

NFPA 231

Standard for General Storage 1995 Edition



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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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Errata

NFPA 231

General Storage

1995 Edition

Reference: 7-1.1; 7-2.2, Note 2, Note 3; Table 8-1, Note 1

Errata: 231-95-01

The Committee on General Storage notes the following errors in the 1995 edition of NFPA 231, *Standard for General Storage*:

1. In Paragraph 7-1.1, first line, replace the dimension "30 ft (9.1 m)" with "25 ft (7.62 m)".
2. In Table 7-2.2, Note 2, revise the phrase "from 500 ft² to 2000 ft²" to read "from 2500 ft² to 2000 ft²".
3. In Table 7-2.2, Note 3, replace the term "densities/areas" with "densities".
4. In Table 8-1, Note 1, second line, replace the phrase "intervals not exceeding 20 ft" with "intervals exceeding 20 ft".

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NFPA 231
Standard for
General Storage
1995 Edition

This edition of NFPA 231, *Standard for General Storage*, was prepared by the Technical Committee on General Storage and acted on by the National Fire Protection Association, Inc., at its Fall Meeting held November 14-16, 1994, in Toronto, Ontario, Canada. It was issued by the Standards Council on January 13, 1995, with an effective date of February 7, 1995, and supersedes all previous editions.

The 1995 edition of this document 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

In 1943, the U.S. War Production Board promulgated *General Storage Specifications for Critical-Strategic Materials*. These were based largely 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 the 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, the document was changed from a recommended practice to a standard, and the current 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.

In the 1970 edition, amendments included doubling the maximum recommended area for Type I and Type II storage, placing height limitations on empty wooden pallet storage, and reducing the water requirements for Type II storage.

In 1972, protection requirements for empty combustible pallets and design curves for sprinkler water demands were added.

In 1974, the height of storage to which this standard applies was increased from 25 ft (7.6 m) to 30 ft (9.1 m).

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

The 1987 edition incorporated minor revisions and superseded the 1985 edition.

The 1990 edition of the standard was modified to include the requirements of Early Suppression Fast Response (ESFR) Sprinklers. In addition, Chapter 6 was modified to include encapsulated commodities up to 15 ft (4.6 m).

This 1995 edition of the standard was revised to include recent developments with regard to miscellaneous storage, extra-large orifice sprinklers, large drop sprinklers, and ESFR sprinklers. Efforts were made to increase the user friendliness of the document throughout. However, chapters 6 and 7 underwent significant modification.

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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.

Committee Scope: This Committee shall have primary responsibility for documents on safeguarding general warehousing and commodities stored indoors or outdoors against fire. Storage specifically covered by other NFPA standards is not within the scope of this committee.

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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 11 and Appendix D.

Chapter 1 Introduction

1-1 Scope.

1-1.1 This standard shall apply to the storage of materials representing the broad range of combustibles, including plastics that are stored palletized, solid-piled, in bin boxes, or on shelves.

Exception: Miscellaneous storage shall be permitted to be protected in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems.

1-1.2 Outdoor Storage of a Broad Range of Combustibles. (See Appendix C.)

1-1.3 This standard shall not apply to:

- (a) Unsprinklered buildings.
- (b) Storage of commodities that, with their packaging and storage aids, would be classified as noncombustible.
- (c) Unpackaged bulk materials such as grain, coal, or similar commodities.
- (d) Inside or outside storage of commodities covered by other NFPA standards, except where specifically mentioned herein (e.g., pyroxylin plastics.)
- (e) Storage on racks.

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

1-2 Retroactivity Clause. The provisions of this document shall be considered necessary to provide a reasonable level of protection from loss of life and property from fire. They reflect situations and the state of the art at the time the standard was issued.

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

Exception: In those cases where it is determined by the authority having jurisdiction that the existing situation involves a distinct hazard to life or property, this standard shall apply.

1-3 Definitions. Unless expressly stated elsewhere, for the purpose of this standard, the terms in this section shall be defined as follows:

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 five-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.

Ceiling Height. The distance between the floor and the underside of the ceiling above (or roof deck) within the storage area.

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.

Early Suppression Fast Response (ESFR) Sprinklers.

A listed ESFR sprinkler is a thermosensitive device designed to react at a predetermined temperature by automatically releasing a stream of water and distributing it in a specified pattern and quantity over a designated area so as to provide early suppression of a fire where installed on the appropriate sprinkler piping.

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 encapsulation.

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 absorb water or otherwise appreciably retard the burning hazard of the commodity (paper wrapped or encapsulated, or both, should be considered exposed).

Free-Flowing Plastic Materials. Those plastics that fall out of their containers during a fire, fill flue spaces, and create a smothering effect on the fire. Examples: powder, pellets, flakes, or random-packed small objects [e.g., razor blade dispensers, 1-oz to 2-oz (28-g to 57-g) bottles].

Large Drop Sprinkler. A listed large drop sprinkler is characterized by a K factor between 11.0 and 11.5, and a proven ability to meet prescribed penetration, cooling, and distribution criteria prescribed in the large drop sprinkler examination requirements. The deflector/discharge char-

acteristics of the large drop sprinkler generate large drops of such size and velocity as to enable effective penetration of the high-velocity fire plume.

Miscellaneous Storage. Storage that does not exceed 12 ft (3.7 m) in height and is incidental to another occupancy use group as defined in NFPA 13, *Standard for the Installation of Sprinkler Systems*. Such storage shall not constitute more than 10 percent of the building area or 4000 ft² (372 m²) of the sprinklered area, whichever is greater. Such storage shall not exceed 1000 ft² (93 m²) in one pile or area, and each such pile or area shall be separated from other storage areas by at least 25 ft (7.6 m).

Noncombustible. Commodities, packaging, or storage aids that do not ignite, burn, or liberate flammable gases when heated to a temperature of 1380°F (749°C) for 5 minutes.

Packaging. A 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, and 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 occurs soon after initial fire development.

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

Roof Height. The distance between the floor and the underside of the roof deck within the storage area.

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 that burns only on the exterior of the load; water from sprinklers might reach most surfaces available to burn.

Spray Sprinkler. A type of sprinkler listed for its capability to provide fire control for a wide range of fire hazards.

Sprinkler Temperature Rating.

(a) Ordinary-temperature rated sprinklers include temperature ratings between 135°F and 170°F (57°C and 77°C).

(b) High-temperature rated sprinklers include temperature ratings between 250°F and 300°F (121°C and 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 commodities are 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 commodities include:

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 nonwax-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; 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; metal cabinets.

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

2-1.2 Class II commodities are 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 commodities include:

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

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

Examples of Class III commodities include:

Leather Products. Shoes; jackets; gloves; luggage.

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

Textiles. Natural fiber upholstered nonplastic furniture; wood or metal furniture with plastic padded and covered armrests; 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; other wood products.

