20.1 * General.

This chapter shall provide the necessary steps for identifying commodity, storage arrangements, storage heights, and clearances as well as general protection criteria for storage conditions relative to Chapters 21 through 25.

20.1.1

Miscellaneous and low-piled storage meeting the criteria of Chapter 4 shall be protected in accordance with the relative occupancy hazard criteria referenced in that section.

20.2 * Protection of Storage.

Protection of storage shall follow the following criteria:

(1) Identify the storage commodity class in accordance with Sections 20.3 and 20.4.
(2) Identify the method of storage in accordance with Section 20.5.
(3) Establish storage height, building height, and associated clearances in accordance with Section 20.9.
(4) Define the general protection criteria that are common to all storage protection options in accordance with Sections 20.10 through 20.18.
(5) Select the appropriate system/sprinkler technology for protection criteria (Chapters 21 through 25).
(6) Design and install system in accordance with the remainder of this document.
(7) Design and install sprinklers in accordance with the sections to which they apply or in accordance with their specific application listing.

20.2.1

Protection criteria for Group A plastics shall be permitted for the protection of the same storage height and configuration of Class I through Class IV commodities.

20.2.2

CMSA and ESFR sprinklers shall be permitted to protect storage of Class I through Class IV commodities, Group A plastic commodities, miscellaneous storage, and other storage as specified in Chapters 20 through 25 or by other NFPA standards.

20.2.3 Systems with Multiple Hazard Classifications.

For systems with multiple hazard classifications, the hose stream allowance and water supply duration shall be in accordance with 20.15.2 as well as one of the following:

(1) The water supply requirements for the highest hazard classification within the system shall be used.
(2) The water supply requirements for each individual hazard classification shall be used in the calculations for the design area for that hazard.
(3)* For systems with multiple hazard classifications where the higher classification only lies within single rooms less than or equal to 400 ft^2 (37 m^2) in area with no such rooms adjacent, the water supply requirements for the principal occupancy shall be used for the remainder of the system.

20.3 * Classification of Commodities.

20.3.1 *

Commodity classification and the corresponding protection requirements shall be determined based on the makeup of individual storage units. *(See Section C.2.)*

20.3.1.1

The type and amount of materials used as part of the product and its primary packaging as well as the storage pallet shall be considered in the classification of the commodity.

20.3.1.2

When specific test data of commodity classification by a nationally recognized testing agency are available, the data shall be permitted to be used in determining classification of commodities.

20.3.1.3

For the same storage arrangement, the following commodity classification ranking shall apply from lowest (Class I) to highest (exposed expanded plastic) severity as follows:

(1) Class I
(2) Class II
(3) Class III
(4) Class IV
(5) Cartoned nonexpanded plastic
(6) Cartoned expanded plastic
(7) Exposed nonexpanded plastic
(8) Exposed expanded plastic

20.3.1.4

Protection criteria for commodities listed in 20.3.1.3 shall be permitted to protect lower commodities in the same list.

20.3.2 Pallet Types.

20.3.2.1 General.

When loads are palletized, the use of wood or metal pallets, or listed pallets equivalent to wood, shall be assumed in the classification of commodities.

20.3.2.2 Plastic Pallet.

A pallet having any portion of its construction consisting of a plastic material that has not been listed as equivalent to wood shall increase the class of commodity determined for a storage load in accordance with 20.3.2.2.1 or 20.3.2.2.2.

20.3.2.2.1 * Unreinforced Plastic Pallets.

Plastic pallets that have no secondary reinforcing shall be treated as unreinforced plastic pallets.

20.3.2.2.1.1

For Class I through Class IV commodities, when unreinforced polypropylene or unreinforced high-density polyethylene plastic pallets are used, the classification of the commodity unit shall be increased one class.

20.3.2.2.1.2

Unreinforced polypropylene or unreinforced high-density polyethylene plastic pallets shall be marked with a permanent symbol to indicate that the pallet is unreinforced.

20.3.2.2.2 Reinforced Plastic Pallet.

A plastic pallet incorporating a secondary reinforcing material (such as steel or fiberglass) within the pallet shall be considered a reinforced plastic pallet.

20.3.2.2.2.1 *

For Class I through Class IV commodities, when reinforced polypropylene or reinforced high-density polyethylene plastic pallets are used, the classification of the commodity unit shall be increased two classes except for Class IV commodity, which shall be increased to a cartoned nonexpanded Group A plastic commodity.

20.3.2.2.2.2

Pallets shall be assumed to be reinforced if no permanent marking or manufacturer's certification of nonreinforcement is provided.

20.3.2.2.3

No increase in the commodity classification shall be required for Group A plastic commodities stored on plastic pallets.

20.3.2.2.4

For ceiling-only sprinkler protection, the requirements of 20.3.2.2.1 and 20.3.2.2.2.1 shall not apply where plastic pallets are used and where the sprinkler system uses spray sprinklers with a minimum K-factor of K-16.8 (240).

20.3.2.3

The requirements of 20.3.2.2.1 through 20.3.2.4 shall not apply to nonwood pallets that have demonstrated a fire hazard that is equal to or less than wood pallets and are listed as such.

20.3.2.4 Plastic Pallets Other Than Polypropylene or High-Density Polyethylene.

20.3.2.4.1

For Class I through Class III commodities stored on plastic pallets other than polypropylene or high-density polyethylene, the classification of the commodity unit shall be determined by specific testing conducted by an approved testing laboratory or shall be increased two classes.

20.3.2.4.2

For Class IV commodities stored on plastic pallets other than polypropylene or high-density polyethylene, the classification shall be increased to a cartoned nonexpanded Group A plastic commodity.

20.3.2.5 Slave Pallet.

Where solid, flat-bottom, combustible pallets are used for rack storage of Class I through IV commodity up to 25 ft (7.6 m) in height in combination with CMDA sprinklers, 21.4.1.6.1 shall apply. *(See Figure A.3.3.161.1.)*

20.3.3 Open-Top Container.

A container of any shape that is entirely or partially open on the top and arranged to allow for the collection of discharging sprinkler water cascading through the storage array shall be considered outside the criteria of rack storage protection outlined in Chapters 21 through 25. *(See Section C.12.)*

20.3.4 Solid Unit Load of 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 and that water from sprinklers will reach most surfaces available to burn shall allow a reduction in design density of CMDA sprinklers. *[See Table 21.3.3(a).]*

20.4 * Commodity Classes.

20.4.1 * Class I.

A Class I commodity shall be defined as a noncombustible product that meets one of the following criteria:

(1) Placed directly on wood pallets
(2) Placed in single-layer corrugated cartons, with or without single-thickness cardboard dividers, with or without pallets
(3) Shrink-wrapped or paper-wrapped as a unit load with or without pallets

20.4.2 * Class II.

A Class II commodity shall be defined as a noncombustible product that is in slatted wooden crates, solid wood boxes, multiple-layered corrugated cartons, or equivalent combustible packaging material, with or without pallets.

20.4.3 * Class III.

20.4.3.1

A Class III commodity shall be defined as a product fashioned from wood, paper, natural fibers, or Group C plastics with or without cartons, boxes, or crates and with or without pallets.

