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# NFPA 231 General Storage 1987 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.

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### Statement on NFPA Procedures

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In 1974 the height of storage to which this standard applies was increased from 25 feet to 30 feet.

The standard was partially revised in 1979, and again in 1985.

This 1987 edition incorporates minor revisions and supersedes the 1985 edition.

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NFPA 231

Standard for

# General Storage

1987 Edition



This edition of NFPA 231, *Standard for General Storage*, was prepared by the Technical Committee on General Storage, released by the Correlating Committee on Storage, and acted on by the National Fire Protection Association, Inc. at its Fall Meeting held November 17-20, 1986, in Denver, Colorado. It was issued by the Standards Council on December 10, 1986, with an effective date of December 30, 1986, and supersedes all previous editions.

The 1987 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 231

The U.S. War Production Board promulgated in 1943 General Storage Specifications for Critical-Strategic Materials. These were largely based on existing NFPA standards and upon generally accepted good practice in fire protection. They were published for convenient reference in NFPA National Fire Codes for Building Construction and Equipment in 1944, and an NFPA Committee on General Storage was appointed that same year. On recommendation of that Committee, a General Storage Standard was adopted at the NFPA Annual Meeting in 1946. This covered both indoor and outdoor storage. A revision of the standard was tentatively adopted in 1953.

In 1955 the Committee presented a draft of a new document, Recommended Safe Practices for General Storage, No. 231-T, covering Indoor Storage, Outdoor Storage and Refrigerated Warehouses. This was tentatively adopted, leaving the 1946 General Storage Standard still official. With a few amendments, NFPA 231, Recommended Safe Practices for General Storage, was adopted in 1956.

In 1965 this was changed from a recommended practice to a standard, and the present title was introduced. The sections of the 1965 edition pertaining to Outdoor Storage and Refrigerated Warehouses were deleted, and an Appendix on Pallets and Palletized Storage was added.

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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

# NFPA 231

## Standard for

# General Storage

## 1987 Edition

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A.
Information on referenced publications can be found in Chapter 10 and Appendix D.

## Chapter 1 Introduction

**1-1 Scope.**

**1-1.1** This standard applies to:

**1-1.1.1** Storage of materials representing the broad range of combustibles up to 30 ft (9.1 m) in height.

**1-1.1.2** Storage of plastics (Groups B and C — all configurations; Group A — free-flowing only) up to 30 ft (9.1 m) in height.

**1-1.1.3** Storage of Group A plastics (except free-flowing) up to 25 ft (7.6 m) in height.

**1-1.1.4** New buildings and existing buildings that are converted to storage occupancy.

NOTE: It may be used as a basis for evaluating existing storage facilities.

**1-1.1.5 Outdoor Storage of a Broad Range of Combustibles.** (*See Appendix C.*)

**1-1.2** Storage piled higher than stated in 1-1.1.1, 1-1.1.2 or 1-1.1.3 is not within the scope of this standard and requires special consideration.

**1-1.3** This standard does not apply to:

**1-1.3.1** Unsprinklered buildings.

**1-1.3.2** Storage of commodities which, with their packaging and storage aids, would be classified as noncombustible.

**1-1.3.3** Unpackaged bulk materials such as grain, coal, or similar commodities.

**1-1.3.4** Inside or outside storage of commodities covered by other NFPA standards except where specifically mentioned herein, e.g., pyroxylin plastics.

**1-1.3.5** Commodities presenting special fire hazards *not* covered by specific NFPA standards, e.g., roll paper, wax-coated cartons, etc.

**1-1.3.6** Storage on racks.

**1-1.4** Nothing in this standard is intended to restrict new technologies or alternate arrangements providing the level of safety prescribed by the standard is not lowered.

**1-2* Definitions.** Unless expressly stated elsewhere, for the purpose of this standard, the following definitions shall apply:

**Array.**

**Closed Array.** A storage arrangement where air movement through the pile is restricted because of 6 in (152 mm) or less vertical flues.

**Open Array.*** A storage arrangement where air movement through the pile is enhanced because of vertical flues larger than 6 in. (152 mm).

**Available Height for Storage.*** The maximum height at which commodities can be stored above the floor and still maintain adequate clearance from structural members and the required clearance below sprinklers.

**Bin Box Storage.** Storage in 5-sided wood, metal, or cardboard boxes with open face on the aisles. Boxes are self-supporting or supported by a structure so designed that little or no horizontal or vertical space exists around boxes.

**Clearance.** The distance from the top of storage to the ceiling sprinkler deflectors.

**Commodity.** Combinations of products, packing material, and container.

**Compartmented.*** The rigid separation of the products in a container by dividers that form a stable unit under fire conditions.

**Container (shipping, master, or outer container).*** A receptacle strong enough, by reason of material, design, and construction, to be shipped safely without further packaging.

**Encapsulated.** A method of packing consisting of a plastic sheet completely enclosing the sides and top of a pallet load containing a combustible commodity or combustible packages.

NOTE: Banding, i.e., stretch wrapping, around the sides only of a pallet load is not considered to be encapsulated.

**Expanded (foamed or cellular) Plastics.** Those plastics, the density of which is reduced by the presence of numerous small cavities (cells), interconnecting or not, dispersed throughout their mass.

**Exposed Group A Plastic Commodities.** Those plastics not in packaging or coverings that will absorb water or otherwise appreciably retard the burning hazard of the commodity (paper wrapped and/or encapsulated should be considered exposed).

**Free-flowing Plastic Materials.** Those plastics that will fall out of their containers in a fire condition, fill flue

spaces, and create a smothering effect on the fire. Example: Powder, pellets, flakes, or *random packed* small objects [razor blade dispensers, 1-2 oz (28-57 g) bottles, etc.].

**Noncombustible.** Commodities, packaging, or storage aids that will not ignite, burn or liberate flammable gases when heated to a temperature of 1,380°F (749°C) for 5 minutes.

**Packaging.** Commodity wrapping, cushioning, or container.

**Palletized Storage.** Storage of commodities on pallets or other storage aids that form horizontal spaces between tiers of storage.

**Pile Stability.***

**Stable Piles.** Those arrays where collapse, spillage of content, or leaning of stacks across flue spaces is *not* likely to occur soon after initial fire development.

NOTE: Storage on pallets, compartmented storage, or plastic components that are held in place by materials that do not deform readily under fire conditions are examples of stable storage.

**Unstable Piles.** Those arrays where collapse, spillage of contents, or leaning of stacks across flue spaces will occur soon after initial fire development.

NOTE: Leaning stacks, crushed bottom cartons, or reliance on combustible bands for stability are examples of potential pile instability under a fire condition. An increase in pile height will tend to increase instability.

**Shall.** Indicates a mandatory requirement.

**Shelf Storage.** Storage on structures less than 30 in (76.2 cm) deep with shelves usually 2 ft (0.6 m) apart vertically and separated by approximately 30-in (76.2-cm) aisles.

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

**Solid Unit Load of a Nonexpanded Plastic (either cartoned or exposed).** A load that does not have voids (air) within the load and will burn only on the exterior of the load; water from sprinklers may reach most surfaces available to burn.

**Sprinkler Temperature Rating.** A 165°F (74°C) rating includes temperature ratings between 135°F (57°C) and 175°F (80°C), and a 286°F (141°C) rating includes temperature ratings between 250°F (121°C) and 300°F (149°C).

**Storage Aids.** Commodity storage devices, such as pallets, dunnage, separators, and skids.

**Unit Load.** A pallet load or module held together in some manner and normally transported by material-handling equipment.

## Chapter 2 Classification of Storage

### 2-1 Commodity Classification.

2-1.1 Class I commodity is defined as essentially noncombustible products on combustible pallets, in ordinary corrugated cartons with or without single-thickness dividers, or in ordinary paper wrappings with or without pallets.

Examples of Class I products are:

**Foods.** Noncombustible foodstuffs and beverages. Foods in noncombustible containers; frozen foods; meats; fresh fruits and vegetables in nonplastic trays or containers; liquid dairy products in non-wax-coated paper containers or in plastic-coated paper containers; beer and wine, up to 20 percent alcohol, in metal, glass or ceramic containers in ordinary corrugated cartons.

**Glass Products.** Glass bottles, empty or filled with noncombustible liquids; and mirrors.

**Metal Products.** Metal desks with plastic tops and trim; electrical coils; electrical devices in their metal enclosures; pots and pans; electrical motors; dry cell batteries; metal parts; empty cans; stoves; washers; dryers; and metal cabinets.

**Others.** Oil-filled and other types of distribution transformers; cement in bags; electrical insulators; gypsum board; inert pigments; and dry insecticides.

2-1.2 Class II commodity is defined as Class I products in slatted wooden crates, solid wooden boxes, multiple thickness paperboard cartons or equivalent combustible packaging material with or without pallets.

Examples of Class II products are:

Thinly coated fine wire such as radio coil wire on reels or in cartons; incandescent or fluorescent light bulbs; Class I products if in small cartons or small packages placed in ordinary paperboard cartons; book signatures; and beer or wine up to 20 percent alcohol in wood containers.

2-1.3 Class III commodity is defined as wood, paper, natural fiber cloth, or Group C plastics or products thereof, with or without pallets. Products may contain a limited amount of Group A or B plastics. Metal bicycles with plastic handles, pedals, seats, and tires are an example of a commodity with a limited amount of plastic.

Examples of Class III products are:

**Leather Products.** Shoes; jackets; gloves; and luggage.

**Paper Products.** Books; magazines; stationery; plastic-coated paper food containers; newspapers; paper or cardboard games; and tissue products.

**Textiles.** Natural fiber upholstered nonplastic furniture; wood or metal furniture with plastic padded and covered arm rests; mattresses without expanded plastic or

rubber; absorbent cotton in cartons; natural fiber and viscose yarns, thread, and products; synthetic thread and yarn; natural fiber clothing or textile products.

**Wood Products.** Doors; windows; door and window frames; combustible fiberboard; wood cabinets and furniture, and other wood products.

**Others.** Tobacco products in paperboard cartons; nonflammable liquids such as soaps, detergents, and bleaches in plastic containers; non-negative-producing film packs in sealed tin foil wrappers in paperboard packages; combustible foods or cereal products; and nonflammable pharmaceuticals.

**2-1.4** Class IV commodity is defined as Class I, II, or III products containing an appreciable amount of Group A plastics in ordinary corrugated cartons and Class I, II, and III products in corrugated cartons with Group A plastic packing, with or without pallets. Group B plastics and free-flowing Group A plastics are also included in this class. An example of packing material is a metal typewriter in a foamed plastic cocoon in an ordinary corrugated carton. (*Figure 7-1.1, Note 3.*)

Examples of Class IV products are:

Small appliances, typewriters, and cameras with plastic parts; plastic-backed tapes; and nonviscose synthetic fabrics or clothing. Telephones; vinyl floor tiles; wood or metal frame upholstered furniture or mattresses with plastic covering and/or padding; plastic-padded metal bumpers and dashboards; insulated conductor and power cable on wood or metal reels or in cartons; inert solids in plastic containers; and building construction insulating panels of polyurethane sandwiched between nonplastic material.

**2-1.5* Classification of Plastics, Elastomers, and Rubber.**

NOTE: The following categories are based on unmodified plastic materials. The use of fire or flame-retarding modifiers or the physical form of the material may change the classification.