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

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

Examples of Class IV commodities include:

Small appliances, typewriters, and cameras with plastic parts; plastic-backed tapes; nonviscose synthetic fabrics or clothing; telephones; vinyl floor tiles; wood or metal frame upholstered furniture or mattresses with plastic covering or padding, or both; plastic-padded metal bumpers and dashboards; insulated conductor and power cable on wood or metal reels or in cartons; inert solids in plastic containers; 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 could change the classification.

2-1.5.1 Group A.

ABS (acrylonitrile-butadiene-styrene copolymer)
Acetal (polyformaldehyde)
Acrylic (polymethyl methacrylate)
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)

2-1.5.2 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

2-1.5.3 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)

PVDF (polyvinylidene fluoride)

PVF (polyvinyl fluoride)

Urea (urea formaldehyde)

Chapter 3 Building Construction

3-1 Construction.

3-1.1* Buildings used for storage of materials that are stored and protected in accordance with this standard shall 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 shall apply 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 are 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) of 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 Exhaust Systems for Air Conveying of Materials*, Section 2-18.

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 ensure 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 the 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.

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

Exception: Indoor pallet storage shall be permitted in accordance with 4-4.1.2.

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

(a) Pallets shall be stored no higher than 6 ft (1.8 m); and

(b) Each pallet pile of no more than four 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, provided the requirements of 4-4.1.2(a) and (b) 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/ft ² [(L/s)/m ²]	Area of Sprinkler Demand ft ² (m ²)	
		Temperature Rating	
		286°F (141°C)	165°F (74°C)
Up to 6 (1.8)	.20 (.14)	2000 (186)	3000 (279)
6 to 8 (1.8 to 2.4)	.30 (.20)	2500 (232)	4000 (372)
8 to 12 (2.4 to 3.7)	.60 (.41)	3500 (325)	6000 (557)
12 to 20 (3.7 to 6.1)	.60 (.41)	4500 (418)	—

4-4.2* Plastic Pallets.

4-4.2.1 Plastic pallets shall be stored outside or in a detached structure.

Exception No. 1: Indoor plastic pallet storage shall be permitted in accordance with 4-4.2.2.

Exception No. 2: Indoor nonexpanded polyethylene solid deck pallets shall be permitted to be protected in accordance with 4-4.1.2.

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

(a) Where 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) Where 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 high-temperature 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.

NOTE: For further information, 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*.

Exception: Where modified by this standard.

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 or 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 III or 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 2 in NFPA 13, *Standard for the Installation of Sprinkler Systems*.

5-1.2.2 The water supply requirements for sprinklers only shall be based on the actual calculated demand for the hazard in accordance with Chapter 6, Chapter 7, Chapter 8, or Chapter 9, depending on the type of sprinkler selected and the commodity being protected.

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 with areas containing rack storage and other areas containing palletized, solid pile, bin box, or shelf storage, the standard applicable to the storage configuration shall apply.

5-1.5 Standard response standard orifice $\frac{1}{2}$ -in. (12.7-mm) or standard response large orifice $\frac{1}{2}$ -in. (13.5-mm) sprinklers shall be used in applying the curves and tables in Chapters 6 and 7.

Exception No. 1: Use of these curves and tables with quick response sprinklers shall be permitted at the discretion of the authority having jurisdiction.

Exception No. 2: The use of extra-large orifice (ELO) sprinklers [$\frac{3}{8}$ in. (15.9 mm)] shall be permitted where listed for such use and where installed at a minimum design pressure of 10 psi (69 kPa).

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*.

Exception: Where modified by this standard.

5-2.2 High-expansion foam used to protect the idle pallets shall have a maximum fill time of 4 minutes.

5-2.3 High-expansion foam systems shall be automatic in operation.

5-2.4 Detectors for high-expansion foam systems shall be listed and shall be installed at no more than one-half listed spacing.

5-2.5 Detection systems, concentrate pumps, generators, and other system components essential to the operation of the system shall have an approved standby power source.

5-2.6 A reduction in ceiling density to one-half that required for Class I through Class IV commodities, idle pallets, or plastics (using the secondary demand point) shall be permitted 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 [$\frac{1}{2}$ 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 shall be supplied from one of the following:

- (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.

NOTE: For further information on adjacent sprinkler systems, see NFPA 13, *Standard for the Installation of Sprinkler Systems*.

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 shall be permitted to be omitted in storage areas where fixed small hose lines [$\frac{1}{2}$ 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 NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*.

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) Maintenance of 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 the 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.

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

5-6 Alarm Service. A central station, auxiliary, remote station, or proprietary sprinkler waterflow alarm shall be provided. A local waterflow alarm shall be permitted where recorded guard service is provided.

NOTE: For further information, see NFPA 72, *National Fire Alarm Code*.

Chapter 6* Fire Protection for Commodity Classes I through IV—Spray Sprinklers

6-1 General.

6-1.1 Class I through Class IV commodities of the following configurations protected by spray sprinklers shall be in accordance with this chapter.

- (a) Nonencapsulated commodities that are solid pile, palletized, or bin box storage up to 30 ft (9.1 m) in height;
- (b) Nonencapsulated commodities on shelf storage up to 15 ft (4.6 m) in height;

(c)* Encapsulated commodities that are solid pile, palletized, bin box, or shelf storage up to 15 ft (4.6 m) in height.

6-1.2 Bin box and shelf storage over 12 ft (3.7 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 shall be permitted to be in accordance with the height adjustment of Figure 6-2.2.4.

6-2 Water Supplies.

6-2.1 The water supply shall be capable of providing the sprinkler system demand determined in accordance with 6-2.3, including the hose stream demand of 6-2.4 for the duration requirements of 6-2.5.

6-2.2 The area and density for the hydraulically remote area shall be determined as specified in 6-2.2.1 through 6-2.2.7.

6-2.2.1 Storage 12 ft (3.7 m) or less in height of Class I and Class II commodities shall be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, for Ordinary Hazard Group 1. Storage 12 ft (3.7 m) or less in height of Class III and Class IV commodities shall be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, for Ordinary Hazard Group 2.

6-2.2.2 Where using ordinary-temperature rated sprinklers, a single point shall be selected from the appropriate commodity curve on Figure 6-2.2.2.

6-2.2.3 Where using high-temperature rated sprinklers, a single point shall be selected from the appropriate commodity curve on Figure 6-2.2.3.