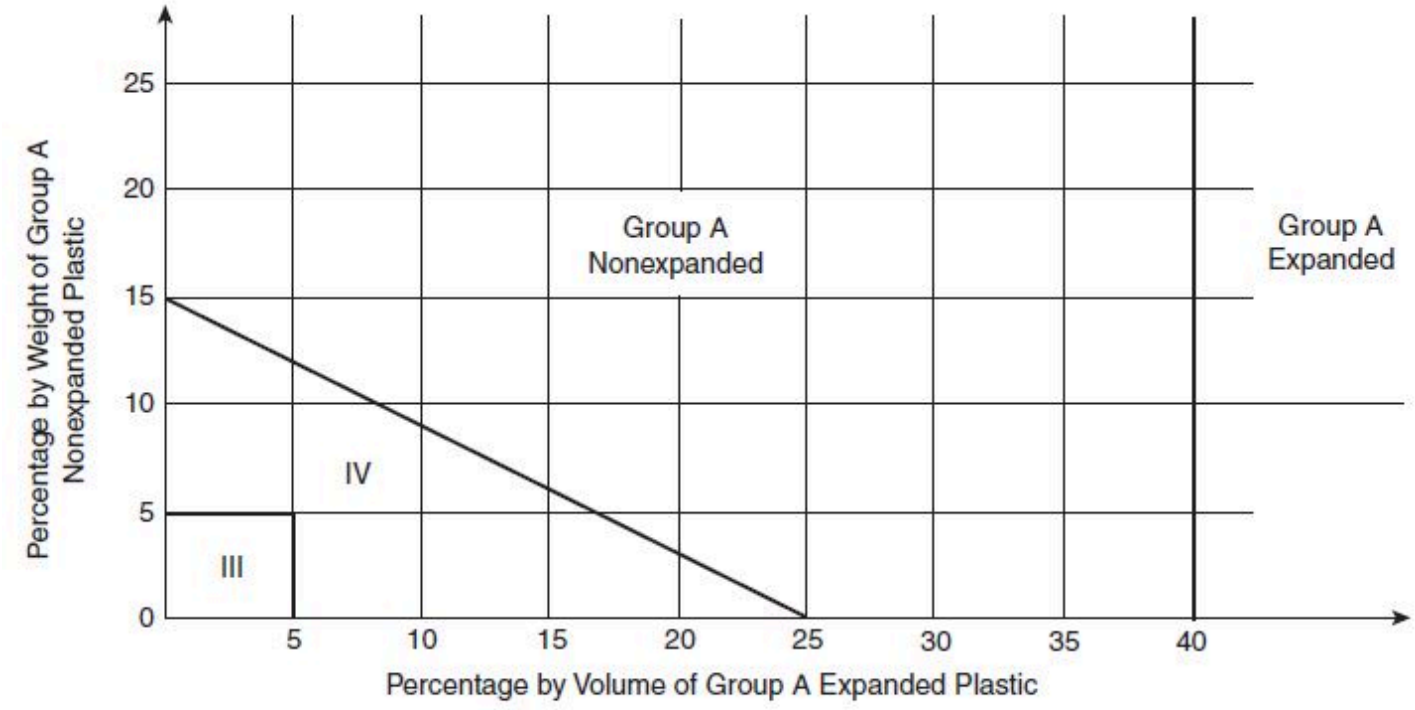
20.4.3.2

A Class III commodity shall be permitted to contain a limited amount (5 percent or less by weight of nonexpanded plastic or 5 percent or less by volume of expanded plastic) of Group A or Group B plastics.

20.4.3.3

Class III commodities containing a mix of both Group A expanded and nonexpanded plastics shall comply with Figure 20.4.3.3(a) where they are within cartons, boxes, or crates or with Figure 20.4.3.3(b) where they are exposed.

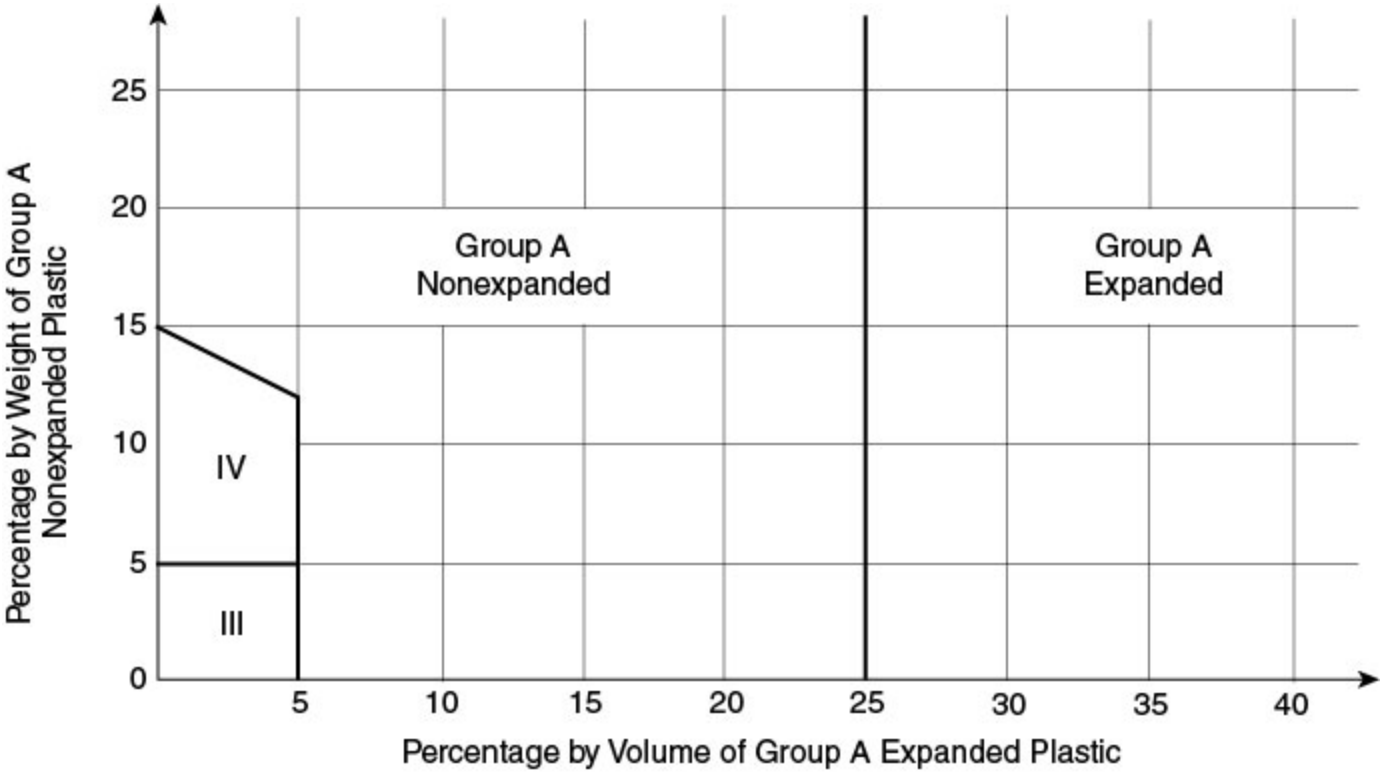
Figure 20.4.3.3(a) Commodities, Cartoned or Within a Wooden Container, Containing a Mixture of Expanded and Nonexpanded Group A Plastics.



III - Class III Commodity. Refer to 20.3.2 if a plastic pallet is used.

IV - Class IV Commodity. Refer to 20.3.2 if a plastic pallet is used.

Figure 20.4.3.3(b) Exposed Commodities Containing a Mixture of Expanded and Nonexpanded Group A Plastics.



III - Class III Commodity. Refer to 20.3.2 if a plastic pallet is used.

IV - Class IV Commodity. Refer to 20.3.2 if a plastic pallet is used.

20.4.4 * Class IV.

20.4.4.1

A Class IV commodity shall be defined as a product, with or without pallets, that meets one of the following criteria:

(1) Constructed partially or totally of Group B plastics
(2) Consists of free-flowing Group A plastic materials
(3) Cartoned, or within a wooden container, that contains greater than 5 percent and up to 15 percent by weight of Group A nonexpanded plastic
(4) Cartoned, or within a wooden container, that contains greater than 5 percent and up to 25 percent by volume of expanded Group A plastics
(5) Cartoned, or within a wooden container, that contains a mix of Group A expanded and nonexpanded plastics and complies with Figure 20.4.3.3(a)
(6) Exposed, that contains greater than 5 percent and up to 15 percent by weight of Group A nonexpanded plastic
(7) Exposed, that contains a mix of Group A expanded and nonexpanded plastics and complies with Figure 20.4.3.3(b)

20.4.4.2

The remaining materials shall be permitted to be noncombustible, wood, paper, natural fibers, or Group B or Group C plastics.

20.4.5 * Classification of Plastics, Elastomers, and Rubber.

Plastics, elastomers, and rubber shall be classified as Group A, Group B, or Group C.

20.4.5.1 * Group A.

