**Chapter 23 ESFR Requirements for Storage Applications**

23.1 General

The criteria in Chapter 20 shall apply to storage protected with ESFR sprinklers.

23.1.1

ESFR sprinklers designed to meet any criteria in this chapter shall be permitted to protect any of the following:

Light hazard occupancies

Ordinary hazard occupancies

Any storage arrangement OH1, OH2, EH1, and EH2 design criteria

23.1.2 Draft Curtains

23.1.2.1

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.

23.1.2.2

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

23.1.3

ESFR sprinkler systems shall be designed such that the minimum operating pressure is not less than that indicated in Table 23.3.1 for commodity, storage height, and building height involved.

23.1.4

The ceiling design criteria for single-, double-, and multiple-row racks in Chapter 23 shall be based on open-rack configurations as defined in 3.3.140.

23.1.4.1

ESFR sprinklers shall not be permitted to protect storage on solid shelf racks unless the solid shelf racks are protected with in-rack sprinklers in accordance with Chapter 25.

23.1.4.2

ESFR sprinklers shall not be permitted to protect storage with open-top containers.

23.1.4.3

ESFR sprinkler shall be designed such that the minimum operating pressure is not less than that indicated in this chapter for type of storage, commodity, storage height, and building height involved.

23.2 ESFR Design Criteria

ESFR design criteria shall be selected from Section 23.3 through Section 23.13.

23.3 Early Suppression Fast-Response (ESFR) Sprinklers for Palletized or Solid-Piled Storage of Class I Through Class IV Commodities

23.3.1

Protection of palletized and solid-piled storage of Class I through Class IV commodities shall be in accordance with Table 23.3.1.

Table 23.3.1 ESFR Protection of Palletized and Solid-Piled Storage of Class I Through Class IV Commodities

Commodity Maximum Storage Height Maximum Ceiling/Roof Height Nominal K-Factor Orientation Minimum Operating Pressure

ft m ft m psi bar

Class I, II, III, or IV, encapsulated and nonencapsulated (no open-top containers) 20 6.1 25 7.6 14.0 (200) Upright/pendent 50 3.4

16.8 (240) Upright/pendent 35 2.4

22.4 (320) Pendent 25 1.7

25.2 (360) Pendent 15 1.0

25 7.6 30 9.1 14.0 (200) Upright/pendent 50 3.4

16.8 (240) Upright/pendent 35 2.4

22.4 (320) Pendent 25 1.7

25.2 (360) Pendent 15 1.0

32 10 14.0 (200) Upright/pendent 60 4.1

16.8 (240) Upright/pendent 42 2.9

30 9.1 35 11 14.0 (200) Upright/pendent 75 5.2

16.8 (240) Upright/pendent 52 3.6

22.4 (320) Pendent 35 2.4

25.2 (360) Pendent 20 1.4

35 11 40 12 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 25 1.7

35 11 45 14 22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 40 2.7

40 12 45 14 22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 40 2.7

23.4 Early Suppression Fast-Response (ESFR) Sprinklers for Palletized or Solid-Piled Storage of Group A Plastic Commodities

23.4.1\* Storage Conditions

The design of the sprinkler system shall be based on those conditions that routinely or periodically exist in a building and create the greatest water demand, which include the following:

Pile height

Clearance to ceiling

Pile stability

Array

23.4.2

Protection of palletized and solid-piled storage of cartoned or exposed nonexpanded plastic and cartoned expanded or exposed expanded plastic shall be in accordance with Table 23.4.2.