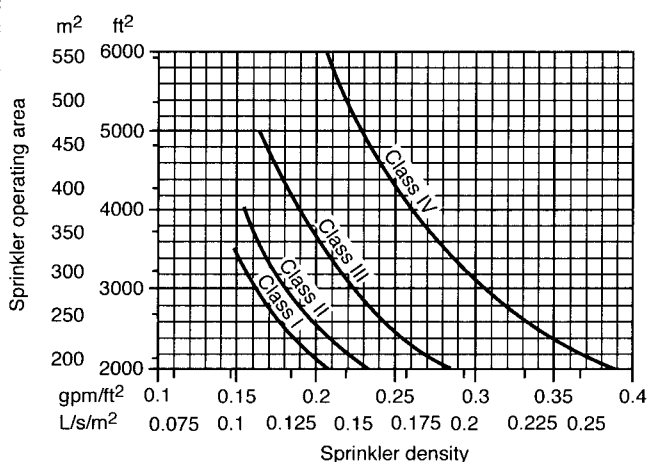


Figure 6-2.2.2 Sprinkler system design curves, 20-ft (6.1-m) high storage — ordinary-temperature rated sprinklers.

NOTE: Sprinkler demand for 20-ft (6.1-m) high storage shall be selected from any point on the appropriate class curve in Figure 6-2.2.3.

Figure 6-2.2.3 provides protection curves for sprinkler systems using only high-temperature rated sprinklers.

6-2.2.4 The densities selected in accordance with 6-2.2.2 or 6-2.2.3 shall be modified in accordance with Figure 6-2.2.4 without revising the design area.

6-2.2.5 Where dry-pipe systems are used, the areas of operation indicated in the design curves shall be increased by 30 percent.

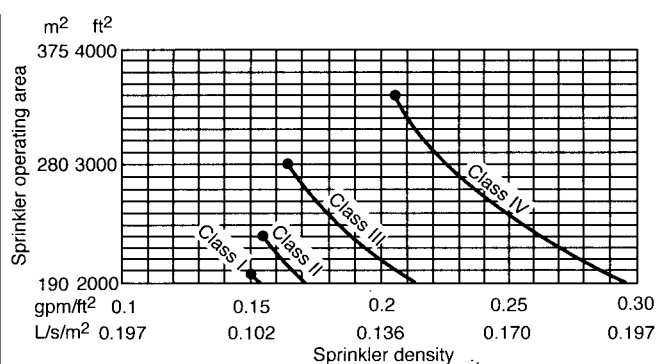


Figure 6-2.2.3 Sprinkler system design curves, 20-ft (6.1-m) high storage — high-temperature rated sprinklers.

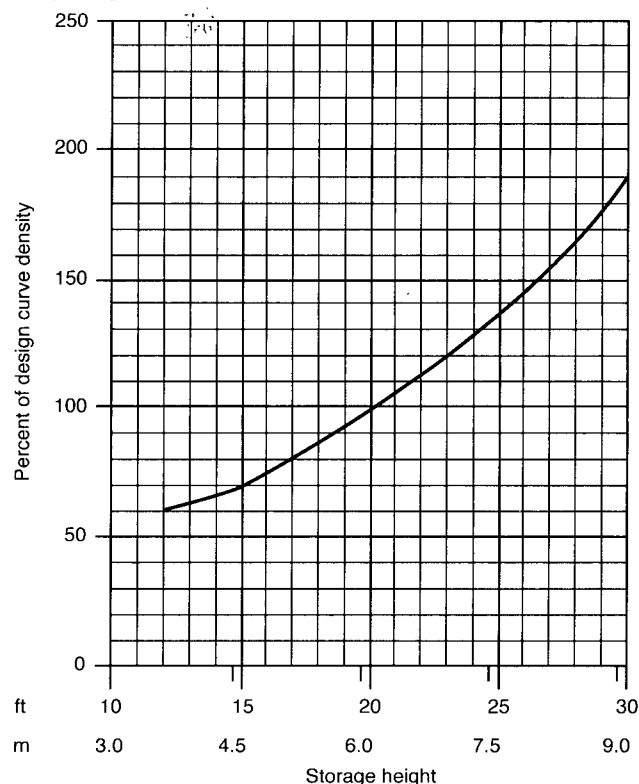


Figure 6-2.2.4 Ceiling sprinkler density vs storage height.

6-2.2.6 For bin boxes and closed shelves constructed of metal with a face area not exceeding 16 ft² (1.5 m²), the area of application shall be permitted to be reduced by 50 percent, provided the minimum requirements of Chapter 5 are met.

6-2.2.7 The final area and density shall not be less than the minimum specified in Chapter 5.

6-2.3 Given the area and density determined in accordance with 6-2.2, the fire sprinkler system shall be hydraulically calculated in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

6-2.4* A minimum of 500 gpm (32 L/s) shall be added to the sprinkler demand for combined large and small hose stream demand.

6-2.5 Water supply duration shall be in accordance with Table 6-2.5.

Table 6-2.5 Duration (hours)

Storage Height ft (m)	Commodity Class	
	Classes I, II, and III	Class IV
over 12 (3.7) up to 20 (6.1)	1½	2
over 20 (6.1) up to 30 (9.1)	2	2½

6-3 High-Expansion Foam. See Section 5-2.

Chapter 7 Fire Protection for Plastic and Rubber Commodities—Spray Sprinklers

7-1* General. See Appendix B.

7-1.1* Plastics stored up to 30 ft (9.1 m) in height protected by spray sprinklers shall be in accordance with Chapter 7. The decision tree (Figure 7-1.1) shall be used 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, and stable/unstable piles, 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 determining the final protection requirements. This decision tree also shall 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. Storage 12 ft (3.7 m) or less in height shall be protected in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, for Ordinary Hazard Group 2.

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

7-2 Water Supplies.

7-2.1* The design of the sprinkler system shall be based on those conditions that routinely or periodically exist in a building that create the greatest water demand.

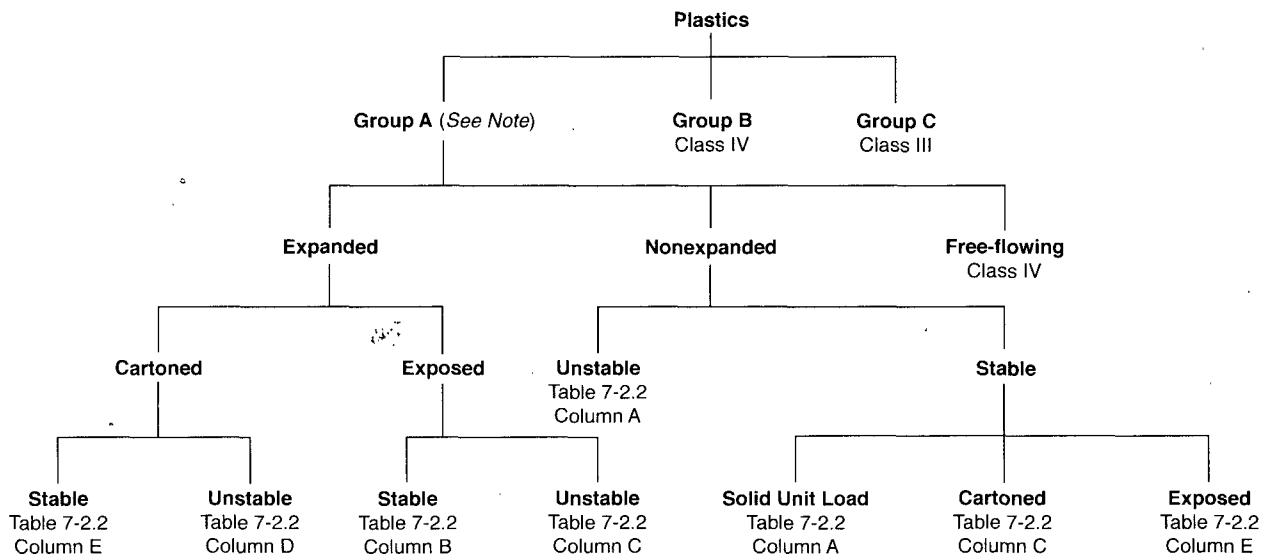
These conditions include:

- (a) Pile height
- (b) Clearance
- (c) Pile stability
- (d) Array.

7-2.2* Design areas and densities shall be selected for the appropriate storage configuration from Table 7-2.2.

7-2.3 Where sprinkler protection has been designed for Group A plastics, at least 500 gpm (32 L/s) shall be added to the density/area demand for hose streams.

7-2.4 Water supply duration (sprinkler demand plus hose streams) shall be 2-hour duration for 5 ft to 20 ft (1.5 m to 6.1 m) and 2½-hour duration for 20 ft to 25 ft (6.1 m to 7.6 m).



NOTE: Cartons that contain Group A plastic material shall be permitted to be treated as Class IV commodities under the following conditions:

- (a) there shall be multiple layers of corrugation or equivalent outer material that would significantly delay fire involvement of the Group A plastic, and
- (b) the amount and arrangement of Group A plastic material within an ordinary carton would not be expected to significantly increase the fire hazard.

Figure 7-1.1 Decision tree.

Table 7-2.2

Storage Height ft (m)	Roof/Ceiling Height ft (m)	Density (gpm/ft ²) [(L/s)/m ²]				
		A	B	C	D	E
5 (1.52)	15 (4.57)	OH-2	OH-2	OH-2	OH-2	OH-2
	20 (6.10)	OH-2	OH-2	OH-2	OH-2	OH-2
	25 (7.62)	OH-2	OH-2	OH-2	OH-2	OH-2
12 (3.66)	15 (4.57)	0.2 (0.14)	EH-2	0.3 (0.20)	EH-1	EH-2
	20 (6.10)	0.3 (0.20)	0.6 (0.41)	0.5 (0.34)	EH-2	EH-2
	25 (7.62)	0.4 (0.27)	0.8 (0.54)	0.6 (0.41)	0.45 (0.31)	0.7 (0.48)
15 (4.57)	20 (6.10)	0.25 (0.17)	0.5 (0.34)	0.4 (0.27)	0.3 (0.20)	0.45 (0.31)
	25 (7.62)	0.4 (0.27)	0.8 (0.54)	0.6 (0.41)	0.45 (0.31)	0.7 (0.48)
	30 (9.14)	0.45 (0.31)	0.9 (0.61)	0.7 (0.48)	0.55 (0.37)	0.85 (0.58)
20 (6.1)	25 (7.62)	0.3 (0.20)	0.6 (0.41)	0.45 (0.31)	0.35 (0.24)	0.55 (0.37)
	30 (9.14)	0.45 (0.31)	0.9 (0.61)	0.7 (0.48)	0.55 (0.37)	0.85 (0.58)
	35 (10.67)	0.6 (0.41)	1.2 (0.82)	0.85 (0.58)	0.7 (0.48)	1.1 (0.75)
25 (7.62)	30 (9.14)	0.4 (0.27)	0.75 (0.51)	0.55 (0.37)	0.45 (0.31)	0.7 (0.48)
	35 (10.67)	0.6 (0.41)	1.2 (0.82)	0.85 (0.58)	0.7 (0.48)	1.1 (0.75)
	40 (12.19)	N/A	N/A	N/A	N/A	N/A

NOTE 1: For Table 7-2.2, the design areas are a minimum of 2500 ft² (Exception: OH-2).

NOTE 2: For closed array, areas shall be reduced from 500 ft² to 2000 ft².

NOTE 3: Interpolation of densities/areas between storage heights shall be permitted. Interpolation of ceiling/roof heights shall not be permitted.

NOTE 4: For density demands of 0.4 gpm/ft² or greater, large orifice or extra-large orifice (ELO) sprinklers shall be used.

NOTE 5: It is recommended that high-temperature rated sprinklers be installed, since most tests upon which this standard is based used high-temperature rated sprinklers.

NOTE 6: Column designations correspond to the configuration of plastics storage as follows:

- A: (1) Nonexpanded, unstable
- (2) Nonexpanded, stable, solid unit load
- B: Expanded, exposed, stable
- C: (1) Expanded, exposed, unstable
- (2) Nonexpanded, stable, cartoned
- D: Expanded, cartoned, unstable
- E: (1) Expanded, cartoned, stable
- (2) Nonexpanded, stable, exposed

NOTE 7

OH-2 = Density required for Ordinary Hazard Group 2 occupancies.

EH-1 = Density required for Extra Hazard Group 1 occupancies.

EH-2 = Density required for Extra Hazard Group 2 occupancies as specified in NFPA 13, *Standard for the Installation of Sprinkler Systems*.

Hose streams shall be provided in accordance with 7-2.3.

N/A: Not applicable.

7-2.5* Where dry-pipe systems are used for Group A plastics, the operating area shall be increased by 30 percent without revising the density.

Chapter 8 Fire Protection—Large Drop Sprinklers

8-1 General.

8-1.1 Large drop sprinklers shall be permitted for use with the hazards listed in Table 8-1.

8-2 Water Supplies.

8-2.1 Sprinkler water demand for large drop sprinklers shall be in accordance with Table 8-1.

8-2.2 A minimum of 500 gpm (32 L/s) shall be added to the sprinkler demand for combined large and small hose stream demand.

8-2.3 Water supply duration shall be as indicated in Table 8-1.

8-3 Sprinkler System Design.

8-3.1 All requirements contained in NFPA 13, *Standard for the Installation of Sprinkler Systems*, pertaining to large drop sprinklers shall apply.

Exception: Where modified by this standard.

Chapter 9 Fire Protection—Early Suppression Fast Response (ESFR) Sprinklers

9-1* General.

9-1.1 ESFR sprinklers shall be permitted for the protection of commodities in accordance with Table 9-1.