The following materials shall be classified as Group A:

(1) ABS (acrylonitrile-butadiene-styrene copolymer)
(2) Acetal (polyformaldehyde)
(3) Acrylic (polymethyl methacrylate)
(4) Butyl rubber
(5) Cellulosics (cellulose acetate, cellulose acetate butyrate, ethyl cellulose)
(6) EPDM (ethylene-propylene rubber)
(7) FRP (fiberglass-reinforced polyester)
(8) Natural rubber
(9) Nitrile-rubber (acrylonitrile-butadiene-rubber)
(10) Nylon (nylon 6, nylon 6/6)
(11) PET (thermoplastic polyester)
(12) Polybutadiene
(13) Polycarbonate
(14) Polyester elastomer
(15) Polyethylene
(16) Polypropylene
(17) Polystyrene
(18) Polyurethane
(19) PVC (polyvinyl chloride — highly plasticized, with plasticizer content greater than 20 percent) (rarely found)
(20) PVF (polyvinyl fluoride)
(21) SAN (styrene acrylonitrile)
(22) SBR (styrene-butadiene rubber)

20.4.5.2 *

Group A plastics shall be further subdivided as either expanded or nonexpanded.

20.4.5.3

A Group A expanded plastic commodity shall be defined as a product, with or without pallets, that meets one of the following criteria:

(1) Cartoned, or within a wooden container, that contains greater than 40 percent by volume of Group A expanded plastic
(2) Exposed, that contains greater than 25 percent by volume of Group A expanded plastic

20.4.5.4

A Group A nonexpanded plastic commodity shall be defined as a product, with or without pallets, that meets one of the following criteria:

(1) Cartoned, or within a wooden container, that contains greater than 15 percent by weight of Group A nonexpanded plastic
(2) Cartoned, or within a wooden container, that contains greater than 25 percent and up to 40 percent by volume of Group A expanded plastic

(3) Cartoned, or within a wooden container, that contains a mix of Group A nonexpanded and expanded plastics, in compliance with Figure 20.4.3.3(a)
(4) Exposed, that contains greater than 15 percent by weight of Group A nonexpanded plastic
(5) Exposed, that contains greater than 5 percent and up to 25 percent by volume of Group A expanded plastic
(6) Exposed, that contains a mix of Group A nonexpanded and expanded plastics, in compliance with Figure 20.4.3.3(b)

20.4.5.5

The remaining materials shall be permitted to be noncombustible, wood, paper, natural or synthetic fibers, or Group A, Group B, or Group C plastics.

20.4.6 Group B.

The following materials shall be classified as Group B:

(1) Chloroprene rubber
(2) Fluoroplastics (ECTFE — ethylene-chlorotrifluoro-ethylene copolymer; ETFE — ethylene-tetrafluoroethylene-copolymer; FEP — fluorinated ethylene-propylene copolymer)
(3) Silicone rubber

20.4.7 Group C.

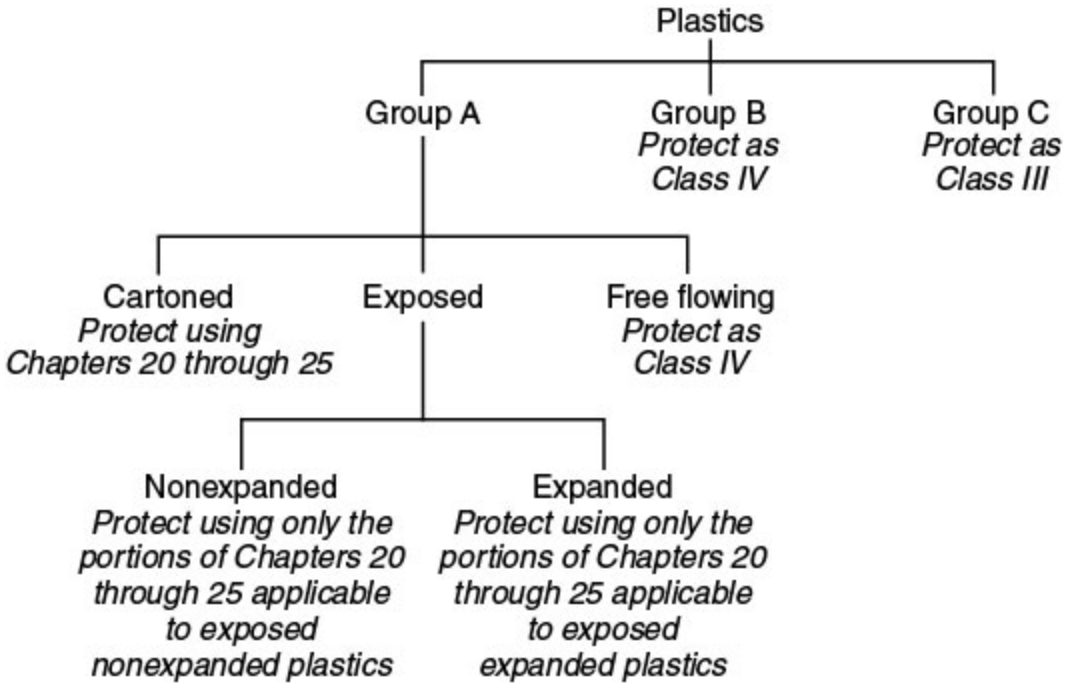
The following materials shall be classified as Group C:

(1) Fluoroplastics (PCTFE — polychlorotrifluoroethylene; PTFE — polytetrafluoroethylene)
(2) Melamine (melamine formaldehyde)
(3) Phenolic
(4) PVC (polyvinyl chloride — flexible — PVCs with plasticizer content up to 20 percent)
(5) PVDC (polyvinylidene chloride)
(6) PVDF (polyvinylidene fluoride)
(7) Urea (urea formaldehyde)

20.4.8 *

Plastic commodities shall be protected in accordance with Figure 20.4.8. *(See Section C.21.)*

Figure 20.4.8 Decision Tree.



20.4.8.1

Unless the requirements of 20.4.3 are met, Group B plastics or free-flowing Group A plastics shall be protected the same as Class IV commodities.

20.4.8.2

Group C plastics shall be protected the same as Class III commodities.

20.4.9 Rubber Tires.

Pneumatic tires for passenger automobiles, aircraft, light and heavy trucks, trailers, farm equipment, construction equipment (off-the-road), and buses shall be protected as rubber tire storage in accordance with Chapters 20 through 25.

20.4.10 * Classification of Rolled Paper Storage.

For the purposes of this standard, the classifications of paper described in 20.4.10.1 through 20.4.10.4 shall apply and shall be used to determine the sprinkler system design criteria in accordance with Chapters 20 through 25.

20.4.10.1 Heavyweight Class.

Heavyweight class shall be defined so as to include paperboard and paper stock having a basis weight [weight per 1000 ft^2 (93 m^2)] of 20 lb (100 g/m^2).

20.4.10.2 Mediumweight Class.

Mediumweight class shall be defined so as to include all the broad range of papers having a basis weight [weight per 1000 ft^2 (93 m^2)] of 10 lb to 20 lb (50 g/m^2 to 100 g/m^2).

20.4.10.3 Lightweight Class.

Lightweight class shall be defined so as to include all papers having a basis weight [weight per 1000 ft^2 (93 m^2)] of 10 lb (50 g/m^2).

20.4.10.4 Tissue.

20.4.10.4.1

Tissue shall be defined so as to include the broad range of papers of characteristic gauzy texture, which, in some cases, are fairly transparent.

20.4.10.4.2

For the purposes of this standard, tissue shall be defined as the soft, absorbent type, regardless of basis weight — specifically, crepe wadding and the sanitary class including facial tissue, paper napkins, bathroom tissue, and toweling.

20.4.11 Display/Storage of Up to Group A Plastics.

Group A plastics combined with Class I through Class IV commodities in a display/storage arrangement shall be permitted to be protected as display/storage of up to Group A plastics in accordance with Section 26.3.

20.4.12 Baled Cotton.

Baled cotton shall be protected in accordance with Section 26.5. *(See Table A.3.3.16.)*

20.4.13 * Plastic Motor Vehicle Components.