Table 23.4.2 ESFR Protection of Palletized and Solid-Piled Storage of Group A Plastic Commodities

Storage Arrangement Commodity Maximum Storage Height Maximum Ceiling/Roof Height Nominal K-Factor Orientation Minimum Operating Pressure

ft m ft m psi bar

Palletized and solid-piled storage (no open-top containers) Cartoned nonexpanded plastic 20 6.1 25 7.6 14.0 (200) Upright/pendent 50 3.4

16.8 (240) Upright/pendent 35 2.4

22.4 (320) Pendent 25 1.7

25.2 (360) Pendent 15 1.0

30 9.1 14.0 (200) Upright/pendent 50 3.4

16.8 (240) Upright/pendent 35 2.4

22.4 (320) Pendent 25 1.7

25.2 (360) Pendent 15 1.0

35 11 14.0 (200) Upright/pendent 75 5.2

16.8 (240) Upright/pendent 52 3.6

22.4 (320) Pendent 35 2.4

25.2 (360) Pendent 20 1.4

40 12 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 25 1.7

45 14 22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 40 2.7

25 7.6 30 9.1 14.0 (200) Upright/pendent 50 3.4

16.8 (240) Upright/pendent 35 2.4

22.4 (320) Pendent 25 1.7

25.2 (360) Pendent 15 1.0

32 10 14.0 (200) Upright/pendent 60 4.1

16.8 (240) Upright/pendent 42 2.9

35 11 14.0 (200) Upright or pendent 75 5.2

16.8 (240) Upright/pendent 52 3.6

22.4 (320) Pendent 35 2.4

25.2 (360) Pendent 20 1.4

40 12 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 25 1.7

45 14 22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 40 2.7

30 9.1 35 11 14.0 (200) Upright/pendent 75 5.2

16.8 (240) Upright/pendent 52 3.6

22.4 (320) Pendent 35 2.4

25.2 (360) Pendent 20 1.4

40 12 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 25 1.7

45 14 22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 40 2.7

35 10.7 40 12 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 25 1.7

45 14 22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 40 2.7

40 12.2 45 14 22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 40 2.7

Exposed nonexpanded plastic 20 6.1 25 7.6 14.0 (200) Pendent 50 3.4

16.8 (240) Pendent 35 2.4

30 9.1 14.0 (200) Pendent 50 3.4

16.8 (240) Pendent 35 2.4

35 11 14.0 (200) Pendent 75 5.2

16.8 (240) Pendent 52 3.6

40 12 16.8 (240) Pendent 52 3.6

25 7.6 30 9.1 14.0 (200) Pendent 50 3.4

16.8 (240) Pendent 35 2.4

32 9.7 14.0 (200) Pendent 60 4.1

16.8 (240) Pendent 42 2.9

35 11 14.0 (200) Pendent 75 5.2

16.8 (240) Pendent 52 3.6

40 12 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 50 3.4

25.2 (360) Pendent 50 3.4

30 9.1 35 11 14.0 (200) Pendent 75 5.2

16.8 (240) Pendent 52 3.6

40 12 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 50 3.4

25.2 (360) Pendent 50 3.4

35 11 40 12 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 50 3.4

25.2 (360) Pendent 50 3.4

Cartoned expanded plastic 20 6.1 25 7.6 14.0 (200) Upright/pendent 50 3.4

16.8 (240) Upright/pendent 35 2.4

30 9.1 14.0 (200) Upright/pendent 50 3.4

16.8 (240) Upright/pendent 35 2.4

25 7.6 30 9.1 14.0 (200) Upright/pendent 50 3.4

16.8 (240) Upright/pendent 35 2.4

32 10 14.0 (200) Pendent 60 4.1

16.8 (240) Upright/pendent 42 2.9

Exposed\* expanded plastic 25 7.6 40 12 25.2 (360) Pendent 60 4.1

\*Applies to closed array storage only.

23.5 Early Suppression Fast-Response (ESFR) Sprinklers for Rack Storage of Class I Through Class IV Commodities

23.5.1

Protection of single-, double-, and multiple-row rack storage of Class I through Class IV commodities shall be in accordance with Table 23.5.1.