**Group A**

ABS (Acrylonitrile-Butadiene-Styrene Copolymer)
Acrylic (Polymethyl Methacrylate)
Acetal (Polyformaldehyde)
Butyl Rubber
EPDM (Ethylene-Propylene Rubber)
FRP (Fiberglass Reinforced Polyester)
Natural Rubber (if expanded)
Nitrile Rubber (Acrylonitrile-Butadiene Rubber)
PET (Thermoplastic Polyester)
Polybutadiene
Polycarbonate
Polyester Elastomer
Polyethylene
Polypropylene
Polystyrene
Polyurethane
PVC (Polyvinyl Chloride — highly plasticized, e.g., coated fabric, unsupported film)
SAN (Styrene Acrylonitrile)
SBR (Styrene-Butadiene Rubber)

**Group B**

Cellulosics (Cellulose Acetate, Cellulose Acetate Butyrate, Ethyl Cellulose)
Chloroprene Rubber
Fluoroplastics (ECTFE — Ethylene-Chlorotrifluoroethylene Copolymer; ETFE — Ethylene-Tetrafluoroethylene Copolymer; FEP — Fluorinated Ethylene-Propylene Copolymer)
Natural Rubber (not expanded)
Nylon (Nylon 6, Nylon 6/6)
Silicone Rubber

**Group C**

Fluoroplastics (PCTFE — Polychlorotrifluoroethylene; PTFE — Polytetrafluoroethylene)
Melamine (Melamine Formaldehyde)
Phenolic
PVC (Polyvinyl Chloride — rigid or lightly plasticized, e.g., pipe, pipe fittings)
PVDC (Polyvinylidene Chloride)
PVF (Polyvinyl Fluoride)
PVDF (Polyvinylidene Fluoride)
Urea (Urea Formaldehyde)

## Chapter 3 Building Construction

**3-1 Construction.**

**3-1.1*** Buildings used for storage of materials which are stored and protected in accordance with this standard may be of any of the types described in NFPA 220, *Standard on Types of Building Construction.*

**3-1.2** Adequate access shall be provided to all portions of the premises for fire fighting purposes.

**3-2* Emergency Smoke and Heat Venting.** Protection outlined in this standard applies to buildings with or without roof vents and draft curtains.

## Chapter 4 Storage Arrangement

**4-1 Piling Procedures and Precautions.**

**4-1.1** Any commodities that may be hazardous in combination with each other shall be stored so they cannot come into contact with each other.

**4-1.2*** Safe floor loads shall not be exceeded. For water absorbent commodities, normal floor loads shall be reduced to take into account the added weight of water that can be absorbed during fire fighting operations.

**4-2 Commodity Clearance.**

**4-2.1** The clearance between top of storage and sprinkler deflectors shall conform to NFPA 13, *Standard for the Installation of Sprinkler Systems*, except as modified by this standard.

**4-2.2*** If the commodity is stored above the lower chord of roof trusses, at least 1 ft (30.5 cm) clear space shall be maintained to permit wetting of the truss unless the truss is protected with 1-hour fireproofing.

**4-2.3** Storage clearance from ducts shall be maintained in accordance with NFPA 91, *Standard for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying*, Section 2-8.

**4-2.4** The clearance between stored materials and unit heaters, radiant space heaters, duct furnaces, and flues shall not be less than 3 ft (0.9 m) in all directions or shall be in accordance with the clearances shown on the approval agency label.

**4-2.5*** Clearance shall be maintained to lights or light fixtures to prevent possible ignition.

**4-2.6** Sufficient clearance shall be maintained around the path of fire door travel to assure proper operation and inspection.

**4-3 Aisles.**

**4-3.1** Wall aisles shall be at least 24 in (61 cm) wide in warehouses used for the storage of commodities that expand with the absorption of water.

**4-3.2*** Aisles shall be maintained to retard transfer of fire from one pile to another and to permit convenient access for fire fighting, salvage and removal of storage.

**4-4* Storage of Idle Pallets.**

**4-4.1 Wood Pallets or Nonexpanded Polyethylene Solid Deck Pallets.**

**4-4.1.1*** Pallets shall preferably be stored outside or in a detached building.

**4-4.1.2** Pallets, when stored indoors, shall be protected as indicated in Table 4-4.1.2, unless the following conditions are met:

(a) Stored no higher than 6 ft (1.8 m), and

(b) Each pallet pile of no more than 4 stacks shall be separated from other pallet piles by at least 8 ft (1.4 m) of clear space or 25 ft (7.6 m) of commodity.

NOTE: No additional protection is necessary as long as items (a) and (b) above are met.

**Table 4-4.1.2 Protection for Indoor Storage of Wood Idle Pallets or Nonexpanded Polyethylene Solid Deck Idle Pallets.**

| Height of Pallet Storage ft (m) | Sprinkler Density Requirements gpm/ft² [(L/S)/m²] | Area of Sprinkler Demand ft²(m²) | |
|---|---|---|---|
| | | Temperature Rating 286°F (141°C) | 165°F (74°C) |
| Up to 6 (1.8) | .20 [.14] | 2,000 (186) | 3,000 (279) |
| 6 (1.8) to 8 (2.4) | .30 [.20] | 2,500 (232) | 4,000 (372) |
| 8 (2.4) to 12 (3.7) | .60 [.41] | 3,500 (325) | 6,000 (557) |
| 12 (3.7) to 20 (6.1) | .60 [.41] | 4,500 (418) | — |

**4-4.2* Plastic Pallets (other than noted in 4-4.1).**

**4-4.2.1** Plastic pallets shall preferably be stored outdoors or in a detached shed (*see Table A-4.4.1.1*).

**4-4.2.2** Plastic pallets where stored indoors shall be protected as follows:

(a) When stored in cutoff rooms:

(1) The cutoff rooms shall have at least one exterior wall.

(2) The plastic pallet storage shall be separated from the remainder of the building by 3-hour rated fire walls.

(3) The storage shall be protected by sprinklers designed to deliver 0.60 gpm/ft² [0.41 (L/s)/m²] for the entire room or by high expansion foam and sprinklers as indicated in Section 5-2.

(4) The storage shall be piled no higher than 12 ft (3.7 m).

(5) Any steel columns shall be protected by 1-hour fireproofing or a sidewall sprinkler directed to one side of the column at the top or at the 15-ft (4.6-m) level, whichever is lower (*see A-4-2.2*).

(b) When stored without cutoffs from other storage:

(1) Plastic pallet storage shall be piled no higher than 4 ft (1.2 m).

(2) Sprinkler protection shall employ 286°F (141°C) rated sprinklers.

(3) Each pallet pile of no more than two stacks shall be separated from other pallet piles by at least 8 ft (2.4 m) of clear space or 25 ft (7.6 m) of stored commodity.

**4-5 Flammable and Combustible Liquids.** Only limited quantities of flammable and combustible liquids shall be permitted in general storage warehouses. Any such storage shall be segregated from other stored combustible material. See Chapter 4 of NFPA 30, *Flammable and Combustible Liquids Code*.

## Chapter 5 Fire Protection — General

**5-1 Automatic Sprinkler Systems.**

**5-1.1** Sprinkler systems installed in buildings used for solid pile, bin box, shelf, or palletized storage shall be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, except as modified by this chapter.

**5-1.2** The design density shall not be less than 0.15 gpm/ft² [0.10 (L/s)/m²] and the design area shall not be less than 2000 ft² (186 m²) for wet systems, 2600 ft² (242 m²) for dry systems, for any commodity, class, or group.

**5-1.2.1** The sprinkler design density for any given area of operation for a Class IV commodity, calculated in accordance with Chapter 6, *shall not be less than* the density for the corresponding area of operation for Ordinary Hazard Group 3 in Figure 2-2.1(B) in NFPA 13, *Standard for the Installation of Sprinkler Systems*.

5-1.2.2 The sprinkler design density for any given area of operation for a Class III commodity, calculated in accordance with Chapter 6, *shall not be less than* the density for the corresponding area of operation for Ordinary Hazard Group 2 in Figure 2-2.1(B) in NFPA 13, *Standard for the Installation of Sprinkler Systems.*

5-1.2.3 The water supply requirements for sprinklers only shall be based on the actual calculated demand for the hazard using Chapter 6 requirements, and adjusting (if necessary) to satisfy paragraphs 5-1.2, 5-1.2.1, and 5-1.2.2.

5-1.3 Where palletized or solid pile storage is placed on top of racks, the provisions of NFPA 231C, *Standard for Rack Storage of Materials*, shall apply to the entire height of storage with regard to sprinkler requirements and water supplies for ceiling and rack sprinklers.

5-1.4 In warehouses that have portions containing rack storage and other portions containing palletized, solid pile, bin box, or shelf storage, the standard applicable to the storage configuration shall apply.

5-1.5* The densities and areas provided in the curves in Chapters 6 and 7 are based on fire tests using standard orifice ½ in (12.7 mm) and large orifice 17/32 in (13.5 mm) sprinklers. For use of other types of sprinklers consult the authority having jurisdiction.

5-1.6 In buildings occupied in part for storage, within the scope of this standard, the required sprinkler protection shall extend 15 ft (4.6 m) beyond the perimeter of the storage area.

**5-2 High Expansion Foam.**

5-2.1 High expansion foam systems installed in addition to automatic sprinklers shall be installed in accordance with NFPA 11A, *Standard for Medium and High Expansion Foam Systems*, except as modified herein.

High expansion foam used to protect the idle pallets shall have a maximum fill time of 4 minutes.

5-2.2 High expansion foam systems shall be automatic in operation.

5-2.3 Detectors shall be listed and shall be installed at no more than one-half listed spacing.

5-2.4 Detection systems, concentrate pumps, generators, and other system components essential to the operation of the system shall have an approved standby power source.

5-2.5 A reduction in ceiling density to one-half that required for Class I through IV commodities, idle pallets, or plastics (using the secondary demand point) will be allowed without revising the design area, but shall be not less than 0.15 gpm/ft² [0.10 (L/s)/m²].

**5-3 Manual Inside Protection.**

**5-3.1 Small Hose Systems.** Small hose lines [1½ in (38 mm)] shall be available to reach all portions of the storage area, giving due consideration to access aisle configuration with maximum anticipated storage in place. Such small hose may be supplied from:

(a) Outside hydrants.

(b) A separate piping system for small hose stations.

(c) Valved hose connections on sprinkler risers where such connections are made upstream of sprinkler control valves.

(d) Adjacent sprinkler systems (*see NFPA 13*).

**5-3.2 Portable Fire Extinguishers.** Portable fire extinguishers shall be provided in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*. Up to one-half of the required complement of portable fire extinguishers for Class A fires may be omitted in storage areas where fixed, small hose lines [1½ in (38 mm)] are available to reach all portions of the storage area.

**5-4* Hydrants.** At locations without public hydrants, or where hydrants are not within 250 ft (76.2 m), private hydrants shall be installed in accordance with *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* NFPA 24.

**5-5* Fire Organization.**

5-5.1 Arrangements shall be made to permit rapid entry into the premises by the municipal fire department, police department, or other authorized personnel in case of fire or other emergency.

5-5.2 Plant emergency organizations, where provided, shall be instructed and trained in the following procedures:

(a) Maintaining the security of the premises.

(b) Means of summoning outside aid immediately, in an emergency.

(c) Use of hand extinguishers and hose lines on small fires and mop-up operations.

(d) Operation of sprinkler system and water supply equipment.

(e) Use of material handling equipment while sprinklers are operating to effect final extinguishment.

(f) Supervision of sprinkler valves after system is turned off so that system can be reactivated if rekindling occurs.

(g) Need for breathing apparatus.

(h) Proper operation of emergency smoke and heat venting systems where these have been provided.

NOTE: Information on emergency organization is given in the following publications:

NFPA *Industrial Fire Brigades Training Manual.*
NFPA 600, *Recommendations for Organization, Training, and Equipment of Private Fire Brigades.*

5-5.3 A fire watch shall be maintained when the sprinkler system is not in service.

**5-6 Alarm Service.** Central station, auxiliary, remote station, or proprietary sprinkler waterflow alarm shall be provided. Local waterflow alarm is acceptable where recorded guard service is provided. (*See NFPA 71, Standard for the Installation, Maintenance and Use of Cen-*

*tral Station Signaling Systems; NFPA 72A, Standard for the Installation, Maintenance and Use of Local Protective Signaling Systems for Guard's Tour, Fire Alarm and Supervisory Services; NFPA 72B, Standard for the Installation, Maintenance and Use of Auxiliary Protective Signaling Systems for Fire Alarm Service; NFPA 72C, Standard for the Installation, Maintenance and Use of Remote Station Protective Signaling Systems; and NFPA 72D, Standard for the Installation, Maintenance and Use of Proprietary Protective Signaling Systems.)*

## Chapter 6* Fire Protection — Commodity Classes I through IV

### 6-1 General.

**6-1.1** Protection specified in this chapter shall apply to nonencapsulated commodities only.

**6-1.2** Sprinkler design criteria for solid pile, palletized, and bin box storage over 12 ft (3.7 m), and shelf storage over 12 to 15 ft (3.7 to 4.6 m) high, shall be in accordance with Figures 6-1.2 and 6-2.2.