9-1.2* ESFR sprinklers shall be permitted for use in buildings with the following types of roof construction:

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

Table 8-1 Large Drop Sprinkler Data
Pressure and Number of Design Sprinklers Required for Various Hazards for Large Drop Sprinklers

Hazard	Minimum Operating Pressure [psi (bars)] (See Note 1.)					Water Supply Duration (hr)
	Type of System	25 (1.7)	50 (3.4)	75 (5.2)	Hose Stream Demand gpm (dm ³ /min)	
Palletized Storage Classes I, II, and III commodities up to 25 ft (7.6 m) with maximum 10-ft (3.0-m) clearance to ceiling	Number of Design Sprinklers					
	Wet	15	Note 2	Note 2	500 (1900)	2
	Dry	25	Note 2	Note 2		
Class IV commodities up to 20 ft (6.1 m) with maximum 10-ft (3.0-m) clearance to ceiling	Wet	20	15	Note 2	500 (1900)	2
	Dry	N/A	N/A	N/A		
Unexpanded plastics up to 20 ft (6.1 m) with maximum 10-ft (3.0-m) clearance to ceiling	Wet	25	15	Note 2	500 (1900)	2
	Dry	N/A	N/A	N/A		
Expanded plastics commodities up to 18 ft (5.5 m) with maximum 8-ft (2.4-m) clearance to ceiling	Wet	N/A	15	Note 2	500 (1900)	2
	Dry	N/A	N/A	N/A		
Idle wood pallets up to 20 ft (6.1 m) with maximum 10-ft (3.0-m) clearance to ceiling	Wet	15	Note 2	Note 2	500 (1900)	1½
	Dry	25	Note 2	Note 2		
Solid Pile Storage Classes I, II, and III commodities up to 20 ft (6.1 m) with maximum 10-ft (3.0-m) clearance to ceiling	Wet	15	Note 2	Note 2	500 (1900)	1½
	Dry	25	Note 2	Note 2		
	Class IV commodities and unexpanded plastics up to 20 ft (6.1 m) with maximum 10-ft (3.0-m) clearance to ceiling	Wet	N/A	15	Note 2	500 (1900)
Dry		N/A	N/A	N/A		

NOTE 1: Open wood joist construction. Each joist channel shall 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 not exceeding 20 ft (6.1 m), the minimum operating pressures of Table 8-1 shall be increased by 40 percent.

NOTE 2: The high pressure shall be permitted to be used, but the required number of design sprinklers shall not be permitted to be reduced from that required for the lower pressure.

N/A: Not applicable.

Table 9-1 ESFR Sprinkler Data

Type of Storage	Commodity	Maximum Height of Storage ft (m)	Maximum Height of Building (See Note 1.) ft (m)	Nominal K factor	Sprinkler Design Pressure psi (bars)	Commodity Limitation
Palletized and solid pile storage (no open-top containers or solid shelves)	Cartoned unexpanded plastic; cartoned expanded plastic; uncartoned unexpanded plastic; and Class I, II, III, or IV commodities encapsulated or unencapsulated	25 (7.6)	30 (9.1)	13.5-14.5	50 (3.4)	
	Cartoned unexpanded plastic; and Class I, II, III, or IV commodities, encapsulated or unencapsulated	35 (10.7)	40 (12.2)	13.5-14.5	75 (5.2)	(See Note 2.)
		20 (6.1)	25 (7.6)	11.0-11.5	50 (3.4)	

NOTE 1: Maximum building height shall be measured to the underside of the roof deck or ceiling.

NOTE 2: Only ESFR sprinklers specifically listed for 40-ft (12.2-m) high buildings shall be used in buildings higher than 30 ft (9.1 m) up to 40 ft (12.2 m).

9-1.3 Roof slope shall not exceed 1 in./ft.

9-2* Water Supplies.

9-2.1 The design area shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of 4 sprinklers on each of 3 branch lines. The design shall include a minimum of 960 ft² (89.2 m²).

9-2.2 A minimum of 250 gpm (946 L/min) shall be added to the sprinkler demand for combined large and small hose streams.

9-2.3 Water supply duration shall be at least 1 hour.

9-2.4 ESFR sprinklers shall be limited to wet-pipe systems.

9-3 Sprinkler System Design.

9-3.1 All requirements contained in NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall apply.

Exception: Where modified by this standard.

Chapter 10 Building Equipment, Maintenance, and Operations

10-1* Mechanical Handling Equipment.

10-1.1* Industrial Trucks. Power-operated industrial trucks shall comply with NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Maintenance, and Operation*.

10-2 Building Service Equipment.

10-2.1 Electrical equipment shall be installed in accordance with the provisions of NFPA 70, *National Electrical Code*®.

10-3 Cutting and Welding Operations.

10-3.1* Where welding or cutting operations are necessary, the requirements of NFPA 51B, *Standard for Fire Prevention in Use of Cutting and Welding Processes*, shall apply. Where possible, work shall be removed to a safe area.

10-3.2 Welding, soldering, brazing, and cutting shall be permitted to 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 area. 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 attended 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.

10-4 Waste Disposal. Rubbish, trash, and other waste material shall be disposed of at regular intervals.

10-5 Smoking. Smoking shall be strictly prohibited. "No Smoking" signs shall be posted in prohibited areas.

Exception: Smoking shall be permitted in locations prominently designated as smoking areas.

10-6 Maintenance and Inspection.

10-6.1 Fire walls, fire doors, and floors shall be maintained in good repair at all times.

10-6.2 The sprinkler system and the water supplies shall be inspected, tested, and maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

10-7 Refrigeration Systems. Refrigeration systems, if used, shall conform to ASHRAE 15-70, *Safety Code for Mechanical Refrigeration*.

Chapter 11 Referenced Publications

11-1 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.

11-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 10, *Standard for Portable Fire Extinguishers*, 1994 edition.

NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*, 1994 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1994 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 1992 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 1992 edition.

NFPA 51B, *Standard for Fire Prevention in Use of Cutting and Welding Processes*, 1994 edition.

NFPA 70, *National Electrical Code*, 1993 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Materials*, 1995 edition.

NFPA 220, *Standard on Types of Building Construction*, 1995 edition.

NFPA 231C, *Standard for Rack Storage of Materials*, 1995 edition.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Maintenance, and Operation*, 1992 edition.

11-1.2 Other Publication.

11-1.2.1 ASHRAE Publication. American Society of Heating, Refrigerating and Air Conditioning Engineers, United Engineering Center, 345 East 49th Street, New York, NY 10017.

ASHRAE 15, *Safety Code for Mechanical Refrigeration*, 1992.

Appendix A Explanatory Material

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

A-1-3 Array, Open. Fire tests conducted to represent a closed array utilized 6-in. (152-mm) longitudinal flues and no transverse flues. Fire tests conducted to represent an open array utilized 12-in. (305-mm) longitudinal flues.