20.4.13.1

Group A plastic automotive components and associated packaging material consisting of exposed, expanded Group A plastic dunnage, instrument panels, and plastic bumper fascia shall be permitted to be protected as provided in Section 26.2.

20.4.13.2

Automotive components covered in this section shall not include the storage of air bags, tires, and seats on portable racks.

20.4.14 Carton Records Storage.

A Class III commodity consisting predominantly of paper records in cardboard cartons shall be permitted to be protected as cartoned record storage in accordance with Section 26.6.

20.4.15 Mixed Commodities.

20.4.15.1

Protection requirements shall not be based on the overall commodity mix in a fire area.

20.4.15.2

Unless the requirements of 20.4.15.3 or 20.4.15.4 are met, mixed commodity storage shall be protected by the requirements for the highest classified commodity and storage arrangement.

20.4.15.3

The protection requirements for the lower commodity class shall be permitted to be utilized where all of the following are met:

(1) Up to 10 pallet loads of a higher hazard commodity, as described in 20.4.1 through 20.4.7, shall be permitted to be present in an area not exceeding 40,000 ft^2 (3720 m^2).
(2) The higher hazard commodity shall be randomly dispersed with no adjacent loads in any direction (including diagonally).
(3) Where the ceiling protection is based on Class I or Class II commodities, the allowable number of pallet loads for Class IV or Group A plastics shall be reduced to five.

20.4.15.4 Mixed Commodity Segregation.

The protection requirements for the lower commodity class shall be permitted to be utilized in the area of lower commodity class, where the higher hazard material is confined to a designated area and the area is protected to the higher hazard in accordance with the requirements of this standard.

20.5 Equivalent Storage Arrangement.

20.5.1 Movable Racks.

Rack storage in movable racks shall be protected in the same manner as multiple-row racks.

20.5.2 Portable Racks.

Except where otherwise allowed in this standard, portable rack storage shall be protected in the same manner as multiple-row racks.

20.5.3 * Rack Storage.

20.5.3.1 Shelving.

20.5.3.1.1

Shelving material that is less than 50 percent open, or placement of loads that block openings that would otherwise serve as the required flue spaces, greater than 20 ft^2 (1.9 m^2) in area shall be treated as solid shelf racks.

20.5.3.1.2 Double-Row Racks.

20.5.3.1.2.1

Unless the requirements of 20.5.3.1.2.2 are met, double-row racks without solid shelves shall be considered racks with solid shelves where longitudinal flue spaces are not provided.

20.5.3.1.2.2

Double-row racks without solid shelves and a longitudinal flue space shall be considered open racks where the storage height does not exceed 25 ft (7.6 m) and transverse flue spaces are provided at maximum 5 ft (1.5 m) intervals.

20.5.3.1.3 Multiple-Row Racks.

Unless the requirements of 20.5.3.1.3.1 or 20.5.3.1.3.2 are met, multiple-row racks without solid shelves shall be considered racks with solid shelves.

20.5.3.1.3.1

Multiple-row racks without solid shelves shall be considered open racks where both transverse and longitudinal flue spaces are provided at maximum 5 ft (1.5 m) intervals.

20.5.3.1.3.2

Multiple-row racks without solid shelves shall be considered open racks where transverse flue spaces are provided at maximum 5 ft (1.5 m) intervals and the rack depth does not exceed 20 ft (6.1 m) between aisles that are a minimum width of 3.5 ft (1.1 m).

20.5.3.2 * Slatted Shelves.

Slatted rack shelves shall be considered equivalent to solid rack shelves where the shelving is not considered open rack shelving or where the requirements of 26.4.1.2 or 26.4.1.3 are not met. *(See Section C.20.)*

20.6 Aisle and Flue Space Requirements for Storage.

20.6.1 Aisles.

Aisles required by Chapters 21 through 25 shall not be obstructed unless Chapters 21 through 25 include specific guidance allowing obstructions over the aisle.

20.6.2 Flues.

20.6.2.1 Longitudinal Flue Space.

20.6.2.1.1

For Class I through Class IV and Group A plastic commodities in double-row open racks, a longitudinal flue space shall not be required for storage up to and including 25 ft (7.6 m). *(See Section C.13.)*

20.6.2.1.2

For Class I through IV and Group A plastic commodities in double-row open racks, a nominal 6 in. (150 mm) longitudinal flue space shall be provided for storage over 25 ft (7.6 m).

20.6.2.1.3

For Class I through Class IV and Group A plastic commodities in multiple-row open racks, longitudinal flue spaces shall not be required when all of the following are met:

(1) Minimum nominal 6 in. (150 mm) wide transverse flue spaces are provided on maximum 5 ft (1.5 m) intervals.
(2) The rack depth does not exceed 20 ft (6.1 m).
(3) The minimum aisle width is 3.5 ft (1.1 m).

20.6.2.2 Transverse Flue Space.

Nominal 6 in. (150 mm) transverse flue spaces between loads and at rack uprights shall be maintained in single-row, double-row, and multiple-row racks.

20.6.3

Random variations in the width of flue spaces or in their vertical alignment shall be permitted. *(See Section C.26.)*

20.7 Protection Criteria for Roll Paper Storage.

20.7.1

Wet pipe systems shall be used in tissue storage areas.

20.7.2

Horizontal storage of heavyweight or mediumweight paper shall be protected as a closed array.

20.7.3

Lightweight paper or tissue paper shall be permitted to be protected as mediumweight paper where wrapped completely on the sides and both ends, or where wrapped on the sides only with steel bands, with the wrapping material being either a single layer of heavyweight paper with a basis weight of 40 lb (18 kg) or two layers of heavyweight paper with a basis weight of less than 40 lb (18 kg).

20.7.4

For purposes of sprinkler system design criteria, lightweight class paper shall be protected as tissue.

20.7.5

Mediumweight paper shall be permitted to be protected as heavyweight paper where wrapped completely on the sides and both ends, or where wrapped on the sides only with steel bands, with the wrapping material being either a single layer of heavyweight paper with a basis weight of 40 lb (18 kg) or two layers of heavyweight paper with a basis weight of less than 40 lb (18 kg).

20.8 * High Volume Low Speed (HVLS) Fans.

20.8.1

The installation of HVLS fans in buildings equipped with sprinklers, including ESFR sprinklers, shall comply with the following:

(1) The maximum fan diameter shall be 24 ft (7.3 m).
(2) The HVLS fan shall be centered approximately between four adjacent sprinklers.
(3) The vertical clearance from the HVLS fan to sprinkler deflector shall be a minimum of 36 in. (900 mm).
(4) All HVLS fans shall be interlocked to shut down immediately upon a waterflow alarm.

20.8.2

Where a building is protected with a fire alarm system, the interlock required by 20.8.1(4) shall be in accordance with the requirements of *NFPA 72* or other approved fire alarm code.

20.9 Building Construction and Storage: Heights and Clearance.

20.9.1 Sloped Ceilings.

Except as permitted by 20.9.1.1, the sprinkler system criteria specified in Chapters 20 through 26 shall apply to buildings with ceiling slopes not exceeding 2 in 12 (16.7 percent).

20.9.1.1 * Protection Options.

Where the ceiling slope is greater than 2 in 12 (16.7 percent), storage shall be permitted to be protected by any one of the following methods:

(1) Protect storage with in-rack sprinklers in accordance with one of the options in Section 25.7 provided that no storage is placed above the highest level of in-rack sprinklers.
(2) Install a horizontal false ceiling capable of withstanding an uplift force of 3 lb/ft^2 (15 kg/m^2) below the sloped ceiling supplemented with ceiling sprinklers below.
(3) Install sprinklers per guidance in Chapters 20 through 26, which permits a ceiling that exceeds 2 in 12.
(4) For obstructed construction where the ceiling slope does not exceed 4 in 12 and the storage is protected with CMDA sprinkler approach, install sprinklers in every channel.
(5) For unobstructed construction where the ceiling slope does not exceed 4 in 12, increase the design area of the ceiling sprinklers by 50 percent from the criteria in Chapters 20 through 26 unless that criteria is specifically for sloped ceilings.
(6) Use the sprinkler system criteria specified in Chapters 20 through 26 for obstructed construction where the ceiling slope does not exceed 4 in 12 and all of the following conditions are met:
    (a) Purlins or beams supporting the roof deck run across the roof slope.
    (b) Purlins or beams do exceed 18 in. (450 mm) deep.
    (c) Purlins do not exceed 5 ft (1.5 m) on center.
    (d) Bays created by the solid structural members are not more than 40 ft (12 m) on center.
    (e) Purlin or beam channels are provided with blocking above each solid structural member.