*Exception: For bin boxes and closed shelves constructed of metal with a face area not exceeding 16 ft² (1.49 m²), the area of application may be reduced by 50 percent, but not to less than 2000 ft² (186 m²) for wet systems and 2600 ft² for dry systems.*

The density provided for the area of application may be selected from any point on the curve applicable to the commodity, classification, and arrangement of the stored commodities. It is not necessary to meet more than one point on the selected curve.

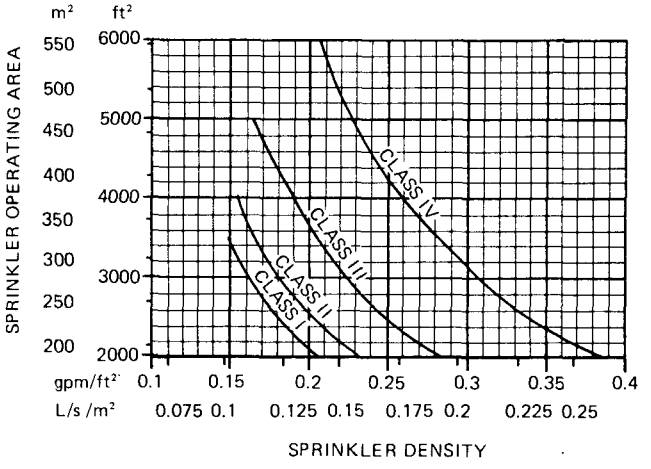


Figure 6-1.2 Sprinkler System Design Curves Twenty-Foot-High Storage — 165°F (74°C) Sprinklers.

**6-1.2.1** For storage heights other than 20 ft (6.1 m) apply Figure 6-2.2.

**6-1.2.2** In Figure 6-1.2 for all heights of storage, where 286°F (141°C) sprinklers are used, reduce sprinkler operating area 40 percent without revising the density, but to not less than 2000 ft² (186 m²) for wet systems and 2600 ft² (242 m²) for dry systems.

**6-1.3** Bin box and shelf storage over 12 ft (2.7 m) and provided with walkways at not over 12-ft (3.7-m) vertical intervals shall be provided with automatic sprinklers under the walkways as well as at the ceiling. The design density for ceiling and walkway sprinklers may be in accordance with the height adjustment of Figure 6-2.2.

### 6-2* Water Supplies.

**6-2.1** Sprinkler water demand for 20 ft (6.1 m) high palletized storage, solid pile, and bin box storage shall be in accordance with Figure 6-1.2.

**6-2.2** Where storage height is less than 30 ft (9.1 m) high, but more than 12 ft (3.7 m) high in solid piles, palletized, or bin box storage, ceiling densities indicated in the design curves in Figure 6-1.2 shall be modified in accordance with Figure 6-2.2, without revising the design area. (*See A-1-2, Available Height for Storage.*)

**6-2.3** For shelf storage over 12 to 15 ft (3.7 to 4.6 m) high, ceiling densities indicated in the design curves in Figure 6-1.2 shall be modified in accordance with Figure 6-2.2 without revising the design area.

**6-2.4** Where dry-pipe systems are used, the areas of operation indicated in the design curves shall be increased by 30 percent. Densities shall be selected so that areas of operation, after the 30 percent increase, do not exceed the upper area limits given in the design curves.

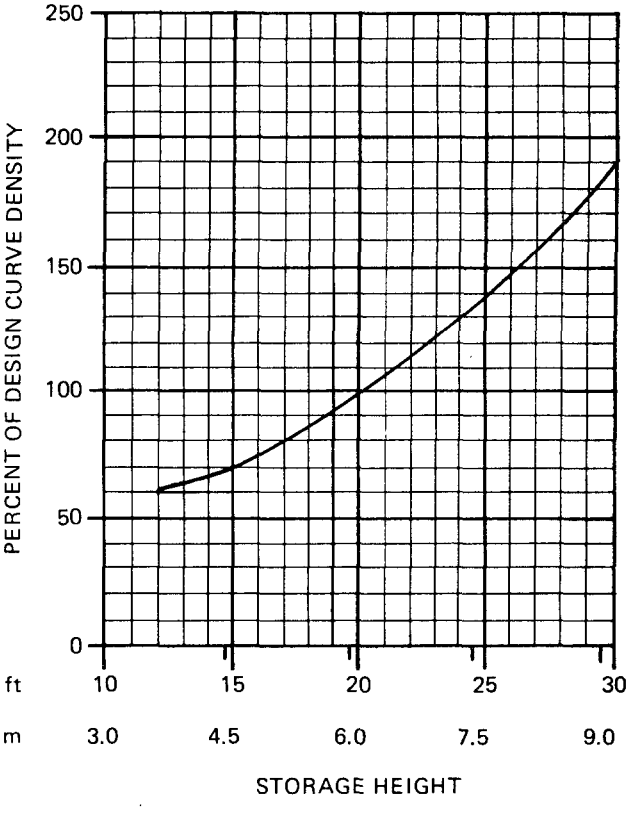


Figure 6-2.2 Ceiling Sprinkler Density Versus Storage Height.

**6-2.5** A minimum of 500 gpm (32 L/s) shall be added to the sprinkler demand (*see 5-1.2.3*) for large and small hose stream demand.

**6-2.6** Water supply duration shall be:

Duration (hours)

| Storage Height ft (m) | Commodity Class | |
|---|---|---|
| | Classes I, II, & III | Class IV |
| over 12 (3.7) up to 20 (6.1) | 1 ½ | 2 |
| over 20 (6.1) up to 30 (9.1) | 2 | 2 ½ |

**6-3 High Expansion Foam** (*see Section 5-2*).

## Chapter 7 Fire Protection — Plastics and Rubber

### 7-1* General. (*See Appendix B.*)

**7-1.1*** Group A plastics shall be protected as indicated by Figure 7-1.1, Decision Tree. The decision tree shall be followed to determine the protection in each specific situation.

**7-1.2*** Factors affecting protection requirements such as closed/open array, clearance between storage and sprinklers, stable/unstable piles, and two-point demands shall be applicable only to storage of Group A plastics. The factors contained in 7-2.1, A-7-2.1 and Appendix B shall be given serious consideration prior to giving the final protection requirements. This decision tree shall also be used to determine protection for commodities that are not wholly Group A plastics but contain such quantities and arrangements of the same that they are deemed more hazardous than Class IV commodities.

**7-1.3** Group B plastics and free-flowing Group A plastics shall be protected in the same manner as a Class IV commodity. Storages 12 ft (3.7 m) or less in height shall be protected in accordance with NFPA 13 for Ordinary Hazard Group 3.

**7-1.4** Group C plastics shall be protected in the same manner as a Class III commodity. Storages 12 ft (3.7 m) or less in height shall be protected in accordance with NFPA 13 for Ordinary Hazard Group 2.

### 7-2 Water Supplies.

**7-2.1*** The design of the sprinkler system shall be based on the conditions that will routinely or periodically exist in a building creating the greatest water demand. These conditions include: (a) pile height, (b) clearance, (c) pile stability, and (d) array.

**7-2.2** Design areas and densities for 20-ft (6.1-m) high storage with between 1½ ft (0.5 m) to 4½ ft (1.4 m) clearance shall be selected for the appropriate storage configuration from Figures 7-2.2(a), 7-2.2(b), 7-2.2(c), 7-2.2(d), and 7-2.2(e).

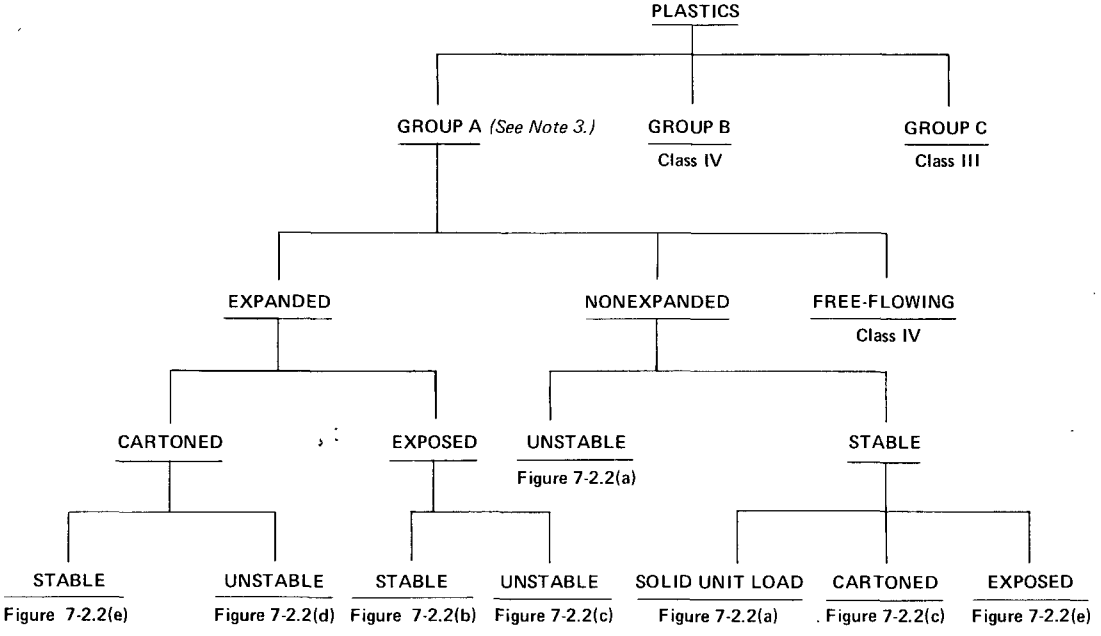


**Figure 7-1.1 Decision Tree.**

NOTES:

1. It is recommended that 286°F (141°C) rated sprinklers be installed, since most tests upon which this standard is based used 286°F (141°C) rated sprinklers.
2. The density/area curves are the starting points for determining proper protection in a given situation. The starting point assumes 20-ft (6.1-m) high storage and 1½-ft (0.5-m) to 4½-ft (1.4-m) clearance.
3. Cartons that contain Group A plastic material may be treated as Class IV commodities under the following conditions:

   (a) There are multiple layers of corrugation or equivalent outer material that would significantly delay fire involvement of the Group A plastic.

   (b) The amount and arrangement of the Group A plastic material within an ordinary carton would not be expected to significantly increase the fire hazard.