A-1-3 Available Height for Storage. For new sprinkler installations, maximum height of storage is the height at which commodities can be stored above the floor where the

minimum required unobstructed space below sprinklers is maintained. For the evaluation of existing situations, maximum height of storage is the maximum existing height, if space between sprinklers and storage is equal to or greater than required.

A-1-3 Compartmented. Cartons used in most of the Factory Mutual-sponsored plastic tests involved an ordinary 200-lb (90.7-kg) test of outside corrugated cartons with five 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 Society of Plastics Industry, Industrial Risk Insurers, Factory Mutual, 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.

A-1-3 Container. The term container includes items such as cartons and wrappings. Fire retardant containers or tote boxes do not of themselves create a need for automatic sprinklers unless coated with oil or grease. Containers can lose their fire retardant properties if washed. For obvious reasons, they should not be exposed to rainfall.

A-1-3 Pile Stability. Pile stability performance has been shown to be a difficult factor to judge prior to being subjected to an actual fire. In the test work completed, compartmented cartons (see A-1-2, "Compartmented") have been shown to be stable under fire conditions. Those tests on cartons that were not compartmented tended to be unstable under fire conditions.

A-2-1.5 The classes of plastics used in this standard basically were 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 exhibit exactly the same characteristics while burning.

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

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

It is recommended that walls or partitions be provided 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 was developed without the use of such venting. However, venting through eave-line 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 might 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 the 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 few exterior openings exist. 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. Therefore, it is preferable to store pallets outdoors where possible.

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	0	0	0
	Wired glass with outside sprinklers 1-hr doors	0	10 (3.0)	20 (6.1)
	Wired or plain glass with outside sprinklers ¾-hr 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 also should be provided for combustible eave lines, vent openings, etc.
2. Where 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 generally are 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 means of prewet-ting. 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-5-4 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 seen clearly and the extent of fire reduced to a stage that needs only mopping up. It is essential that charged hose lines be available before venting is started because of a possible increase in fire intensity. Where a sprinkler valve has been 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.

Information on emergency organization and pre-incident planning is provided in the following publications:

NFPA *Industrial Fire Brigades Training Manual*.

NFPA 600, *Standard on Industrial Fire Brigades*.

NFPA 1420, *Recommended Practice for Pre-Incident Planning for Warehouse Occupancies*.

A-6 The following procedure should be followed in determining the proper density and area as specified in Chapter 6.

1. Determine the commodity class.
2. Select the density and area of application from Figure 6-2.2.2 or Figure 6-2.2.3.
3. Adjust the required density for storage height in accordance with Figure 6-2.2.4.
4. Increase the operating area by 30 percent in accordance with 6-2.2.5 where a dry-pipe system is used.
5. Satisfy the minimum densities and areas as indicated in 5-1.2 and 5-1.2.1.

Example:

Storage — greeting cards in boxes in cartons on pallets

Height — 22 ft (6.7 m)

Clearance — 6 ft (1.8 m)

Sprinklers — 165°F (74°C)

System type — dry

1. Classification — Class III
2. Selection of density/area — 0.225 gpm/ft² over 3000 ft² [0.014 (L/s)/m² over 276 m²] from Figure 6-2.2.2
3. Adjustment for height of storage using Figure 6-2.2.4 — $1.15 \times 0.225 = 0.259$ gpm/ft²; round up to 0.26 gpm/ft²
4. Adjustment of area of operation for dry system — 1.3×3000 ft² = 3900 ft² (363 m²)
5. Confirmation that minimum densities and areas have been achieved

In 5-1.2, the minimum design density for a dry sprinkler system is 0.15 gpm/ft² over 2600 ft² [0.10 (L/s)/m² over 242 m²] (this has been satisfied) for Class III.

Paragraph 5-1.2.1 refers to Ordinary Hazard Group 2 of NFPA 13, *Standard for the Installation of Sprinkler Systems*. That density at 3000 ft² (279 m²) is 0.17 gpm/ft² [0.12 (L/s)/m²] (this minimum has been satisfied) 3000 ft² \times $1.3 = 3900$ ft² (363 m²), 0.17 gpm/ft² over 3900 ft² [0.12 (L/s)/m² over 363 m²].

The design density and area of application equals 0.26 gpm/ft² [0.18 (L/s)/m²] over 3900 ft² (363 m²).

A-6-1.1(c) Full-scale tests show no appreciable difference in the number of sprinkler heads that open for either non-encapsulated or encapsulated products up to 15 ft (4.6 m) high. Test data is not available for encapsulated products stored higher than 15 ft (4.6 m). However, in rack storage tests involving encapsulated storage 20 ft (6 m) high, increased protection was needed over that for nonencapsulated storage.

The protection specified in Chapter 6 contemplates a maximum of 10-ft (3-m) clearances from top of storage to sprinkler deflectors for storage heights of 15 ft (4.6 m) and higher.

A-6-2.4 Recommended water supplies anticipate successful sprinkler operation. Because of the small, but still significant, number of uncontrolled fires in sprinklered properties, which have various causes, 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 [1⅞ in. (13.5 mm)] sprinklers and 80-ft² or 100-ft² (7.4-ft² 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 ft² to 100 ft² (7.4 m² to 9.3 m²) sprinkler spacing than where 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) could have produced a different result due to the tendency of the higher pressure to atomize the water and the greater distance that the fine water droplets had to travel to the burning fuel.

A-7-1.1 Two direct comparisons between ordinary-temperature and high-temperature rated sprinklers are 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) versus 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 ordinary-temperature rated sprinklers operated as did high-temperature rated sprinklers [11 at 286°F (141°C) versus 33 at 165°F (74°C)].

The cartoned plastics requirements of this standard are based to a great extent on test work that used a specific commodity — 16-oz (0.473-L) polystyrene plastic jars individually separated by thin carton stock within a large corrugated carton [3½ ft² (0.32 m²)]. [See Figure A-7-1.1(a).]

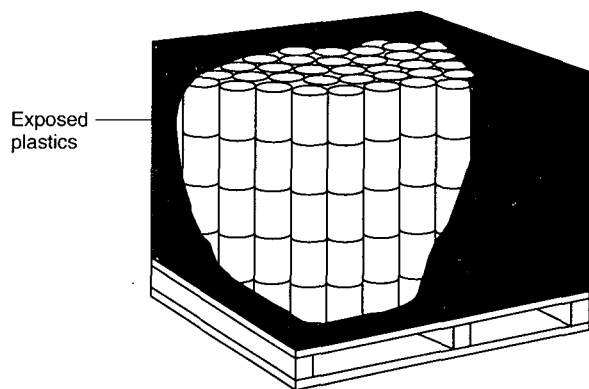


Figure A-7-1.1(a) Corrugated carton containing individually separated plastic jars.