20.9.2 * Building Height.

20.9.2.1

The maximum building height shall be measured to the underside of the roof deck or ceiling in the storage area or in accordance with 20.9.2.4.1 through 20.9.2.4.2.

20.9.2.2

For corrugated metal deck roofs up to 3 in. (75 mm) in depth, the maximum roof height shall be measured from floor to the bottom of the deck.

20.9.2.3

For decks deeper than 3 in. (75 mm), the maximum roof height shall be measured to the highest point on the deck.

20.9.2.4

For ceilings that have insulation installed directly against underside of the ceiling or roof structure, the maximum roof height shall be measured to the bottom of insulation and shall be in accordance with 20.9.2.4.1 or 20.9.2.4.2.

20.9.2.4.1

For insulation that is installed directly against the ceiling or roof structure and is installed flat and parallel to the ceiling or roof structure, the maximum roof height shall be measured to the underside of the insulation.

20.9.2.4.2

For insulation that is installed in a manner that causes it to deflect or sag down from the ceiling or roof structure, the maximum roof height shall be measured as half of the distance of the deflection from the insulation high point to the insulation low point. If the deflection or sag in the insulation exceeds 6 in. (150 mm), the maximum roof height shall be measured to the high point of the insulation.

20.9.2.5 *

Where the building height changes within a compartment, the sprinklers directly over the storage shall be capable of protecting storage directly beneath.

20.9.2.5.1

Where a barrier to heat and smoke in accordance with 20.13.1(2) or 20.13.1(3) is not present, the sprinkler criteria 15 ft (4.6 m) into the perimeter of the lower ceiling area shall be the same as the sprinkler protection for the high ceiling area.

20.9.2.6

ESFR sprinklers shall be used only in buildings equal to, or less than, the height of the building for which they have been listed.

20.9.3 Storage Height.

20.9.3.1

The sprinkler system design shall be based on the storage height that routinely or periodically exists in the building and creates the greatest water demand.

20.9.3.2

The storage height shall be measured from the floor level to the top of the commodity.

20.9.3.3

Where storage is placed above doors, the storage height shall be calculated from the base of storage above the door.

20.9.4 Clearance to Ceiling.

20.9.4.1 *

The clearance to ceiling shall be measured in accordance with 20.9.4.1.1 through 20.9.4.1.3.

20.9.4.1.1

For corrugated metal deck roofs up to 3 in. (75 mm) in depth, the clearance to ceiling shall be measured from the top of storage to the bottom of the deck.

20.9.4.1.2

For corrugated metal deck roofs deeper than 3 in. (75 mm), the clearance to ceiling shall be measured to the highest point on the deck.

20.9.4.1.3

For ceilings that have insulation attached directly to underside of the ceiling or roof structure, the clearance to ceiling shall be measured from the top of storage to the bottom of the insulation and shall be in accordance with 20.9.4.1.3.1 or 20.9.4.1.3.2.

20.9.4.1.3.1

For insulation that is attached directly to the ceiling or roof structure and is installed flat and parallel to the ceiling or roof structure, the clearance to ceiling shall be measured from the top of storage to the underside of the insulation.

20.9.4.1.3.2

For insulation that is installed in a manner that causes it to deflect or sag down from the ceiling or roof structure, the clearance to ceiling shall be measured from the top of storage to a point half of the distance of the deflection from the insulation high point to the insulation low point. If the deflection or sag in the insulation exceeds 6 in. (150 mm), the clearance to ceiling shall be measured from the top of storage to the high point of the insulation.

20.9.5 Roof Vents and Draft Curtains.

See Section C.6.

20.9.5.1 *

Automatic roof vents shall not be required in areas protected by automatic sprinkler systems.

20.9.5.2

Where automatic roof vents are provided, the automatic roof vents shall have a higher temperature rating and a higher RTI than the automatic sprinklers.

20.9.5.3 *

Draft curtains shall not be used within ESFR sprinkler systems.

20.9.5.3.1

Draft curtains separating ESFR sprinklers at system breaks or from control mode sprinklers or between hazards shall be permitted. *(See 14.2.4.)*

20.9.5.3.2

Where ESFR sprinkler systems are installed adjacent to sprinkler systems with standard-response sprinklers, a draft curtain of noncombustible construction and at least 2 ft (600 mm) in depth shall be required to separate the two areas.

20.9.5.3.3

A clear aisle of at least 4 ft (1.2 m) centered below the draft curtain shall be maintained for separation.

20.9.6 Clearance from Deflector to Storage.

20.9.6.1

Unless the requirements of 20.9.6.2 through 20.9.6.4 are met, the clearance between the deflector and the top of storage or contents of the room shall be 18 in. (450 mm) or greater.

20.9.6.2

Greater clearance to storage minimums specified by other standards or sprinkler listings shall be followed.

20.9.6.3

A minimum clearance to storage of less than 18 in. (450 mm) between the top of storage and ceiling sprinkler deflectors shall be permitted where proven by successful large-scale fire tests for the particular hazard.

20.9.6.4

The clearance from the top of storage to sprinkler deflectors shall be not less than 36 in. (900 mm) where rubber tires are stored.

20.9.6.5

A minimum clearance to storage of 36 in. (900 mm) shall be provided for ESFR and CMSA sprinklers.

20.10 Unsprinklered Combustible Concealed Spaces.

20.10.1 *

When using the density/area method or room design method, unless the requirements of 20.10.2 are met for buildings having unsprinklered combustible concealed spaces as described in 9.2.1 and 9.3.18, the minimum area of sprinkler operation for that portion of the building shall be 3000 ft^2 (280 m^2).

20.10.1.1

The design area of 3000 ft^2 (280 m^2) shall be applied only to the sprinkler system or portions of the sprinkler system that are adjacent to the qualifying combustible concealed space.

20.10.1.2

The term *adjacent* shall apply to any sprinkler system protecting a space above, below, or next to the qualifying concealed space except where a barrier with a fire resistance rating at least equivalent to the water supply duration completely separates the concealed space from the sprinklered area.

20.10.2

The following unsprinklered combustible concealed spaces shall not require a minimum design area of sprinkler operation of 3000 ft^2 (280 m^2):

(1) Noncombustible and limited-combustible concealed spaces with minimal combustible loading having no access. The space shall be considered a concealed space even with small openings such as those used as return air for a plenum.
(2) Noncombustible and limited-combustible concealed spaces with limited access and not permitting occupancy or storage of combustibles. The space shall be considered a concealed space even with small openings such as those used as return air for a plenum.
(3) Combustible concealed spaces filled entirely with noncombustible insulation.
(4) Concealed spaces where rigid materials are used and the exposed surfaces comply with one of the following in the form in which they are installed in the space:

(a) The surface materials have a flame spread index of 25 or less and the materials have demonstrated that the flame front does not progress more than 10.5 ft (3.2 m) beyond the centerline of the burners at any time during the 30-minute test period, when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials,* or UL 723, *Test for Surface Burning Characteristics of Building Materials*, extended for an additional 20 minutes in the form in which they are installed in the space

(b) The surface materials comply with the requirements of ASTM E2768, *Standard Test Method for Extended Duration Surface Burning Characteristics of Building Materials (30 min Tunnel Test)*

(5) Concealed spaces in which the exposed materials are constructed entirely of fire-retardant-treated wood as defined by NFPA 703.

(6) Concealed spaces over isolated small compartments not exceeding 55 ft^2 (5.1 m^2) in area.

(7) Vertical pipe chases under 10 ft^2 (0.9 m^2), provided that in multifloor buildings the chases are constructed with blocking at each floor. Such pipe chases shall contain no sources of ignition, piping shall be noncombustible, and pipe penetrations at each floor shall be properly sealed.