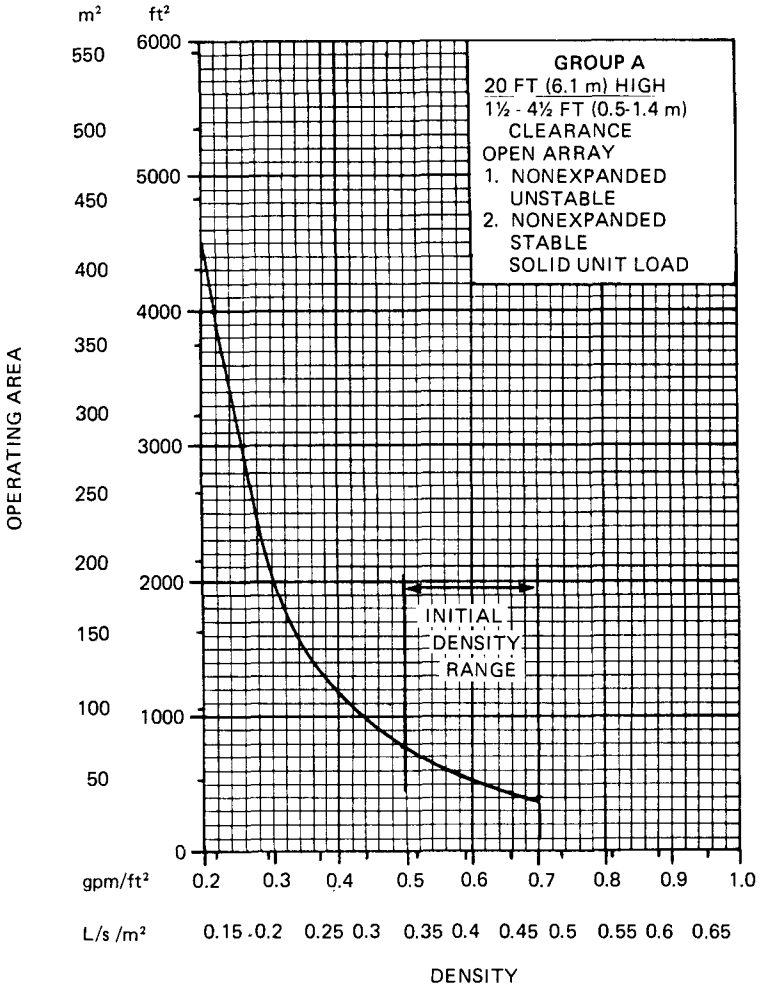


Figure 7-2.2(a)

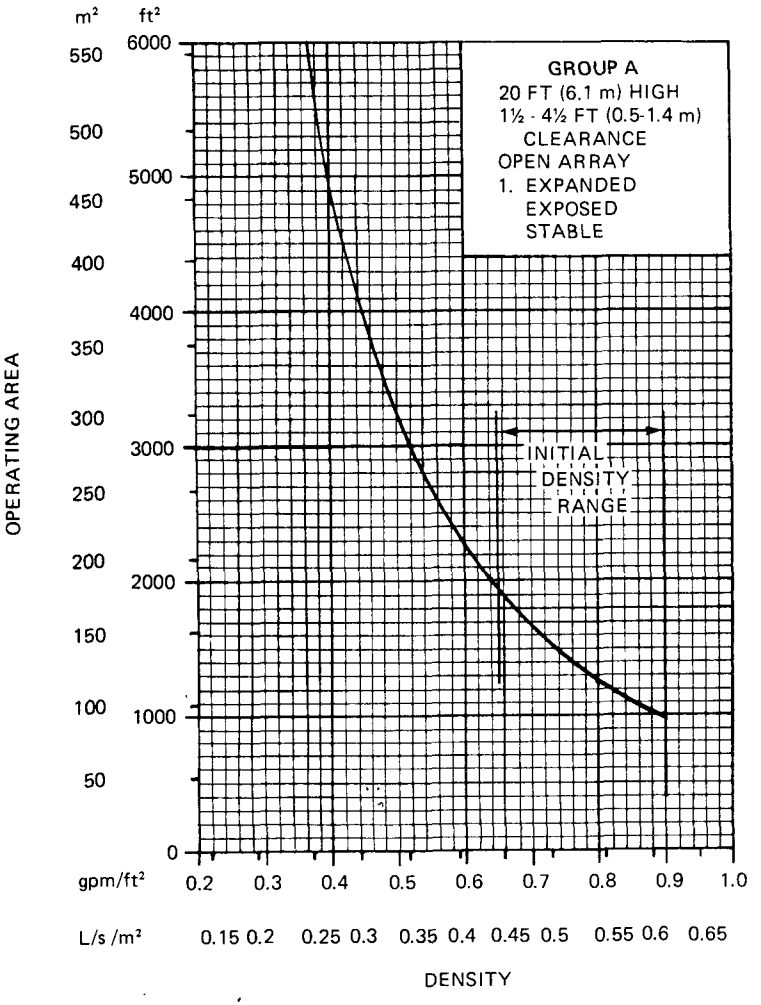


Figure 7-2.2(b)

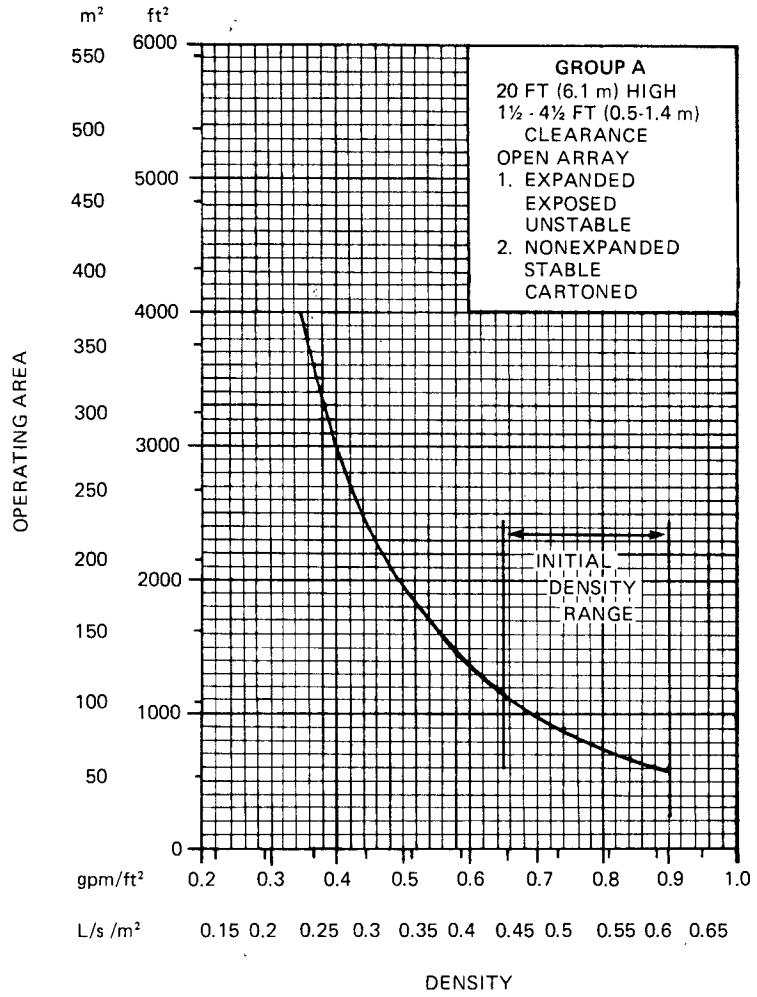


Figure 7-2.2(c)

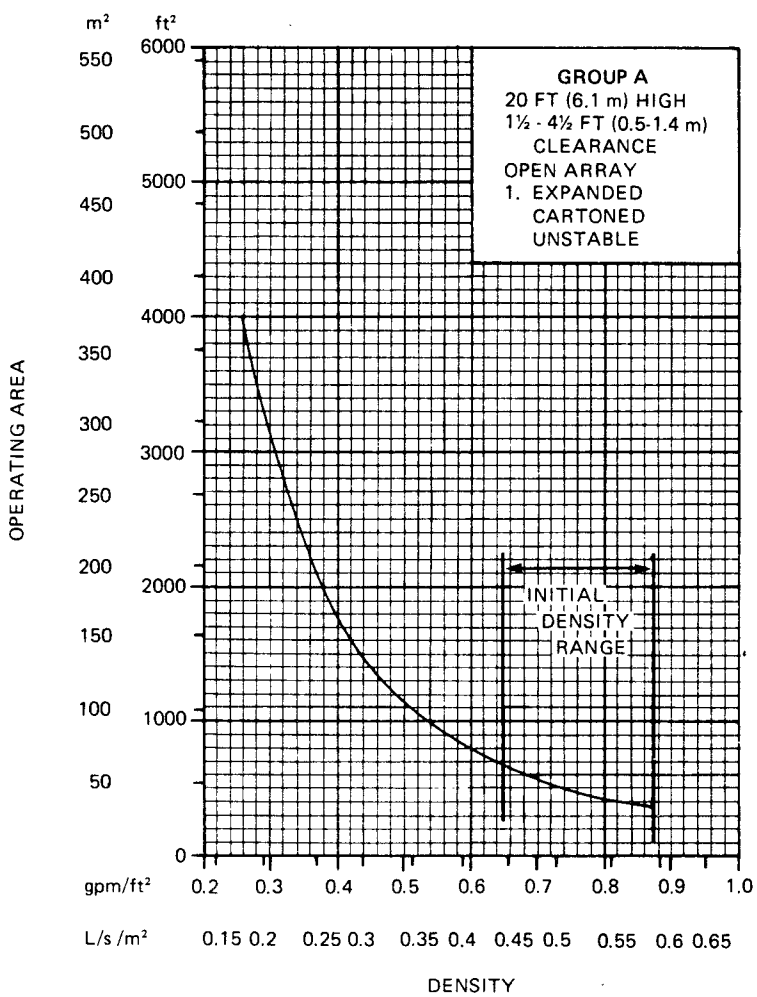


Figure 7-2.2(d)

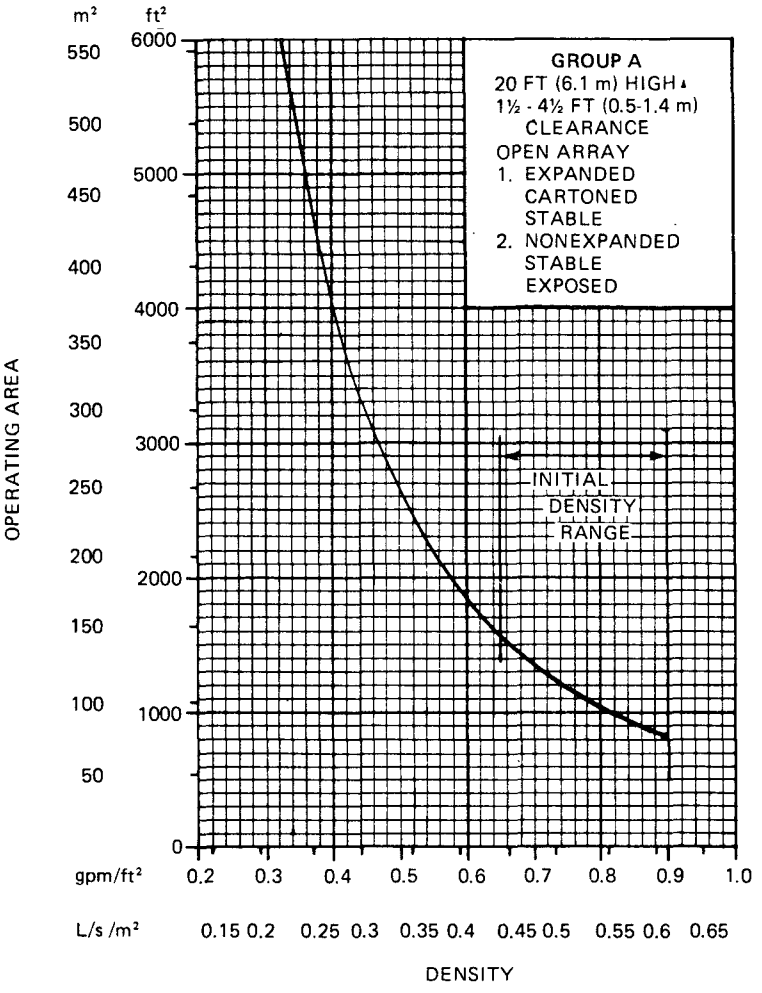


Figure 7-2.2(e)

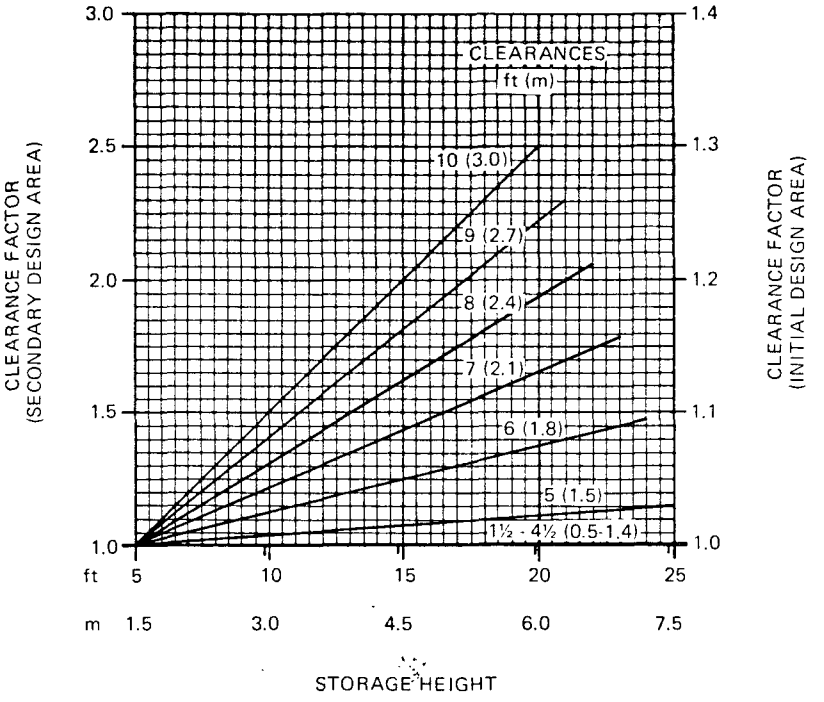


Figure 7-2.2.2

NOTE: There is insufficient test data available to define protection requirements for clearances in excess of 10 ft (3 m).

