction, it is recommended that at least two doors be provided, each not less than 30 in. (76 cm) wide and 72 in. (183 cm) 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 should be of the conventional stairway type having a suitable landing at the top or opening directly onto a corridor.

Appendix B Additional Information on Cellulose Nitrate Film[1]

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

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 generally given as about 300°F (149°C), 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 325°F (163°C) within 80 seconds; at 400°F (204°C), ignition occurred in 10 seconds; and at 500°F (260°C), 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 200°F (93°C) 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 120°F (49°C). 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 100°F (378°C) weather.[2]

The actual heat of combustion of cellulose nitrate film is low compared with that of more common fuels:

Heat of Combustion

	Btu per lb	kJ per kg
Nitrate Film	6000—8000	13 944—18 921
Wood	7000—8000	16 268—18 921
Alcohol	11,620	27 005
Coal, bituminous	10,000—14,000	23 240—32 536
Gasoline	20,750	

However, the rate of combustion of nitrate film is about 15 times that of wood in any form, so that the heat evolved per minute is initially much greater. This 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

[1]Abstracted, with permission of Eastman Kodak Company, from *Hazard in the Handling and Storage of Nitrate and Safety Motion Picture Film*, Eastman Kodak Company, Rochester, NY, 1951.

[2]Cummings, J.W., Hutton, A.C., and Silton, H., "Spontaneous Ignition of Decomposing Cellulose Nitrate Film," *J Soc. Mot. Pict. and Tel. Eng.*, 54, 268-274, March 1950.

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 may 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-2A. Traces of hydrogen cyanide have also been detected, but not in significant amounts.

Table B-2A

Gases Evolved in Flameless Combustion of Nitrate Film[1]
Volume of Combustion Chamber: 8 to 27 cu ft (0.22 to 0.756 m^3)
Weight of Film: 2 lb/cu ft (32.4 kg/m^3)

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

Complete combustion of nitrate film yields 4 to 5 cu ft of gas per lb (0.22 to 0.31 m^3 per kg) of film at normal temperature and pressure. The proportions of the various gases will vary somewhat with the temperature, pressure, air supply, etc.

B-3 Detection and Disposal of Unstable Nitrate Film. New nitrate film is as stable as it is possible to make it and some nitrate films 30 or 40 years old still appear to be in reasonably good condition. However, all nitrate film deteriorates with age and the deterioration is increased by chemical contamination and improper storage conditions. Nitrate film in an advanced stage of deterioration is less stable, ignites at lower temperatures, and is more likely to ignite spontaneously than new film.

All nitrate films that are to be saved for future reprocessing or for archive purposes should be carefully examined 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 may 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 and then destroyed. Any films in cans that are corroded on the inside should be treated similarly.

The disposal of deteriorated or unstable nitrate film presents a problem. It must not be mixed with regular nitrate film scrap or ordinary rubbish. Such film should be kept under water in a steel drum until disposal can be arranged. Deteriorated nitrate film should be burned, but this involves a hazard. It should be done only by a qualified person outdoors. A large area, well removed from any building or combustible material, should be selected and only a few rolls burned at a time. Where this is not possible, safe disposal should be arranged through proper authorities.

B-4 Identifying Nitrate Film. A simple, reasonably foolproof test to distinguish nitrate film from safety base film is to punch or cut a ¼-in. (0.64-cm) diameter sample from the film and place it in a test tube or a small bottle containing trichloroethylene. The liquid should be shaken to make sure the film sample is completely immersed. If the sample sinks, it is nitrate film; if it floats to the surface, it is safety film.

Appendix C Referenced Publications

C-1 The following documents or portions thereof are referenced within this standard for informational purposes only and thus are not considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

C-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 14-1986, *Standard for the Installation of Standpipe and Hose Systems*

NFPA 232-1986, *Standard for the Protection of Records*

C-1.2 Other Publications.

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

Journal of the Society of Motion Picture and Television Engineers, Vol. 54, March 1950, Cummings, J.W., et al., "Spontaneous Ignition of Decomposing Cellulose Nitrate Film," pp. 268-274.

"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," U.S. Government Printing Office, Washington, D.C., 1929.

[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," U.S. Government Printing Office, Washington, D.C., 1929.

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SUBMITTING PROPOSALS ON NFPA TECHNICAL COMMITTEE DOCUMENTS

Contact NFPA Standards Administration for final date for receipt of proposals on a specific document.

INSTRUCTIONS

Please use the forms which follow for submitting proposed amendments. Use a separate form for each proposal.

1. For each document on which you are proposing amendment indicate:
   (a) The number and title of the document
   (b) The specific section or paragraph.

2. Check the box indicating whether or not this proposal recommends new text, revised text, or to delete text.

3. In the space identified as "Proposal" include the wording you propose as new or revised text, or indicate if you wish to delete text.

4. In the space titled "Statement of Problem and Substantiation for Proposal" state the problem which will be resolved by your recommendation and give the specific reason for your proposal including copies of tests, research papers, fire experience, etc. If a statement is more than 200 words in length, the technical committee is authorized to abstract it for the Technical Committee Report.

5. Check the box indicating whether or not this proposal is original material, and if it is not, indicate source.

6. If supplementary material (photographs, diagrams, reports, etc.) is included, you may be required to submit sufficient copies for all members and alternates of the technical committee.

NOTE: The NFPA Regulations Governing Committee Projects in Paragraph 10-10 state, Each proposal shall be submitted to the Council Secretary and shall include:

(a) identification of the submitter and his affiliation (Committee, organization, company) where appropriate, and

(b) identification of the document, paragraph of the document to which the proposal is directed, and

(c) a statement of the problem and substantiation for the proposal, and

(d) proposed text of proposal, including the wording to be added, revised (and how revised), or deleted.