(8) Exterior columns under 10 ft^2 (0.9 m^2) in area formed by studs or wood joists, supporting exterior canopies that are fully protected with a sprinkler system.

(9) Cavities within unsprinklered wall spaces.

20.11 Room Design Method.

20.11.1 *

The water supply requirements for sprinklers only shall be based upon the room that creates the greatest demand.

20.11.2

To utilize the room design method, all rooms shall be enclosed with walls having a fire resistance rating equal to the required water supply duration.

20.11.2.1

Minimum protection of openings shall include automatic- or self-closing doors with the appropriate fire protection rating for the enclosure.

20.11.3 *

Where the room design method is used, the density shall correspond to that required for the smallest area acceptable under the density/area method.

20.12 * High-Expansion Foam Systems.

20.12.1 General: High Expansion Foam Systems.

20.12.1.1

High-expansion foam systems that are installed in addition to automatic sprinklers shall be installed in accordance with NFPA 11.

20.12.1.2

High-expansion foam systems shall be automatic in operation.

20.12.1.3

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

20.12.1.4

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

20.12.1.5

The release system for the high expansion foam deluge system shall be designed to operate prior to the sprinklers installed in the area.

20.12.1.5.1

The maximum submergence time for the high-expansion foam shall be 5 minutes for Class I, Class II, or Class III commodities and 4 minutes for Class IV commodities.

20.12.2 High-Expansion Foam: Reduction in Ceiling Density.

20.12.2.1

Using CMDA sprinkler protection criteria for palletized, solid-piled, bin box, shelf, or back-to-back shelf storage of Class I through Class IV commodities, idle pallets, or plastics, where high-expansion foam systems are used in combination with ceiling sprinklers, a reduction in ceiling density to one-half that required for Class I through Class IV commodities, idle pallets, or plastics shall be permitted without revising the design area, but the density shall be no less than 0.15 gpm/ft^2 (6.1 mm/min).

20.12.2.2

Using CMDA sprinkler protection criteria for rack storage, where high-expansion foam systems are used in combination with ceiling sprinklers, the minimum ceiling sprinkler design density shall be 0.2 gpm/ft^2 (8.2 mm/min) for Class I, Class II, or Class III commodities or 0.25 gpm/ft^2 (10.2 mm/min) for Class IV commodities for the most hydraulically remote 2000 ft^2 (185 m^2) operating area.

20.12.2.3

Where high-expansion foam systems are used in combination with ceiling sprinklers, the maximum submergence time shall be 7 minutes for Class I, Class II, or Class III commodities and 5 minutes for Class IV commodities.

20.12.2.4

Where high-expansion foam systems are used for rack storage of Class I through IV commodities over 25 ft (7.6 m) high up to and including 35 ft (10.7 m) high, they shall be used in combination with ceiling sprinklers.

20.12.2.5 Reduced-Discharge Density.

Where high-expansion foam systems for rubber tire protection are installed in accordance with NFPA 11, a reduction in sprinkler discharge density to one-half the density specified in Table 21.7.1(a) or 0.24 gpm/ft^2 (9.8 mm/min), whichever is higher, shall be permitted.

20.12.2.6

In-rack sprinklers for the protection of Class I through IV commodities shall not be required where high-expansion foam systems are used in combination with ceiling sprinklers.

20.12.2.7 Detectors for High-Expansion Foam Systems.

20.12.2.7.1

Detectors shall be listed and shall be installed in one of the following configurations:

(1) At the ceiling only where installed at one-half the listed linear spacing [e.g., 15 ft × 15 ft (4.6 m × 4.6 m) rather than at 30 ft × 30 ft (9.1 m × 9.1 m)]; at the ceiling at the listed spacing and in racks at alternate levels
(2) Where listed for rack storage installation and installed in accordance with the listing to provide response within 1 minute after ignition using an ignition source that is equivalent to that used in a rack storage testing program

20.12.2.7.2

Ceiling detectors alone shall not be used where the clearance to ceiling exceeds 10 ft (3.0 m) or the height of the storage exceeds 25 ft (7.6 m).

20.12.2.7.3

Detectors for preaction systems shall be installed in accordance with 20.12.2.7.

20.13 * Adjacent Hazards or Design Methods.

20.13.1

For buildings with two or more adjacent hazards or design methods, the following shall apply:

(1) Where areas are not physically separated by a barrier or partition capable of delaying heat from a fire in one area from fusing sprinklers in the adjacent area, the required sprinkler protection for the more demanding design basis shall extend 15 ft (4.6 m) beyond its perimeter.
(2) The requirements of 20.13.1(1) shall not apply where the areas are separated by a draft curtain or barrier located above an aisle, horizontally a minimum of 24 in. (600 mm) from the adjacent hazard on each side, or a partition that is capable of delaying heat from a fire in one area from fusing sprinklers in the adjacent area.
(3) The requirements of 20.13.1(1) shall not apply to the extension of more demanding criteria from an upper ceiling level to beneath a lower ceiling level where the difference in height between the ceiling levels is at least 24 in. (600 mm), located above an aisle, horizontally a minimum 24 in. (600 mm) from the adjacent hazard on each side.

20.14 * Hose Connections.

20.14.1 Small [1 1/2 in. (40 mm)] Hose Connections.

See Section C.5.

20.14.1.1 Hose Connection.

Small hose connections [1 1/2 in. (40 mm)] shall be provided where required by the authority having jurisdiction in accordance with Section 16.15 for first-aid, firefighting, and overhaul operations.

20.14.1.2

Small hose connections shall not be required for the protection of Class I, II, III, and IV commodities stored 12 ft (3.7 m) or less in height.

20.15 Hose Stream Allowance and Water Supply Duration. *(See Section C.8.)*

20.15.1

Hose stream allowance and water supply duration for Chapters 20 through 25 shall be in accordance with Section 20.15.

20.15.2 Hose Stream Allowance and Water Supply Duration.

20.15.2.1 *

Tanks shall be sized to supply the equipment that they serve.

20.15.2.2 *

Pumps shall be sized to supply the equipment that they serve.

20.15.2.3

Water allowance for outside hose shall be added to the sprinkler requirement at the connection to the city main or a yard hydrant, whichever is closer to the system riser.

20.15.2.4

Where inside hose connections are planned or are required, the following shall apply:

(1) A total water allowance of 50 gpm (190 L/min) for a single hose connection installation shall be added to the sprinkler requirements.
(2) A total water allowance of 100 gpm (380 L/min) for a multiple hose connection installation shall be added to the sprinkler requirements.
(3) The water allowance shall be added in 50 gpm (190 L/min) increments beginning at the most remote hose connection, with each increment added at the pressure required by the sprinkler system design at that point.

20.15.2.5

When hose valves for fire department use are attached to wet pipe sprinkler system risers in accordance with 16.15.2, the following shall apply:

(1) The water supply shall not be required to be added to standpipe demand as determined from NFPA 14.
(2) Where the combined sprinkler system demand and hose stream allowance of Chapters 20 through 25 exceeds the requirements of NFPA 14, this higher demand shall be used.
(3) For partially sprinklered buildings, the sprinkler demand, not including hose stream allowance, as indicated in Chapters 20 through 25 shall be added to the requirements given in NFPA 14.

20.15.2.6

Unless indicated otherwise, the minimum water supply requirements for a hydraulically designed sprinkler system shall be determined by adding the hose stream allowance from Table 20.15.2.6 to the water demand for sprinklers.