Other Group A plastic commodities can be arranged in cartons so that they are separated by multiple thicknesses of carton material. In such arrangements, less plastic becomes involved in the fire at any one time. This could result in a less vigorous fire that can be controlled by Class IV commodity protection.

Other situations exist in which the plastics component is surrounded by several layers of less hazardous material and is therefore temporarily protected or insulated from a fire involving adjacent plastic products. Such conditions also could produce a less vigorous fire and be successfully handled by Class IV protection. [See Figure A-7-1.1(b).]

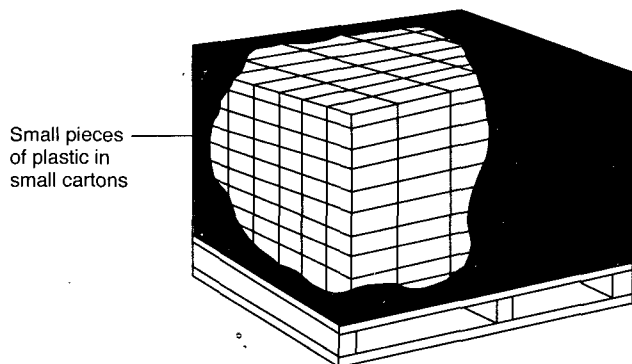


Figure A-7-1.1(b) Corrugated carton containing plastic pieces individually separated by carton material.

The decision to protect as a Class IV commodity, however, should be made only based on experienced judgment and only with an understanding of the consequences of underprotecting the storage segment.

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 can change protection requirements considerably. Design should be based on higher densities and areas of application, and the various reductions allowed should be applied cautiously. For evaluation of existing situations, however, the allowances can 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 piling 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-7-2.2 Test data is not available for all combinations of commodities, storage heights, and clearances. Some of the protection criteria in this standard are based on extrapolations of test data for other commodities and storage configurations, as well as available loss data.

For example, there is very limited test data for storage of expanded plastics higher than 20 ft (6 m). The protection criteria in this standard for expanded plastics higher than 20 ft (6 m) are extrapolated from test data for expanded plastics storage 20 ft (6 m) and less in height and test data for unexpanded plastics above 20 ft (6 m).

Further examples can be found in the protection criteria for clearances up to 15 ft (4.6 m). Test data is limited for clearances greater than 10 ft (3.0 m). It should be assumed that, if protection is adequate for a given storage height in a building of a given height, the same protection will protect storage of any lesser height in the same building. For example, protection adequate for 20-ft (6.1-m) storage in a 30-ft (10-m) building [10-ft (3.0-m) clearance] would also protect 15-ft (4.6-m) storage in a 30-ft (10-m) building [15-ft (4.6-m) clearance]. Therefore, the protection criteria in Table 7-2.2 for 15-ft (4.6-m) clearance are based on the protection criteria for storage 5 ft (1.5 m) higher than the indicated height with 10-ft (3.0-m) clearance.

A-7-2.5 Wet systems are recommended for storage occupancies. Dry-pipe systems may be permitted only where it is impractical to provide heat.

A-9-1 ESFR sprinklers were designed to respond quickly to growing fires and deliver heavy discharge to suppress fires rather than to control them. ESFR sprinklers should not be relied upon to provide suppression if they are used outside these design parameters.

A-9-1.2 Storage in single-story or multistory buildings may be permitted, provided the maximum ceiling/roof height as specified in Table 9-1 is satisfied for each storage area.

A-9-2 Design parameters were determined from a series of full-scale fire tests conducted as a joint effort between Factory Mutual Research Corporation and the National Fire Protection Research Foundation. (Copies of the test reports are available from the NFPRF.)

A-10-1 Locomotives should not be allowed to enter storage areas.

A-10-1.1 Industrial trucks using gas or liquid fuel should be refueled outside of the storage building at a location designated for that purpose.

A-10-3.1 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 Example Determining Protection Criteria for Plastic and Rubber Commodities

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

Appendix B explains and provides an example of the method and procedure to follow in using this standard to determine proper protection for Group A plastics. (See Chapter 7.)

Metric Conversion Factors for Examples

To convert from	to	Multiply by
feet (ft)	meter (m)	0.3048
square feet (ft ²)	meter/square (m ²)	0.0929
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

Building ceiling height — 23 ft
Maximum storage height — 18 ft
Wet or dry sprinkler system — Dry

Commodity. Nonexpanded, unexposed thermoplastic polyethylene and polypropylene toys in cardboard boxes stacked so as to exclude air voids within the load (forming solid unit loads). This meets the Group A plastic definition of Chapter 2.

Protection Requirements. The decision tree (see Figure 7-1.1) directs the user to column A of Table 7-2.2 for nonexpanded, stable, solid unit load.

To determine the proper density for 18-ft high storage, the densities given for 15-ft high and 20-ft high storage corresponding to the ceiling height of 25 ft are interpolated.

NOTE: There is no interpolation between ceiling heights. The exact height should be chosen, or, if the height is higher, it should be rounded up.

Using Table 7-2.2:

15-ft storage height and 25-ft ceiling = 0.4 gpm/ft² over 2500 ft²

20-ft storage height and 25-ft ceiling = 0.3 gpm/ft² over 2500 ft²

NOTE: The reason for the lower density at a 20-ft storage height is due to the favorable factor of less clearance between the top of storage and the ceiling (not the sprinkler deflector).

From interpolation, the design/area demand equals 0.34 gpm/ft² over 2500 ft² for a wet system.

Final demand for a dry system:

Adjustment to area of demand = 2500 ft² × 1.30 = 3250 ft², or

Final sprinkler density and area = 0.34 gpm/ft² over 3250 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 can occur render impossible the formulation of any single table, formulae, or set of rules that can cover all conditions adequately.

C-1.2 Recommendations contained in this appendix are for the protection of outdoor storage of commodities covered by the standard. (See Section 1-1.)

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

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

(c) Of such severe 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 that address outdoor storage of specific commodities are found in Chapter 11.

C-2 Responsibility of Management.

C-2.1 It is the responsibility of management to properly consider the hazards of the various materials handled. Protection requirements and storage arrangements vary with the combustibility of the materials. Management should determine any special precautions that should be followed for the types of material stored. The care, cleanliness, and maintenance exercised by management 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 criteria used to determine the amount of such material that should be

stored in a single location are 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 that can provide the following:

- (a) Adequate municipal fire and police protection;
- (b) An 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 constitutes 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 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 (4.6 m) should be provided to allow the travel of fire equipment to all portions of the storage area. Aisles should be at least twice the pile height to reduce the spread of fire from pile to pile and to allow ready access for fire fighting, emergency removal of material, or salvage purposes.