Table 23.5.1 ESFR Sprinkler Protection of Rack Storage of Class I Through Class IV Commodities

Storage Arrangement Commodity Maximum Storage Height Maximum Ceiling/Roof Height Nominal K-Factor Orientation Minimum Operating Pressure

ft m ft m psi bar

Single-row, double-row, and multiple-row racks (no open-top containers) Class I, II, III, or IV, encapsulated or nonencapsultated 20 6.1 25 7.6 14 (200) Upright/pendent 50 3.4

16.8 (240) Upright/pendent 35 2.4

22.4 (320) Pendent 25 1.7

25.2 (360) Pendent 15 1

30 9.1 14 (200) Upright/pendent 50 3.4

16.8 (240) Upright/pendent 35 2.4

22.4 (320) Pendent 25 1.7

25.2 (360) Pendent 15 1

35 11 14 (200) Upright/pendent 75 5.2

16.8 (240) Upright/pendent 52 3.6

22.4 (320) Pendent 35 2.4

25.2 (360) Pendent 20 1.4

40 12 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 40 2.8

25.2 (360) Pendent 25 1.7

45 14 14 (200) Pendent\* NA NA

16.8 (240) Pendent\* NA NA

22.4 (320) Pendent 40 2.8

25.2 (360) Pendent 40 2.8

25 7.6 30 9.1 14 (200) Upright/pendent 50 3.4

16.8 (240) Upright/pendent 35 2.4

22.4 (320) Pendent. 25 1.7

25.2 (360) Pendent 15 1.0

32 10 14 (200) Upright/pendent 60 4.1

16.8 (240) Upright/pendent 42 2.9

35 11 14 (200) Upright/pendent 75 5.2

16.8 (240) Upright/pendent 52 3.6

22.4 (320) Pendent 35 2.4

25.2 (360) Pendent 20 1.4

40 12 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 40 2.8

25.2 (360) Pendent 25 1.7

45 14 14 (200) Pendent\* NA NA

16.8 (240) Pendent\* NA NA

22.4 (320) Pendent 40 2.8

25.2 (360) Pendent 40 2.8

30 9.1 35 11 14 (200) Upright/pendent 75 5.2

16.8 (240) Upright/pendent 52 3.6

22.4 (320) Pendent 35 2.4

25.2 (360) Pendent 20 1.4

40 12 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 40 2.8

25.2 (360) Pendent 25 1.7

45 14 14 (200) Pendent\* NA NA

16.8 (240) Pendent\* NA NA

22.4 (320) Pendent 40 2.8

25.2 (360) Pendent 40 2.8

35 10.7 40 12 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 40 2.8

25.2 (360) Pendent 25 1.7

45 14 14 (200) Pendent\* NA NA

16.8 (240) Pendent\* NA NA

22.4 (320) Pendent 40 2.8

25.2 (360) Pendent 40 2.8

40 12 45 14 16.8 (240) Pendent\* NA NA

22.4 (320) Pendent 40 2.8

25.2 (360) Pendent 40 2.8

\*In-rack sprinklers required. See Chapter 25.

NA: Not applicable.

23.6 Early Suppression Fast-Response (ESFR) Sprinklers for Rack Storage of Group A Plastic Commodities

23.6.1

Protection of single-, double-, and multiple-row rack storage of cartoned or exposed nonexpanded Group A plastic and cartoned expanded Group A plastic shall be in accordance with Table 23.6.1.

Table 23.6.1 ESFR Protection of Rack Storage of Group A Plastic Commodities

Storage Arrangement Commodity Maximum Storage Height Maximum Ceiling/Roof Height Nominal K-Factor Orientation Minimum Operating Pressure

ft m ft m psi bar

Single-, double-, and multiple-row racks (no open-top containers) Cartoned nonexpanded 20 6.1 25 7.6 14 (200) Upright/pendent 50 3.4