**7-2.2.1** Both an initial and a secondary density/area shall be met. The unadjusted secondary density shall be at least 0.25 gpm/ft² [0.17 (L/s)/m²] less than the unadjusted initial density, and the minimum secondary design area, after all credits and penalties (height, clearance, and array), shall be 2000 ft² (186 m²) for wet systems and 2600 ft² (242 m²) for dry systems.

*Exception: For storage 5 ft (1.5 m) to 10 ft (3.0 m) high, design areas and density for the secondary demand only shall be used.*

**7-2.2.2** Where clearance is in excess of 4½ ft (1.4 m), the design areas for the initial and secondary demands shall be multiplied by the factors from Figure 7-2.2.2, without revising the density.

**7-2.2.3** Where the height is other than 20 ft (6.1 m), the design densities shall be adjusted in accordance with Figure 7-2.2.3, without revising the design area.

**7-2.3** Where there is a closed array (not including solid unit load or expanded exposed storage), the density/area shall be obtained as directed by 7-2.1, and corrected for height and clearance as directed in 7-2.2.2 and 7-2.2.3. A secondary area reduction of 50 percent for stable piles and 25 percent for unstable piles shall be applied (without revising the density) to the less hazardous closed array.

**7-2.4** Where sprinkler protection has been designed for Group A plastics, at least 500 gpm (32 L/s) shall be added to the secondary density/area demand for hose streams.

**7-2.5** Water supply duration (secondary sprinkler demand plus hose streams) shall be 2-hour duration for 5 ft (1.5 m) to 20 ft (6.1 m) and 2½-hour duration for 20 ft (6.1 m) to 25 ft (7.6 m).

**7-2.6*** Where dry-pipe systems are used for Group A plastics, the operating area for the secondary density/area demand only, indicated in the design curves, shall be increased by 30 percent, without revising the density.

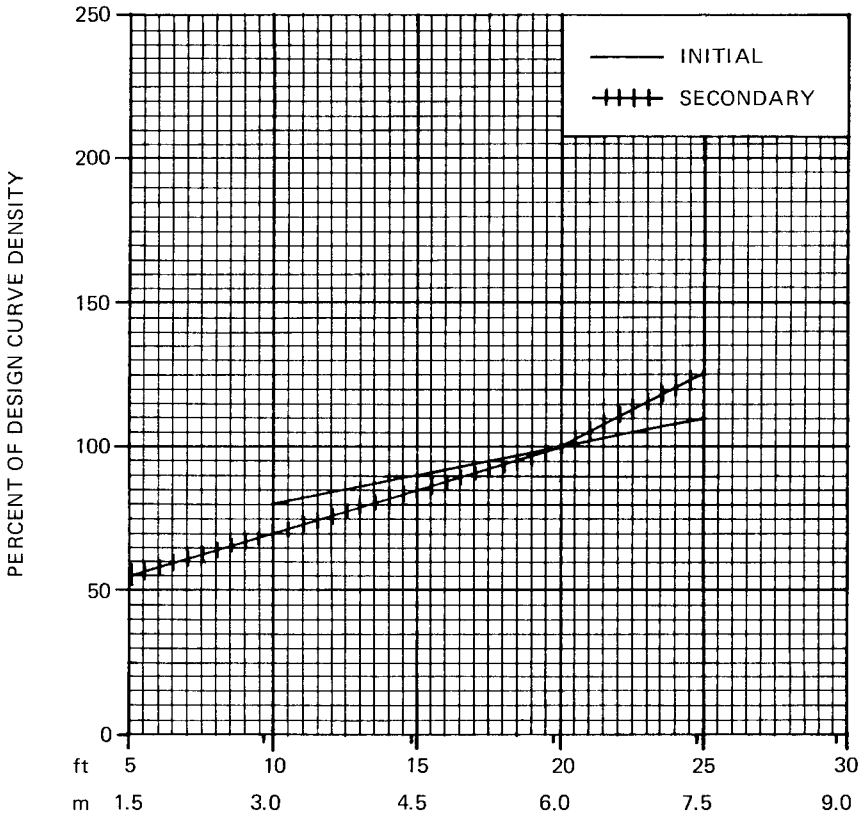


**Figure 7-2.2.3**

## Chapter 8 Large Drop Sprinklers

**8-1 General.**

**8-1.1** Large drop sprinklers are suitable for use with the hazards listed in Table 8-1.

**8-1.2** All requirements contained in NFPA 13, *Standard for Installation of Sprinkler Systems*, particularly Chapter 8, shall apply.

Table 8-1

| Minimum Operating Pressure (Note 1) psi (bar) | 25 (1.7) | 50 (3.4) | 75 (5.2) |
|---|---|---|---|
| Hazard (Note 2) | | Number Design Sprinklers | |
| **Palletized Storage** | | | |
| Class I, II, and III commodities up to 25 ft (7.6 m) with maximum 10-ft (3.0-m) clearance to ceiling | 15 | Note 3 | Note 3 |
| Class IV commodities up to 20 ft (6.1 m) with maximum 10-ft (3.0-m) clearance to ceiling | 20 | 15 | Note 3 |
| Unexpanded plastics up to 20 ft (6.1 m) with maximum 10-ft (3.0-m) clearance to ceiling | 25 | 15 | Note 3 |
| Idle wood pallets up to 20 ft (6.1 m) with maximum 10-ft (3.0-m) clearance to ceiling | 15 | Note 3 | Note 3 |
| **Solid-Piled Storage** | | | |
| Class I, II and III commodities up to 20 ft (6.1 m) with maximum 10-ft (3.0-m) clearance to ceiling | 15 | Note 3 | Note 3 |
| Class IV commodities and unexpanded plastics up to 20 ft (6.1 m) with maximum 10-ft (3.0-m) clearance to ceiling | Does Not Apply | 15 | Note 3 |

**Notes:**

1. Open Wood Joist Construction. Testing with open wood joist construction showed that each joist channel should be fully firestopped to its full depth at intervals not exceeding 20 ft (6.1 m). In unfirestopped open wood joist construction, or if firestops are installed at intervals exceeding 20 ft (6.1 m), the minimum operating pressures should be increased by 40 percent.
2. Building steel required no special protection for the occupancies listed.
3. The higher pressure will successfully control the fire, but the required number of design sprinklers should not be reduced from that required for the lower pressure.
4. Sprinklers used in the tests were high temperature rating.

## Chapter 9 Building Equipment, Maintenance, and Operations

**9-1* Mechanical Handling Equipment.**

**9-1.1* Industrial Trucks.** Power-operated industrial trucks shall comply with *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Maintenance and Operation*, NFPA 505.

**9-2 Building Service Equipment.**

**9-2.1** Electrical equipment shall be installed in accordance with the provisions of NFPA 70, *National Electrical Code®*.

**9-3 Cutting and Welding Operations.**

**9-3.1*** When welding or cutting operations are necessary, the precautions contained in *Standard for Fire Prevention in Use of Cutting and Welding Processes*, NFPA 51B, shall be followed. When possible, work shall be removed to a safe area.

**9-3.2** Welding, soldering, brazing, and cutting may be performed on building components that cannot be removed, provided no storage is located below and within 25 ft (7.6 m) of the working area and flameproof tarpaulins enclose this section. During any of these operations the sprinkler system shall be in service. Extinguishers suitable for Class A fires with a minimum rating of 2A and charged and manned inside hose lines, where provided, shall be located in the working area. A fire watch shall be maintained during these operations and for not less than 30 minutes following completion of open flame operation.

**9-4 Waste Disposal.** Rubbish, trash, and other waste material shall be disposed of at regular intervals.

**9-5 Smoking.** Smoking shall be strictly prohibited, except in locations prominently designated as smoking areas. "No Smoking" signs shall be posted in prohibited areas.

**9-6 Maintenance and Inspection.**

**9-6.1** Fire walls, fire doors, and floors shall be maintained in good repair at all times.

**9-6.2** The sprinkler system and the water supplies shall be maintained and serviced. (*See NFPA 13A, Recommended Practice for the Inspection, Testing and Maintenance of Sprinkler Systems.*)

**9-7 Refrigeration Systems.** Refrigeration systems, if used, shall conform to the recommendations of *Safety Code for Mechanical Refrigeration*, ANSI/ASHRAE 15-70.

## Chapter 10 Referenced Publications

**10-1** 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 shall be the current edition as of the date of the NFPA issuance of this document. These references shall be listed separately to facilitate updating to the latest edition by the user.

**10-1.1 NFPA Publications.** National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 10-1984, *Standard for Portable Fire Extinguishers*

NFPA 11A-1983, *Standard for Medium and High Expansion Foam Systems*

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

NFPA 24-1984, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*

NFPA 30-1984, *Flammable and Combustible Liquids Code*

NFPA 51B-1984, *Standard for Fire Prevention in Use of Cutting and Welding Processes*

NFPA 70-1987, *National Electrical Code*

NFPA 71-1985, *Standard for the Installation, Maintenance and Use of Central Station Signaling Systems*

NFPA 72A-1985, *Standard for the Installation, Maintenance and Use of Local Protective Signaling Systems for Guard's Tour, Fire Alarm and Supervisory Service*

NFPA 72B-1986, *Standard for the Installation, Maintenance and Use of Auxiliary Protective Signaling Systems for Fire Alarm Service*

NFPA 72C-1986, *Standard for the Installation, Maintenance and Use of Remote Station Protective Signaling Systems*

NFPA 72D-1986, *Standard for the Installation, Maintenance and Use of Proprietary Protective Signaling Systems*

NFPA 91-1983, *Standard for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying*

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

NFPA 231C-1987, *Standard for Rack Storage of Materials*

NFPA 505-1982, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Maintenance and Operation.*

**10-1.2 ASHRAE Code.** American Society of Heating, Refrigerating and Air Conditioning Engineers, United Engineering Center, 345 East 49th Street, New York, NY 10017.

ASHRAE 15-1978, *Safety Code for Mechanical Refrigeration.*

## Appendix A

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

**A-1-2 Definitions.**

**Open Array.** Fire tests that were conducted to represent a closed array utilized 6-in (152-mm) longitudinal flues and no transverse flues. Fire tests that were conducted to represent an open array utilized 12-in (305-mm) longitudinal flues.