Table 20.15.2.6 Hose Stream Allowance and Water Supply Duration

Commodity	Sprinkler Type	Sprinkler Spacing Type	Number of Ceiling Sprinklers in Design Area[a]	Size of Design Area at Ceiling	Hose Stream Allowance		Water Supply Duration (minutes)
					gpm	L/min	
Class I–IV commodities, Group A plastics, idle wood pallets, and idle plastic pallets	Control mode density/area (CMDA)	Standard and extended-coverage	NA	Up to 1200 ft^2 (112 m^2)	250	950	60
				Over 1200 ft^2 (112 m^2) up to 1500 ft^2 (140 m^2)	500	1900	90
				Over 1500 ft^2 (140 m^2) up to 2600 ft^2 (240 m^2)	500	1900	120
				Over 2600 ft^2 (240 m^2)	500	1900	150
	Control mode specific application (CMSA)	Standard	Up to 12	NA	250	950	60
			Over 12 to 15	NA	500	1900	90
			Over 15 to 25	NA	500	1900	120
			Over 25	NA	500	1900	150
		Extended-coverage	Up to 6	NA	250	950	60
			Up to 8[b]	NA	250	950	60
			Over 6 to 8	NA	500	1900	90
			Over 8 to 12	NA	500	1900	120
			Over 12	NA	500	1900	150
	Early suppression fast response (ESFR)	Standard	Up to 12	NA	250	950	60
			Over 12 to 15	NA	500	1900	90
			Over 15 to 25	NA	500	1900	120
			Over 25	NA	500	1900	150
On-floor rubber tire storage up to 5 ft (1.5 m) in height	CMDA & CMSA	Standard and extended-coverage	Any	Any	250	950	120
Rubber tire storage	CMDA	Standard and extended-coverage	NA	Up to 5000 ft^2 (465 m^2)	750	2850	180
	CMSA	Standard	Up to 15	NA	500	1900	180
	ESFR	Standard	Up to 12	NA	250	950	60
			Over 12 to 20	NA	500	1900	120[c]
Roll paper	CMDA	Standard	NA	Up to 4000 ft^2 (370 m^2)	500	1900	120
	CMSA	Standard	Up to 25	NA	500	1900	120
	ESFR	Standard	Up to 12	NA	250	950	60
Alternative protection in accordance with Section 25.7	NA	NA	NA	NA	250	950	60

NA: Not applicable.

[a]For CMSA and ESFR sprinklers, the additional sprinklers included in the design area for obstructions do not need to be considered in determining the total number of sprinklers in this column.

[b]Limited to a maximum of 144 ft^2 (13 m^2) per sprinkler.

[c]For storage on-tread, on-side, and laced tires in open portable steel racks or palletized portable racks, with pile height up to 25 ft (7.6 m) and building height up to 30 ft (9.1 m) with K-14.0 (K-200) or K-16.8 (K-240) ESFR sprinklers, the water supply duration is 180 minutes.

20.15.2.7

For the protection of baled cotton, the total water supply available shall be sufficient to provide the recommended sprinkler discharge density over the area to be protected, plus a minimum of 500 gpm (1900 L/min) for hose streams.

20.15.2.7.1

Water supplies shall be capable of supplying the total demand for sprinklers and hose streams for not less than 2 hours.

20.15.2.8

For roll paper storage, the water supply design shall include the demand of the automatic sprinkler system plus the hose stream allowance plus, where provided, the high-expansion foam system for the duration specified in Table 20.15.2.6.

20.15.2.9

For the protection of rubber tires, the total water supply available shall be capable of providing flow sufficient for the recommended sprinkler discharge density over the protected area, hose streams, and foam systems (if provided) for the duration required in Table 20.15.2.6.

20.15.3

The minimum water supply requirements shall be determined by adding the hose stream allowance from 20.15.2 to the water supply for sprinklers as determined by Chapters 20 through 25.

20.15.4

The minimum water supply requirements determined from 20.15.3 shall be available for the minimum duration specified in 20.15.2.

20.15.5

Total system water supply requirements shall be determined in accordance with the hydraulic calculation procedures of Chapter 28.

20.16 Discharge Considerations: General.

20.16.1 Multiple Adjustments.

20.16.1.1

Where multiple adjustments to the area of operation are required to be made, these adjustments shall be compounded based on the area of operation originally selected.

20.16.1.2

If the building has unsprinklered combustible concealed spaces, the rules of Section 20.10 shall be applied after all other modifications have been made.

20.16.2 * Wet Pipe Systems.

20.16.2.1

Sprinkler systems shall be wet pipe systems.

20.16.2.2 *

In areas that are subject to freezing or where special conditions exist, dry pipe systems and preaction systems shall be permitted to protect storage occupancies.

20.16.3 Dry Pipe and Preaction Systems.

For dry pipe systems and preaction systems using control mode density/area (CMDA) criteria, the area of sprinkler operation shall be increased by 30 percent without revising the density.

20.16.4 Design Approaches for Supplemental Sprinklers.

When required to be included in the hydraulic calculations in accordance with 28.2.4.7.4.3, the design approach for supplemental sprinklers shall be permitted to be based on the hazard located directly below the obstruction utilizing the bottom plane of the obstruction as the ceiling level.

20.17 * Protection of Idle Pallets.

20.17.1 Wood Pallets.

20.17.1.1 *

Wood pallets shall be permitted to be stored in the following arrangements:

(1) Stored outside
(2) Stored in a detached structure
(3) Stored indoors where arranged and protected in accordance with 20.17.1.2

20.17.1.2

Wood pallets, where stored indoors, shall be protected in accordance with one of the following:

(1) Control mode density/area sprinkler protection as specified in Table 20.17.1.2(a)
(2) CMSA sprinkler protection in accordance with Table 20.17.1.2(b)
(3) ESFR sprinkler protection in accordance with Table 20.17.1.2(c)
(4) Control mode density/area sprinkler protection in accordance with Ordinary Hazard Group 2 and Table 19.2.3.1.1 with a hose stream demand of at least 250 gpm (950 L/min) for a duration of at least 60 minutes when pallets are stored no higher than 6 ft (1.8 m) and each pile of no more than four stacks is separated from other pallet piles by at least 8 ft (2.4 m) of clear space or 25 ft (7.6 m) of commodity

Table 20.17.1.2(a) Control Mode Density/Area Sprinkler Protection for Indoor Storage of Idle Wood Pallets

Type of Sprinkler	Location of Storage	Nominal K-Factor	Maximum Storage Height		Maximum Ceiling/Roof Height		Sprinkler Density		Areas of Operation	
			ft	m	ft	m	gpm/ft^2	mm/min	ft^2	m^2
Control mode density/area	On floor	8 (115) or larger	Up to 6	Up to 1.8	20	6.1	0.20	8.2	3000*	280*
	On floor	11.2 (160) or larger	Up to 8	Up to 2.4	30	9.1	0.45	18.3	2500	230
	On floor or rack without solid shelves	11.2 (160) or larger	8 to 12	2.4 to 3.7	30	9.1	0.6	24.5	3500	325
			12 to 20	3.7 to 6.1	30	9.1	0.6	24.5	4500	420
	On floor	16.8 (240) or larger	Up to 20	Up to 6.1	30	9.1	0.6	24.5	2000	185

*The area of sprinkler operation should be permitted to be reduced to 2000 ft^2 (185 m^2) when sprinklers having a nominal K-factor of 11.2 (160) or larger are used or if high-temperature-rated sprinklers with a nominal K-factor of 8.0 (115) are used.

Table 20.17.1.2(b) CMSA Sprinkler Protection for Indoor Storage of Idle Wood Pallets

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
On floor	Idle wood pallets	20	6.1	30	9.1	11.2 (160) Upright	Wet	15	25	1.7
							Dry	25	25	1.7
						16.8 (240) Upright	Wet	15	15	1.0
							Dry	25	15	1.0
						19.6 (280) Pendent	Wet	15	16	1.1
				35	10.7	19.6 (280) Pendent	Wet	15	25	1.7
				40	12.2	19.6 (280) Pendent	Wet	15	30	2.1

Table 20.17.1.2(c) ESFR Sprinkler Protection for Indoor Storage of Idle Wood Pallets

Type of Sprinkler (Orientation)	Location of Storage	Nominal K-Factor	Maximum Storage Height		Maximum Ceiling/ Roof Height		Minimum Operating Pressure	
			ft	m	ft	m	psi	bar
ESFR (pendent)	On floor or rack without solid shelves	14.0 (200)	25	7.6	30	9.1	50	3.4
			25	7.6	32	9.8	60	4.1
		16.8 (240)	25	7.6	30	9.1	35	2.4
			25	7.6	32	9.8	42	2.9
			35	10.7	40	12.2	52	3.6
		22.4 (320)	25	7.6	30	9.1	25	1.7
			30	9.1	35	10.7	35	2.4
			35	10.7	40	12.2	40	2.8
		25.2 (360)	25	7.6	30	9.1	15	1.0
			30	9.1	35	10.7	20	1.4
			35	10.7	40	12.2	25	1.7
ESFR (upright)	On floor	14.0 (200)	20	6.1	30	9.1	50	3.4
			20	6.1	35	10.7	75	5.2
		16.8 (240)	20	6.1	30	9.1	35	2.4
			20	6.1	35	10.7	52	3.6

20.17.1.2.1

The maximum clearance to ceiling of 20 ft (6.1 m) specified in 20.9.4 shall not apply to arrangement 20.17.1.2(4).