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

C-4.4 For outdoor idle pallet storage, see Section 4-4 and A-4-4.1.1 of this standard. Separation between piles of idle pallets and other yard storage should be as specified in Table C-4.4.

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

Table C-4.4 Pile Separation

Pile Size	Minimum Distance ft (m)
Fewer than 50 pallets	20 (6)
50-200 pallets	30 (9.1)
More than 200 pallets	50 (15.2)

C-5 Buildings and Other Structures.

C-5.1 Yard storage, particularly storage of 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, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*, to establish clear spaces, the following Classification of Severity with Commodity Classes of this standard should 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 guidelines of C-5.1.1 apply to the equivalent commodity classes of this standard. The severity of the exposing building or structure also should be a consideration where 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 in compliance with NFPA 51B, *Standard for Fire Prevention in Use of Cutting and Welding Processes*.

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 could 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 the 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 conformity 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. (See NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*.)

C-7.2.1 Provisions should be made to permit the direction of an adequate number of hose streams on any pile or portion of the storage area that could be involved in fire. It is recommended that, unless adequate protection is provided by the municipal fire department, sufficient hose and other equipment should be kept on hand at the storage property, suitably housed, and provision should 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 removed promptly.

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 be made available quickly for use at any point. Where the climate is such that there is a 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. The responsibilities and the training of guards should be as specified in NFPA 601, *Standard on Guard Service in Fire Loss Prevention*. It is recommended that there be some suitable means of supervising guard activities to ensure that required rounds are made at regular intervals.

C-8.2 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 should be considered. It is recommended that such watchtowers be connected to the alarm system for prompt notification of fire.

Appendix D Referenced Publications

D-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.

D-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 10, *Standard for Portable Extinguishers*, 1994 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1994 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 1992 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 1993 edition.

NFPA 51B, *Standard for Fire Prevention in Use of Cutting and Welding Processes*, 1994 edition.

NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*, 1995 edition.

NFPA 70, *National Electrical Code*, 1993 edition.

NFPA 72, *National Fire Alarm Code*, 1993 edition.

NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*, 1993 edition.

NFPA 88B, *Standard for Repair Garages*, 1991 edition.

NFPA 204M, *Guide for Smoke and Heat Venting*, 1991 edition.

NFPA 600, *Standard on Industrial Fire Brigades*, 1992 edition.

NFPA 601, *Standard on Guard Service in Fire Loss Prevention*, 1992 edition.

NFPA 1420, *Recommended Practice for Pre-Incident Planning for Warehouse Occupancies*, 1993 edition.

NFPA *Industrial Fire Brigade Training Manual*.

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Tentative Interim Amendment

NFPA 231

Standard for General Storage

1995 Edition

**Reference: 5-1.5 Exception No. 3 (New); Table 7-2.2 Note 4
TIA 95-1 (NFPA 231)**

Pursuant to Section 5 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*, 1995 edition. The TIA was processed by the General Storage Committee, and was issued by the Standards Council on July 22, 1997, with an effective date of August 11, 1997.

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 an Exception No. 3 to 5-1.5 to read as follows:*

Exception No. 3: The use of very extra-large orifice (VELO) sprinklers [3/4 in. (19.0 mm)] shall be permitted where listed for such use, and where installed at a minimum design pressure of 7 psi (0.5 bar).

2. *Revise Table 7-2.2 Note 4 to read as follows:*

"For density demands of 0.4 gpm/ft² or greater, large orifice, extra large orifice (ELO) or very extra large orifice (VELO) sprinklers shall be used."

Tentative Interim Amendment

NFPA 231

Standard for General Storage

1995 Edition

**Reference: Table 9-1
TIA 95-2 (NFPA 231)**

Pursuant to Section 5 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*, 1995 edition. The TIA was processed by the General Storage Committee, and was issued with corrections to metric conversions by the Standards Council on November 16, 1997, with an effective date of December 6, 1997.

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. *Revise Table 9-1 to read as follows:*

Table 9-1 Early Suppression Fast Response (ESFR) Sprinkler Data

Type of Storage	Commodity	Maximum Height of Storage	Maximum Height of Building	Nominal K Factor	Sprinkler Design Pressure psi (bars)	Commodity Limitation
		ft (m)	(ft) (m) (Note 1)			
Palletized and solid pile storage (No open-top containers or solid shelves)	Cartoned unexpanded plastic; cartoned expanded plastic; uncartoned unexpanded plastic; and Class I, II, III, or IV commodities; encapsulated or unencapsulated	25 (7.6)	30 (9.1)	13.5 - 14.5	50 (3.4)	---
	Cartoned unexpanded plastic; and Class I, II, III, or IV commodities, encapsulated or unencapsulated	35 (10.7)	40 (12.2)	13.5 - 14.5	75 (5.2)	Note 2
		20 (6.1)	25 (7.6)	11.0 - 11.5	50 (3.4)	
		35 (10.7)	45(13.7)	13.5 - 14.5	90 (6.2)	

NOTE 1: (no change)

NOTE 2: (no change)

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Since 1896, one of the primary purposes of the NFPA has been to develop and update the standards covering all areas of fire safety.

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The code adoption process takes place twice each year and begins with a call for proposals from the public to amend existing codes and standards or to develop the content of new fire safety documents.

Report on Proposals

Upon receipt of public proposals, the technical committee members meet to review, consider, and act on the proposals. The public proposals – together with the committee action on each proposal and committee-generated proposals – are published in the NFPA's Report on Proposals (ROP). The ROP is then subject to public review and comment.

Report on Comments

These public comments are considered and acted upon by the appropriate technical committees. All public comments – together with the committee action on each comment – are published as the Committee's supplementary report in the NFPA's Report on Comments (ROC).

The committee's report and supplementary report are then presented for adoption and open debate at either of NFPA's semi-annual meetings held throughout the United States and Canada.

Association Action

The Association meeting may, subject to review and issuance by the NFPA Standards Council, (a) adopt a report as published, (b) adopt a report as amended, contingent upon subsequent approval by the committee, (c) return a report to committee for further study, and (d) return a portion of a report to committee.

Standards Council Action

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Voting at an NFPA Annual or Fall Meeting is restricted to members of record for 180 days prior to the opening of the first general session of the meeting, except that individuals who join the Association at an Annual or Fall Meeting are entitled to vote at the next Fall or Annual Meeting.

"Members" are defined by Article 3.2 of the Bylaws as individuals, firms, corporations, trade or professional associations, institutes, fire departments, fire brigades, and other public or private agencies desiring to advance the purposes of the Association. Each member shall have one vote in the affairs of the Association. Under Article 4.5 of the Bylaws, the vote of such a member shall be cast by that member individually or by an employee designated in writing by the member of record who has registered for the meeting. Such a designated person shall not be eligible to represent more than one voting privilege on each issue, nor cast more than one vote on each issue.

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