**Available Height for Storage.** For new sprinkler installations, maximum height of storage is the height at which commodities can be stored above the floor when the minimum required unobstructed space below sprinklers is maintained. For the evaluation of existing situations, maximum height of storage is the maximum existing, if space between sprinklers and storage is equal to or greater than required.

**Compartmented.** Cartons used in most of the Factory Mutual-sponsored plastic tests involved ordinary 200-lb (90.7-kg) test, outside corrugated cartons with 5 layers of vertical pieces of corrugated carton used as dividers on the inside. There were also single horizontal pieces of corrugated carton between each layer. Other tests sponsored by the SPI, IRI, FM, and Kemper used two vertical pieces of carton (not corrugated) to form an "X" in the carton for separation of product. This was not considered compartmented, as the pieces of carton used for separations were flexible (not rigid) and only two pieces were in each carton.

**Container.** Container designates cartons, wrappings, etc. Fire retardant containers or tote boxes do not of themselves create a need for automatic sprinklers unless coated with oil or grease. Containers may lose their fire retardant properties if washed. For obvious reasons, they should not be exposed to rainfall.

**Pile Stability.** Pile stability has been shown to be a difficult item to judge under fire conditions, prior to the fire. In the test work completed, compartmented cartons (described above) have shown to be stable under fire conditions. Those tests that were not compartmented tended to be unstable under fire conditions.

**A-2-1.5** The classes of plastics used in this standard were basically derived from a series of large-scale and laboratory-type small-scale fire tests using a variety of expanded and nonexpanded plastic materials. It is recognized that not all plastics in a class will burn with exactly the same characteristics.

**A-3-1.1** With protection installed in accordance with this standard, fire protection of overhead steel and steel columns may not be necessary.

Consideration should be given to subdividing large area warehouses in order to reduce the amount of merchandise that would be affected by a single fire.

It is desirable to provide walls or partitions to separate the storage area from mercantile, manufacturing, or other occupancies to prevent the possibility of transmission of fire or smoke between the two occupancies. Door openings should be equipped with automatic closing fire doors appropriate for the fire resistance rating of the wall or partition.

**A-3-2** Smoke removal is important to manual fire fighting and overhaul. Since most fire tests were conducted without smoke and heat venting, protection specified in Sections 5-1, 6-1 and 7-1 were developed without the use of such venting. However, venting through eaveline windows, doors, monitors, gravity or mechanical exhaust systems is essential to smoke removal after control of the fire is achieved. (*See NFPA 204M, Guide for Smoke and Heat Venting.*)

**A-4.1.2** Commodities that are particularly susceptible to water damage should be stored on skids, dunnage, pallets, or elevated platforms in order to maintain at least 4 in. (10.2 cm) clearance from the floor.

**A-4-2.2** Protection for exposed steel structural roof members may be needed and should be provided as indicated by the authority having jurisdiction.

**A-4-2.5** Incandescent light fixtures should have shades or guards to prevent ignition of commodity from hot bulbs where possibility of contact with storage exists.

**A-4-3.2** Storage should be separated by aisles so that piles are not more than 50 ft (15.2 m) wide or 25 ft (7.6 m) wide if they abut a wall. Main and cross aisles should be located opposite window or door openings in exterior walls. This is of particular importance in buildings where exterior openings are few. Aisle width should be at least 8 ft (2.4 m). In judging the adequacy of existing sprinkler protection, aisle spacing and frequency should be given consideration.

**A-4-4** Idle pallet storage introduces a severe fire condition. Stacking idle pallets in piles is the best arrangement of combustibles to promote rapid spread of fire, heat release, and complete combustion. After pallets are used for a short time in warehouses, they dry out and edges become frayed and splintered. In this condition, they are subject to easy ignition from a small ignition source. Again, high piling increases considerably both the challenge to sprinklers and the probability of involving a large number of pallets when fire occurs.

**A-4-4.1.1** (*See Table A-4-4.1.1*)

**Table A-4-4.1.1 Recommended Clearance Between Outside Idle Pallet Storage and Building.**

| Wall Construction | | Minimum Distance, ft(m) of Wall from Storage of | | |
|---|---|---|---|---|
| Wall Type | Openings | Under 50 Pallets | 50 to 200 Pallets | Over 200 Pallets |
| Masonry | None[1] | 0 | 0 | 0 |
| | Wired Glass with outside sprinklers one-hour doors | 0 | 10 (3 0) | 20 (6.1) |
| | Wired or Plain Glass with outside sprinklers ¾-hour doors | 10 (3 0) | 20 (6.1) | 30 (9.1) |
| Wood or Metal with Outside Sprinklers | | | | |
| Wood, Metal or Other | | 20 (6.1) | 30 (9.1) | 50 (15.2) |

Notes:

1. Fire-resistive protection comparable to that of the wall should also be provided for combustible eave lines, vent openings, etc.
2. When pallets are stored close to a building, the height of storage should be restricted to prevent burning pallets from falling on the building.
3. Manual outside open sprinklers are generally not a reliable means of protection unless property is attended to at all times by plant emergency personnel.
4. Open sprinklers controlled by a deluge valve are preferred.

**A-4-4.2** A fire in stacks of idle plastic and wooden pallets is one of the greatest challenges to sprinklers. The undersides of the pallets create a dry area on which a fire can grow and expand to other dry or partially wet areas. This process of jumping to other dry, closely located, parallel, combustible surfaces continues until the fire bursts through the top of the stack. Once this happens, very little water is able to reach the base of the fire. The only practical method of stopping a fire in a large concentration of pallets with ceiling sprinklers is by a great amount of prewetting. In high stacks, this cannot be done without abnormally high water supplies. The storage of empty wood pallets should not be permitted in an unsprinklered warehouse containing other storage.

**A-5-1.5** Curves are based on operation of standard sprinklers. Use of "quick response" or other special sprinklers should be based on appropriate tests as approved by the Authority Having Jurisdiction.

**A-5-4** At windowless warehouses and where windows are scant, hydrants should be located at or in the vicinity of entrances.

**A-5-5** Manual fire fighting operations in a storage warehouse are not a substitute for sprinkler operation. The sprinkler system should be kept in operation during manual fire fighting operations until visibility has cleared

so that the fire can be clearly seen and the extent of fire reduced to a stage requiring only mopping up. It is essential that charged hose lines be available before venting is started because of a possible increase in fire intensity. When a sprinkler valve is closed, a responsible person should remain at the valve so it can be opened promptly if necessary. The water supply for the sprinkler system should be augmented where possible and care exercised that the water supply for the sprinkler system is not rendered ineffective by the use of excessive hose streams.

Where a private fire brigade is provided, sufficient large hose [2½ in. (64 mm)] and related equipment should be available.

**A-6** As an example of the use of curves in Figure 6-1.2, cereal storage on pallets 20 ft (6.1 m) high would be a Class III commodity. Using the Class III curve in Figure 6-1.2, any point on the curve can be selected. If 165°F (74°C) heads are to be used on a wet-pipe system, the sprinkler system could be designed to provide a density of 0.25 gpm [0.17 (L/s)/m²] over an area of 2,500 ft² (232 m²). This requires a water supply of 625 gpm (39 L/s) at the proper pressure to supply the area and density selected. To this water supply must be added the quantity required for hose streams in 6-2.5. Total water supply would then be 1,125 gpm (71 L/s) for a duration of at least 90 minutes. Wet systems are recommended for storage warehouses except where it is impractical to provide heat. If a dry system is to be used in the previous example, a density of 0.25 gpm/ft² [0.17 (L/s)/m²] can still be used, but the area of application must be increased to 3,250 ft² (302 m²). This means the water supply for sprinklers should be 812 gpm (51 L/s).

The conclusions arrived at for water demand are a theoretical minimum. Actual water demand will be greater as a result of system sprinkler design.

**A-6-2** Recommended water supplies contemplate successful sprinkler operation. Because of the small, but still significant, number of uncontrolled fires in sprinklered properties for various reasons, there should be an adequate water supply available for fire department use.

**A-7-1** The densities and area of application have been developed from fire test data. Most of these tests were conducted with large orifice [$^{17}/_{32}$ in. (13.5 mm)] sprinklers and 80- or 100-ft² (7.4- or 9.3-m²) sprinkler spacing. These and other tests have indicated that, with densities of 0.40 gpm/ft² [0.27 (L/s)/m²] and higher, better results are obtained with large orifice and 70- to 100-ft² (6.5–9.3 m²) sprinkler spacing than when using ½-in. (12.7-mm) orifice sprinklers at 50 ft² (4.6 m²) spacing. A discharge pressure of 100 psi (689 kPa) was used as a starting point on one of the fire tests. It was successful, but has a 1½-ft (0.5-m) clearance between the top of storage and ceiling sprinklers. A clearance of 10 ft (3.0 m) may have produced a different result due to the tendency of the higher pressure to atomize the water and the greater distance for the fine water droplets to travel to the burning fuel.

**A-7-1.1** Two direct comparisons between 165°F (74°C) and 286°F (141°C) rated sprinklers is possible:

(a) With nonexpanded polyethylene 1-gal (3.8-L) bottles in corrugated cartons, a 3-ft (0.9-m) clearance, and the same density, approximately the same number of sprinklers operated [9 at 286°F (141°C) VS 7 at 165°F (74°C)].

(b) With exposed, expanded polystyrene meat trays, a 9.5-ft (1.9-m) clearance, and the same density, three times as many 165°F (74°C) rated sprinklers operated as did 286°F (141°C) rated sprinklers [11 at 286°F (141°C) VS, 33 at 165°F (74°C)].

**A-7-1.2** There are few storage facilities in which the commodity mix or storage arrangement remains constant, and a designer should be aware that the introduction of different materials may change protection requirements considerably. Design should be on the side of higher densities and areas of application, and the various reductions allowed should be applied cautiously. For evaluation of existing situations, however, the allowances may be quite helpful.

**A-7-2.1** An evaluation for each field situation should be made to determine the worst applicable height-clearance relationship that can be expected to appear in a particular case. Fire tests have shown that considerably greater demands occur where clearance is 10 ft (3.0 m) as compared to 3 ft (0.9 m), and where a pile is stable as compared to an unstable pile. Since a system is designed for a particular clearance, the system could be inadequate when significant areas do not have piling to the design height and larger clearances exist between stock and sprinklers. This can also be true where the packaging or arrangement is changed so that stable piping is created where unstable piling existed. Recognition of these conditions is essential to avoid installation of protection that is inadequate or becomes inadequate because of changes.

No tests were conducted simulating a peaked roof configuration. However, it is expected that the principles of Chapter 7 still apply. The worst applicable height-clearance relationship that can be expected to occur should be found, and protection designed for it. If storage is all at the same height, the worst height-clearance relationship creating the greatest water demand would occur under the peak. If commodities are stored higher under the peak, the various height-clearance relationships should be tried and the one creating the greatest water demand used for designing protection.

**A-7-2.6** Wet systems are recommended for storage occupancies. Dry-pipe systems are acceptable only where it is impractical to provide heat.

**A-8-1** Locomotives should not be allowed to enter storage areas.

**A-9-1.1** Industrial trucks using gas or liquid fuel should be refueled outside of the storage building at a location designated for that purpose.

**A-9-3.1** The use of welding, cutting, soldering or brazing torches in the storage areas introduces a severe fire hazard. The use of mechanical fastenings and mechanical saws or cutting wheels is recommended.

## Appendix B

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

Appendix B explains and gives examples of the methods and procedures to follow in using this standard to determine proper protection for Group A plastics.

### Metric Conversion Factors for Examples

| To convert from | to | Multiply by |
|---|---|---|
| feet (ft) | meter (m) | 0.3048 |
| square feet ($ft^2$) | meter$^2$ ($m^2$) | 0.0920 |
| gal/min (gpm) | liter/second (L/s) | 0 0631 |
| gal per min/$ft^2$ (gpm/$ft^2$) | liter per second/ $m^2$[(L/s)/$m^2$] | 0.679 |

### Example 1

Building height _____ 26 ft

Sprinkler deflector height from floor _____ 25 ft

Commodity _____ rolls of nonexpanded polyethylene film on end on pallets. One roll completely fills one pallet. Each roll with pallet is 5 ft high.