20.17.1.3

Idle wood pallets shall not be stored in racks unless they are protected in accordance with the appropriate requirements of Table 20.17.1.2(a) or Table 20.17.1.2(c). *(See Section C.7.)*

20.17.1.4

Idle wood pallets shall be permitted to be stored in racks when protected in accordance with Section 25.7 using the criteria for exposed expanded plastic commodity hazard.

20.17.2 Plastic Pallets.

20.17.2.1

Plastic pallets shall be permitted to be stored in the following manner:

(1) Plastic pallets shall be permitted to be stored outside.
(2) Plastic pallets shall be permitted to be stored in a detached structure.
(3) Plastic pallets shall be permitted to be stored indoors where arranged and protected in accordance with the requirements of 20.17.2.2.

20.17.2.2 Protection Criteria for Plastic Pallets Stored Indoors.

20.17.2.2.1

Plastic pallets having a demonstrated fire hazard that is equal to or less than idle wood pallets and is listed for such equivalency shall be permitted to be protected in accordance with 20.17.1.

20.17.2.2.2

When specific test data are available, the data shall take precedence in determining the required protection of idle plastic pallets.

20.17.2.2.3

Protection with ESFR sprinklers shall be in accordance with the requirements of Table 20.17.2.2.3.

Table 20.17.2.2.3 ESFR Pendent Sprinkler Protection for Indoor Storage of Idle Plastic Pallets on Floor or Open Frame Racks

Maximum Ceiling Height		Minimum Operating Pressure [psi (bar)]			
ft	m	K14 (200)	K168 (240)	K22.4 (320)	K25.2 (360)
30	9.1	50 (3.4)	35 (2.4)	35 (2.4)	35 (2.4)
40	12.2	Racked options available, but in-rack sprinklers required.*		75 (5.2)	60 (4.1)
>40	>12.2			Racked options available, but in-rack sprinklers required.*	

*See Chapter 25 for exposed nonexpanded Group A plastic commodities.

20.17.2.2.4

Protection with spray sprinklers shall be in accordance with one of the scenarios in 20.17.2.2.4.1 through 20.17.2.2.4.3.

20.17.2.2.4.1

Where plastic pallets are stored in dedicated rooms, the following shall apply:

(1) The 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 0.6 gpm/ft^2 (24.5 mm/min) for the entire room or by high-expansion foam and sprinklers designed to deliver 0.3 gpm/ft^2 (12.2 mm/min) for the entire room.
(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. Flow from these sprinklers shall be permitted to be omitted from the sprinkler system demand for hydraulic calculations.

20.17.2.2.4.2

Where plastic pallets are not separated from other storage, the following shall apply:

(1) Maximum storage height of 10 ft (3.0 m)
(2) Maximum ceiling height of 30 ft (9.1 m)
(3) Sprinkler density 0.6 gpm/ft^2 over 2000 ft^2 (24.5 mm/min over 185 m^2)
(4) Minimum sprinkler K-factor of 16.8 (240)

20.17.2.2.4.3

Plastic pallets shall have no impact on the required sprinkler protection when stored as follows:

(1) 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) Minimum ceiling design of OH2 shall be used.

20.17.2.3

Idle plastic pallets shall be stored only in racks where protected in accordance with the requirements of Table 20.17.2.2.3.

20.17.2.3.1

When specific test data and a product listing are available, the data shall take precedence in determining the required protection of idle plastic pallets stored in racks.

20.17.3 Idle Pallets Stored on Racks, on Shelves, and Above Doors.

20.17.3.1

Idle pallets shall not be stored on racks or shelves, except where permitted in 20.17.1.3, 20.17.2.3, 20.17.3.2, and 20.17.3.4.

20.17.3.2

Idle pallets shall be permitted to be stored on the lowest level of storage only where no storage or shelves are located above the stored pallets and the applicable protection criteria referenced for on-floor storage in Section 20.17 are applied.

20.17.3.3

Where idle pallet storage is above a door, the idle pallet storage height and ceiling height shall be calculated from the base of storage above the door using the applicable protection criteria referenced in Section 20.17.

20.17.3.4

Idle pallets shall be permitted to be stored in racks when protected in accordance with Section 25.7 using criteria for exposed nonexpanded plastic commodity hazard.

20.18 Column Protection: Rack Storage and Rubber Tire Storage.

20.18.1 *

Where fireproofing of building columns is not provided and storage heights are in excess of 15 ft (4.6 m), protection of building columns located wholly or partially within the rack footprint inclusive of flue spaces or within 12 in. (300 mm) of the footprint shall be protected in accordance with one of the following *(see Section C.10)*:

(1) In-rack sprinklers
(2) Sidewall sprinklers at the 15 ft (4.6 m) elevation, pointed toward one side of the steel column
(3) Provision of ceiling sprinkler density for a minimum of 2000 ft^2 (185 m^2) with ordinary-temperature-rated [165°F (74°C)] or high-temperature-rated [286°F (140°C)] sprinklers as shown in Table 20.18.1 for storage heights above 15 ft (4.6 m), up to and including 20 ft (6.1 m)
(4) Provision of CMSA or ESFR ceiling sprinkler protection

Table 20.18.1 Ceiling Sprinkler Densities for Protection of Steel Building Columns

	Aisle Width			
	4 ft (1.2 m)		8 ft (2.4 m)	
Commodity Classification	gpm/ft^2	mm/min	gpm/ft^2	mm/min
Class I	0.37	15.1	0.33	13.4
Class II	0.44	17.9	0.37	15.1
Class III	0.49	20.0	0.42	17.1

	Aisle Width			
	4 ft (1.2 m)		8 ft (2.4 m)	
Commodity Classification	gpm/ft^2	mm/min	gpm/ft^2	mm/min
Class IV and Group A plastics	0.68	27.7	0.57	23.2

20.18.1.1

Where storage heights are in excess of 15 ft (4.6 m) and vertical rack members support the building structure, the vertical rack members shall be protected in accordance with 20.18.1.

20.18.1.2

The flow from a column sprinkler(s) shall be permitted to be omitted from the sprinkler system hydraulic calculations.

20.18.2 Columns Within Rubber Tire Storage.

20.18.2.1

Where fireproofing is not provided, steel columns shall be protected as follows:

(1) Storage exceeding 15 ft through 20 ft (4.6 m through 6.1 m) in height — one sidewall sprinkler directed to one side of the column at a 15 ft (4.6 m) level
(2) Storage exceeding 20 ft (6.1 m) in height — two sidewall sprinklers, one at the top of the column and the other at a 15 ft (4.6 m) level, both directed to the side of the column

20.18.2.2

The flow from a column sprinkler(s) shall be permitted to be omitted from the sprinkler system hydraulic calculations.

20.18.2.3

The protection specified in 20.18.2.1(1) and 20.18.2.1(2) shall not be required where storage in fixed racks is protected by in-rack sprinklers.

20.18.2.4

The protection specified in 20.18.2.1 shall not be required where ESFR or CMSA sprinkler systems that are approved for rubber tire storage are installed.

20.18.2.5

The rate of water supply shall be sufficient to provide the required sprinkler discharge density over the required area of application plus provision for generation of high-expansion foam and in-rack sprinklers where used.

20.19 Protection of Racks with Solid Shelves.

20.19.1

Racks containing solid shelves shall comply with Section 25.3.

20.19.2

Solid shelving requirements shall not apply to a noncombustible product stored with noncombustible storage aids, including pallets, straps, containers, and shelving material.