Storage height normally _____ 20 ft

Wet or dry sprinkler system _____ wet

Clearance normally _____ 5 ft

Open or closed array _____ flue spaces are 10 in.: open array.

(The conclusions arrived at for water demand are theoretical minimum. Actual water demand will be greater as a result of system sprinkler design.)

---

It was decided commodity is a Group A plastic (*see Commodity Classifications, Chapter 2*).

From storage description it was decided it was solid-unit load storage (it would burn only on exterior of unit load) and it was determined it was nonexpanded.

From decision tree (*see Figure 7-1.1*) — Group A, stable, nonexpanded, solid unit load, it says to go to Figure 7-2.2(a).

From Figure 7-2.2(a):

For initial demand there is a range: 0.7 gpm/$ft^2$ over 400 $ft^2$ to 0.5 gpm/$ft^2$ over 780 $ft^2$.

It is decided to choose .... 0.7 gpm/$ft^2$ over 400 $ft^2$.

For secondary demand there is a range: 0.5 gpm/$ft^2$ over 780 $ft^2$ to 0.2 gpm/$ft^2$ over 4,500 $ft^2$.

At least a 0.25-gpm/$ft^2$ difference between the initial density and the secondary density is needed. Also a minimum *final* design area of 2,000 $ft^2$ for the secondary point is necessary. Therefore, it is decided to pick 0.32 gpm/$ft^2$ over 1,800 $ft^2$.

The initial demand is 0.7 gpm/$ft^2$ over 400 $ft^2$ and the secondary demand is 0.32 gpm/$ft^2$ over 1,800 $ft^2$.

However, these demands are for a 20-ft high, 1½- to 4½-ft clearance condition.

The actual condition is 20 ft high and a 5-ft clearance.

To adjust for height use Figure 7-2.2.3:

Initial demand: 100 percent × 0.7 gpm/$ft^2$ = 0.7 gpm/$ft^2$

Secondary demand: 100 percent × 0.32 gpm/$ft^2$ = 0.32 gpm/$ft^2$.

To adjust for clearance use Figure 7-2.2.2:

Initial demand: 1.02 × 400 $ft^2$ = 408 $ft^2$

Secondary demand: 1.13 × 1,800 $ft^2$ = 2,034 $ft^2$.

For 20-ft high storage and 5-ft clearance the demand is:

Initial demand: 0.7 gpm/$ft^2$ over 408 $ft^2$

Secondary demand: 0.32 gpm/$ft^2$ over 2,034 $ft^2$.

However, sometimes storage height is only 3 pallet loads high, or 15 ft high with 10-ft clearance.

The demand for 20-ft high storage and 1½-ft to 4½-ft clearance *was*:

Initial demand: 0.7 gpm/$ft^2$ over 400 $ft^2$

Secondary demand: 0.32 gpm/$ft^2$ over 1,800 $ft^2$.

To adjust for height use Figure 7-2.2.3:

Initial demand: 90 percent × 0.7 gpm/$ft^2$ = 0.63 gpm/$ft^2$

Secondary demand: 85 percent × 0.32 gpm/$ft^2$ = 0.27 gpm/$ft^2$.

To adjust for clearance use Figure 7-2.2.2:

Initial demand: 1.2 × 400 $ft^2$ = 480 $ft^2$

Secondary demand: 2.0 × 1,800 $ft^2$ = 3,600 $ft^2$.

For 15-ft high storage and 10-ft clearance the demand is:

Initial demand: 0.63 gpm/$ft^2$ over 480 $ft^2$

Secondary demand: 0.27 gpm/$ft^2$ over 3,600 $ft^2$.

Conclusion:

0.7 gpm/$ft^2$ over 408 $ft^2$ = 285 gpm
0.32 gpm/$ft^2$ over 2,034 $ft^2$ = 650 gpm
} 20-ft high storage 5-ft clearance

0.63 gpm/$ft^2$ over 480 $ft^2$ = 302 gpm
0.27 gpm/$ft^2$ over 3,600 $ft^2$ = 972 gpm
} 15-ft high storage 10-ft clearance.

The greatest gpm demand would be for 15-ft high storage. Therefore, the protection specified would be:

Initial demand: 0.63 gpm/$ft^2$ over 500 $ft^2$

Secondary demand: 0.27 gpm/$ft^2$ over 3,600 $ft^2$

(Areas should be rounded to nearest 100 $ft^2$).

**Commodity:** Rolls P.E. Film
**Stable/Unstable:** Stable
**Storage Height:** 20
**Open/Closed Array:** Open
**Clear Space:** 5
**Wet/Dry System:** Wet

| Fig. No. | | Density / Area | Hgt. Fact. | Density (Adj.) / Area | Clearance Fact. | Density / Area (Adj.) | Array Fact. | Density / Area (Adj.) | Dry Penalty | Density / Area (Adj.) | Notes: |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 7-2.2(a) | Initial | 0.7 / 400 | 100% | 0.7 / 400 | 1.02 | 0.7 / 408 | None | | | | 285 gpm |
| | Secondary | 0.32 / 1,800 | 100% | 0.32 / 1,800 | 1.13 | 0.32 / 2,034 | None | | None | | 650 gpm |

**Commodity:** Rolls P.E. Film
**Stable/Unstable:** Stable
**Storage Height:** 15
**Open/Closed Array:** Open
**Clear Space:** 10
**Wet/Dry System:** Wet

| Fig. No. | | Density / Area | Hgt. Fact. | Density (Adj.) / Area | Clearance Fact. | Density / Area (Adj.) | Array Fact. | Density / Area (Adj.) | Dry Penalty | Density / Area (Adj.) | Notes: |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 7-2.2(a) | Initial | 0.7 / 400 | 90% | 0.63 / 400 | 1.2 | 0.63 / 480 | None | | | | 302 gpm |
| | Secondary | 0.32 / 1,800 | 85% | 0.27 / 1,800 | 2.0 | 0.27 / 3,600 | None | | None | | 972 gpm |

**Commodity:** P.E. Bottles
**Stable/Unstable:** Stable
**Storage Height:** 18 ft
**Open/Closed Array:** Open
**Clear Space:** 10 ft
**Wet/Dry System:** Wet

| Fig. No. | | Density / Area | Hgt. Fact. | Density (Adj.) / Area | Clearance Fact. | Density / Area (Adj.) | Array Fact. | Density / Area (Adj.) | Dry Penalty | Density / Area (Adj.) | Notes: |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 7-2.2(c) | Initial | 0.9 / 600 | 96% | 0.86 / 600 | 1.26 | 0.86 / 756 | None | | | | 650 gpm |
| | Secondary | 0.65 / 1,150 | 94% | 0.61 / 1,150 | 2.3 | 0.61 / 2,645 | None | | None | | 1,613 gpm |

**Commodity:** P.E. Bottles
**Stable/Unstable:** Stable
**Storage Height:** 24 ft
**Open/Closed Array:** Open
**Clear Space:** 4 ft
**Wet/Dry System:** Wet

| Fig. No. | | Density / Area | Hgt. Fact. | Density (Adj.) / Area | Clearance Fact. | Density / Area (Adj.) | Array Fact. | Density / Area (Adj.) | Dry Penalty | Density / Area (Adj.) | Notes: |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 7-2.2(c) | Initial | 0.9 / 600 | 108% | 0.97 / 600 | 1.00 | 0.97 / 600 | None | | | | 582 gpm |
| | Secondary | .50 / 2,000 | 120% | .600 / 2,000 | 1.00 | .600 / 2,000 | None | | None | | 1,200 gpm |

## Example 2

Building height _____ 29 ft
Sprinkler deflector height from floor _____ 28 ft
Commodity _____ polyethylene bottles in compartmented cartons on pallets. The height of one loaded pallet is 6 ft.
Normal storage height _____ 18 ft
Wet or dry sprinkler system ____ wet
Clearance normally _____ 10 ft high
Open or closed array _____ flue spaces were 11 in.: open array.

(The conclusions arrived at for water demand are theoretical minimum. Actual water demand will be greater as a result of system sprinkler design.)

---

It was decided commodity is a Group A plastic (*see Commodity Classifications, Chapter 2*).

From storage description it was determined to be stable, nonexpanded, and cartoned.

From decision tree (*see Figure 7-1.1*) — Group A, stable, nonexpanded, cartoned, go to Figure 7-2.2(c).

From Figure 7-2.2(c)
For initial demand
there is a range: 0.9 gpm/ft² over 600 ft² to 0.65 gpm/ft² over 1,150 ft².
It is decided to choose.....0.9 gpm/ft² over 600 ft².
For secondary demand
there is a range: 0.65 gpm/ft² over 1,150 ft² 0.35 gpm/ft² over 4,000 ft².
At least a 0.25 gpm/ft² difference between the initial density and the secondary density is needed. Also a minimum *final* design area of 2,000 ft² for the secondary point is necessary. Therefore, it is decided to pick 0.65 gpm/ft² over 1,150 ft².

The initial demand is 0.9 gpm/ft² over 600 ft² and the secondary demand is 0.65 gpm/ft² over 1,150 ft². However, these demands are for a 20-ft high, 1½-ft to 4½-ft clearance condition.

Actual condition is 18 ft high with a 10-ft clearance.

To adjust for height use Figure 7-2.2.3:

Initial demand: 96 percent of 0.9 gpm/ft² = 0.86 gpm/ft²

Secondary demand: 94 percent of 0.65 gpm/ft² = 0.61 gpm/ft².

To adjust for clearance use Figure 7-2.2.2:

Initial demand: 1.26 × 600 ft² = 756 ft²

Secondary demand: 2.3 × 1,150 ft² = 2,645 ft².

For 18-ft high storage and 10-ft clearance the demand is:

Initial demand: 0.86 gpm/ft² over 756 ft²

Secondary demand: 0.61 gpm/ft² over 2,645 ft².

However, sometimes storage height is 24 ft high with 4-ft clearance.

The demand for 20-ft high storage and 1½-ft to 4½-ft clearance *was*:

Initial demand: 0.9 gpm/ft² over 600 ft

Secondary demand: 0.65 gpm/ft² over 1,150 ft².

However, since the clearance factor for increasing the area is going to be small and a final area of at least 2,000 ft² is needed, it is decided to pick a density for the secondary point that would create an area demand equal to or closer to the 2,000 ft² area.

From Figure 7-2.2(c), the demand for 20-ft high storage and 1½-ft to 4½-ft clearance decided on was:

Initial demand: 0.9 gpm/ft² over 600 ft²

Secondary demand: .50 gpm/ft² over 2,000 ft².

To adjust for height use Figure 7-2.2.3:

Initial demand: 108 percent × 0.9 gpm/ft² = 0.97 gpm/ft²

Secondary demand: 120 percent × .50 gpm/ft² = .60 gpm/ft².

To adjust for clearance use Figure 7-2.2.2:

Initial demand: 1.00 × 600 ft² = 600 ft²

Secondary demand: 1.00 × 2,000 ft² = 2,000 ft².

Conclusion:
0.86 gpm/ft² over 756 ft² = 650 gpm 18 ft high and
0.61 gpm/ft² over 2,645 ft² = 1,613 gpm 10-ft clearance
0.97 gpm/ft² over 600 ft² = 582 gpm 24 ft high and
0.60 gpm/ft² over 2,000 ft² = 1,200 gpm 4-ft clearance.

The greatest gpm demand would be for 18-ft high storage and 10-ft clearance. Therefore, the protection specified would be:

Initial demand: 0.86 gpm/ft² over 800 ft²

Secondary demand: 0.61 gpm/ft² over 2,600 ft²

(Areas should be rounded to nearest 100 ft²).

## Appendix C Protection of Outdoor Storage

### C-1 General.

**C-1.1** The hazards of exposure to outdoor storage from ignition sources and exposing fires and the infinite variety of conditions under which such exposures may occur render impossible the formulation of any single table, formulae, or set of rules that will adequately cover all conditions.

**C-1.2** Recommendations contained in this Appendix are for the protection of outdoor storage of commodities covered by the standard. (*See 1-1, Scope.*)

**C-1.3** In general, the provision of automatic fire protection is impractical for outdoor storage. As a result, emphasis must be placed upon:

a. Control of potential ignition sources such as from exposing buildings, transformers, yard equipment, refuse burners, overhead power lines, and vandals.

b. Elimination of adverse factors such as trash accumulations, weeds, and brush.

c. Provision of favorable physical conditions such as limited pile sizes, low storage heights, wide aisles, and possible use of fire retardant covers (e.g., tarpaulins).

d. The rapid and effective application of manual fire fighting efforts by the provision of fire alarms, strategically located hydrants, and adequate hose houses or hose reels.

**C-1.4** Outdoor storage should be avoided in most cases, but is recognized as a necessity in many industries.

**C-1.4.1** Outdoor storage is acceptable for materials that are:

(a) Of low fire hazard, not requiring protection even if located indoors.

(b) Of low value that a potential loss would not justify the utilization of building space.

(c) Of such great fire hazard that indoor protection is impractical, when balanced against potential loss.

(d) Of large volume and bulk, making it impractical to construct and protect a building to house the storage.

**C-1.4.2** Where materials that normally would be stored in buildings are stored outdoors in temporary emergencies, it is recommended that special precaution be taken for their safeguard and that they be moved to a storage warehouse as soon as possible.

**C-1.5** Standards referencing outdoor storage of specific commodities are also listed in Chapter 10.

### C-2 Responsibility of Management.

**C-2.1** It is the responsibility of management to take proper consideration of the hazards of the various materials handled. Protection requirements and storage arrangements will vary with the combustibility of the materials. Management should determine any special precautions that must be followed for the types of material stored. The care, cleanliness, and maintenance exercised by management will determine to a large extent the relative fire safety in the storage area.

**C-2.2** Consideration should be given by management to proper storage of materials in order to prevent the undue concentration of quantities of such materials in a single

location, subject to one catastrophe. The criterion of the amount of such material that should be stored in a single location is not only dependent upon the dollar value of the commodity but also upon the total supply and availability of the material. The impact of the loss of the storage upon the ability to continue production should be considered.

**C-3 Site.**

**C-3.1** In selecting a site for outdoor storage, preference should be given to a location having:

(a) Adequate municipal fire and police protection.

(b) Adequate public water system with hydrants suitably located for protection of the storage.

(c) Adequate all-weather roads for fire department apparatus response.

(d) Sufficient clear space from buildings or from other combustible storage that constitute an exposure hazard.

(e) Absence of flood hazard.

(f) Adequate clearance space between storage piles and any highways, bridges, railroads, and woodlands.

(g) Topography as level as possible to provide storage stability.

**C-3.2** The entire site should be surrounded by a fence or other suitable means to prevent access of unauthorized persons. An adequate number of gates should be provided in the surrounding fence or other barriers so as to permit ready access of fire apparatus.

**C-4 Material Piling.**

**C-4.1** Materials should be stored in unit piles as low in height and small in area as is consistent with good practice for the materials stored. The maximum height should be determined by the stability of pile, effective reach of hose streams, combustibility of the commodity, and ease of pile breakdown under fire or mop-up conditions. Long narrow piles are preferred over large square piles to facilitate manual fire fighting. (The short dimension increases the effectiveness of hose streams and eases pile breakdown.)

**C-4.2** Aisles should be maintained between individual piles, between piles and buildings, and between piles and the boundary line of the storage site. Sufficient driveways having the width of at least 15 ft (4.5 m) should be provided to permit the travel of fire equipment to all portions of the storage area. Aisles should be at least twice the pile height to reduce spread of fire from pile to pile and to permit ready access for fire fighting, emergency removal of material, or for salvage purposes.

**C-4.3** As the commodity class increases in combustibility, or where storage could be easily ignited from radiation, wider aisles should be provided. Smaller unit piles may be an alternative to wider aisles if yard space is limited.

**C-4.4** For outdoor idle pallet storage, see 4-4 and A-4-4.1.1 of this standard. Separation between piles of idle pallets and other yard storage should be as follows:

| Pile Size | Minimum Distance (Ft) |
|---|---|
| Under 50 pallets | 20 |
| 50-200 pallets | 30 |
| Over 200 pallets | 50 |

**C-4.5** Boundary posts with signs designating piling limits should be provided to indicate yard area, roadway and aisle limits.

**C-5 Buildings and Other Structures.**

**C-5.1** Yard storage, particularly commodities in the higher heat release category, should have as much separation as is practical from important buildings and structures, but not less than that offered by NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures.*

**C-5.1.1** As guidance in using NFPA 80A in establishing clear spaces, the following Classification of Severity with Commodity Classes of this standard may be used on the basis of 100 percent openings representing yard storage:

(a) *Light Severity:* Commodity Class I.

(b) *Moderate Severity:* Commodity Class II.

(c) Interpolate between Moderate and Severe Severity for Commodity Class III.

(d) *Severe Severity:* Commodity Class IV and Class A plastics.

NOTE: The above guidelines apply to the equivalent commodity classes of this standard. The severity of the exposing building or structure should also be a consideration when establishing a clear space.

**C-6 Yard Maintenance and Operations.**

**C-6.1** The entire storage site should be kept free from accumulation of unnecessary combustible materials. Vegetation should be kept cut low. Procedures should be provided for weed control and the periodic cleanup of the yard area.

**C-6.2** Adequate lighting should be provided to allow supervision of all parts of the storage area at night.

**C-6.3** All electrical equipment and installations should conform to the provisions of NFPA 70, *National Electrical Code.*

**C-6.4** No heating equipment should be located or used within the storage area. Salamanders, braziers, portable heaters, and other open fires should not be used.

**C-6.5** Smoking should be prohibited, except in locations prominently designated as smoking areas. "No Smoking" signs should be posted in prohibited areas.

**C-6.6** Welding and cutting operations should be prohibited in the storage area, unless the precautions in NFPA 51B, *Standard for Fire Prevention in Use of Cutting and Welding Processes,* are followed.

**C-6.7** Tarpaulins, used for protection of storage against the weather, should be of fire retardant fabric.

**C-6.8** Locomotives from which glowing particles may be emitted from exhaust stacks should not be permitted in the yard.

**C-6.9** Motorized vehicles using gasoline, diesel fuel, or liquefied petroleum gas as fuel should be garaged in a separate detached building.

**C-6.9.1** Storage and handling of fuel should conform with NFPA 30, *Flammable and Combustible Liquids Code*, and NFPA 58, *Standard for Storage and Handling of Liquefied Petroleum Gases*.

**C-6.9.2** Repair operations should be conducted outside the yard unless a separate masonry wall building is provided. Vehicles should not be greased, repaired, painted or otherwise serviced in the yard. Such work should be conducted in conformance with NFPA 88B, *Standard for Repair Garages*.

**C-7 Fire Protection.**

**C-7.1** Provisions should be made for promptly notifying the public fire department and private fire brigade (if available) in case of fire or other emergency.

**C-7.2** Hydrants should be spaced to provide a sufficient number of hose streams. Refer to NFPA 24, *Standard for the Installation of Private Fire Services Mains and Their Appurtenances*.

**C-7.2.1** Provisions should be made to permit direction of an adequate number of hose streams on any pile or portion of the storage area that may be involved in fire. It is recommended that, unless adequate protection is provided by the municipal fire department, sufficient hose and other equipment be kept on hand at the storage property, suitably housed, and provision be made for trained personnel available to put it into operation.

**C-7.2.2** Hydrants and all fire fighting equipment should be accessible for use at all times. No temporary storage should be allowed to obstruct access to fire fighting equipment and any accumulation of snow or obstructing material should be promptly removed.

**C-7.3** Monitor nozzles should be provided at strategic points where large quantities of highly combustible materials are stored or where average amounts of combustible materials are stored in inaccessible locations.

**C-7.4** Fire extinguishers of an appropriate type should be placed at well marked, strategic points throughout the storage area so that one or more portable fire extinguisher units can quickly be made available for use at any point. Where the climate is such to involve the danger of freezing, suitable extinguishers for freezing temperatures should be used. For guidance in the type and use of extinguishers refer to NFPA 10, *Standard for Portable Fire Extinguishers*.

**C-8 Guard Service.**

**C-8.1** Guard service should be provided and continuously maintained throughout the yard and storage area at all times while the yard is otherwise unoccupied. Duties and training of guards should follow that specified in NFPA 601, *Standard for Guard Service in Fire Loss Prevention*. It is recommended that there be some suitable means of supervising the guard's activities to be sure that required rounds are made at regular intervals.

**C-8.2** Attention is directed to the value of strategically placed watchtowers in large yards where a guard stationed at a point of advantage can keep the entire property under observation. It is recommended that such watchtowers be connected to the alarm system so that prompt notification of fire may be given.

## Appendix D Referenced Publications

**D-1** The following documents or portions thereof are referenced within this standard for information purposes only and should not be considered part of the requirements of this document. The edition indicated for each reference should be the current edition as of the date of the NFPA issuance of this document. These references should be listed separately to facilitate updating to the latest edition by the user.

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

NFPA 10-1984, *Standard for Portable Extinguishers*

NFPA 13A-1987, *Recommended Practice for the Inspection, Testing and Maintenance of Sprinkler Systems*

NFPA 30-1984, *Flammable and Combustible Liquids Code*

NFPA 58-1986, *Standard for the Storage and Handling of Liquefied Petroleum Gases*

NFPA 80A-1987, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*

NFPA 88B-1985, *Standard for Repair Garages*

NFPA 204M-1985, *Guide for Smoke and Heat Venting*

NFPA 600-1986, *Recommendation for Organization, Training and Equipment of Private Fire Brigades*

NFPA 601-1986, *Standard for Guard Service in Fire Loss Prevention*

NFPA 601A-1981, *Standard for Guard Operations in Fire Loss Prevention*

## Index

Tentative Interim Amendment

# NFPA 231

## General Storage

**1987 Edition**

**Reference: Chapter 9**
**T.I.A. 87-1**

Pursuant to Section 15 of the NFPA Regulations Governing Committee Projects, the National Fire Protection Association has issued the following Tentative Interim Amendment to NFPA 231, *Standard for General Storage*, 1987 edition. The TIA was processed by the Committee on General Storage and was issued by the Standards Council on July 14, 1989.

A Tentative Interim Amendment is tentative because it has not been processed through the entire standards making procedures. It is interim because it is effective only between editions of the standard. A TIA automatically becomes a Proposal of the proponent for the next edition of the standard; as such, it then is subject to all of the procedures of the standards making process.

*1. Add new Chapter 9, Early Suppression Fast Response (ESFR) Sprinklers, to NFPA 231 as follows and renumber existing chapters accordingly:*

### Chapter 9 Early Suppression Fast Response (ESFR) Sprinklers

**9-1* General.**

9-1.1 ESFR sprinklers shall be permitted for the protection of cartoned plastics (Group A, B or C) and Class I through IV commodities in palletized and solid pile storage up to a height of 25 ft (7.6 m).

*Exception: ESFR as now defined does not apply to:*
*1. Exposed plastics, or expanded polystyrene plastic in cartons.*
*2. Storage involving open top combustible cartons or containers.*

9-1.2 ESFR sprinklers shall be permitted for use in buildings having a maximum height of 30 ft (9.1 m) and one of the following types of roof construction:

(a) Smooth ceiling
(b) Bar joist
(c) Beam and girder
(d) Panel.

9-1.3 Roof slope shall not exceed ¼ in./ft (2.08 cm/m).

**9-2* Water Supplies.**

9-2.1 ESFR sprinkler systems shall be designed to provide a minimum operating pressure of 50 psi (3.4 bars) to the twelve most hydraulically remote sprinklers, based on flowing four sprinklers in each of three branch lines.

*(continued)*