16.8 (240) Upright/pendent 35 2.4

22.4 (320) Pendent 25 1.7

25.2 (360) Pendent 15 1

30 9.1 14 (200) Upright/pendent 50 3.4

16.8 (240) Upright/pendent 35 2.4

22.4 (320) Pendent 25 1.7

25.2 (360) Pendent 15 1

35 11 14 (200) Upright/pendent 75 5.2

16.8 (240) Upright/pendent 52 3.6

22.4 (320) Pendent 35 2.4

25.2 (360) Pendent 20 1.4

40 12 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 25 1.7

45 14 14 (200) Pendent\* NA NA

16.8 (240) Pendent\* NA NA

22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 40 2.7

25 7.6 30 9.1 14 (200) Upright/pendent 50 3.4

16.8 (240) Upright/pendent 35 2.4

22.4 (320) Pendent 25 1.7

25.2 (360) Pendent 15 1

32 10 14 (200) Upright/pendent 60 4.1

16.8 (240) Upright/pendent 42 2.9

35 11 14 (200) Upright/pendent 75 5.2

16.8 (240) Upright/pendent 52 3.6

22.4 (320) Pendent 35 2.4

25.2 (360) Pendent 20 1.4

40 12 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 25 1.7

45 14 14 (200) Pendent\* NA NA

16.8 (240) Pendent\* NA NA

22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 40 2.7

30 9.1 35 11 14 (200) Upright/pendent 75 5.2

16.8 (240) Upright/pendent 52 3.6

22.4 (320) Pendent 35 2.4

25.2 (360) Pendent 20 1.4

40 12 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 25 1.7

45 14 14 (200) Pendent\* NA NA

16.8 (240) Pendent\* NA NA

22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 40 2.7

35 11 40 12 16.8 (240) Pendent 52 3.6

25.2 (360) Pendent 25 1.7

45 14 14 (200) Pendent\* NA NA

16.8 (240) Pendent\* NA NA

22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 40 2.7

40 12 45 14 14 (200) Pendent\* NA NA

16.8 (240) Pendent\* NA NA

22.4 (320) Pendent 40 2.7

25.2 (360) Pendent 40 2.7

Cartoned expanded 20 6.1 25 7.6 14 (200) Upright/pendent 50 3.4

16.8 (240) Upright/pendent 35 2.4

30 9.1 14 (200) Upright/pendent 50 3.4

16.8 (240) Upright/pendent 35 2.4

25 7.6 30 9.1 14 (200) Upright/pendent 50 3.4

16.8 (240) Upright/pendent 35 2.4

32 10 14 (200) Pendent 60 4.1

16.8 (240) Upright/pendent 42 2.9

Exposed nonexpanded 20 6.1 25 7.6 14 (200) Pendent 50 3.4

16.8 (240) Pendent 35 2.4

30 9.1 14 (200) Pendent 50 3.4

16.8 (240) Pendent 35 2.4

35 11 14 (200) Pendent 75 5.2

16.8 (240) Pendent 52 3.6

40 12 16.8 (240) Pendent 52 3.6

45 14 14 (200) Pendent\* NA NA

16.8 (240) Pendent\* NA NA

25 7.6 30 9.1 14 (200) Pendent 50 3.4

16.8 (240) Pendent 35 2.4

32 10 14 (200) Pendent 60 4.1

16.8 (240) Pendent 42 2.9

35 11 14 (200) Pendent 75 5.2

16.8 (240) Pendent 52 3.6

40 12 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 50 3.4

25.2 (360) Pendent 50 3.4

45 14 14 (200) Pendent\* NA NA

16.8 (240) Pendent\* NA NA

30 9.1 35 10.7 14 (200) Pendent 75 5.2

16.8 (240) Pendent 52 3.6

40 11 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 50 3.4

25.2 (360) Pendent 50 3.4

45 12 14 (200) Pendent\* NA NA

16.8 (240) Pendent\* NA NA

35 11 40 12 16.8 (240) Pendent 52 3.6

22.4 (320) Pendent 50 3.4

25.2 (360) Pendent 50 3.4

45 14 14 (200) Pendent\* NA NA

16.8 (240) Pendent\* NA NA

40 12 45 14 14 (200) Pendent\* NA NA

16.8 (240) Pendent\* NA NA

\*In-rack sprinklers required. See Chapter 25.

NA: Not applicable.

23.6.1.1

ESFR protection as defined shall not apply to the following:

Rack storage involving solid shelves, except as permitted by 23.6.1.2

Rack storage involving open-top cartons or containers

23.6.1.2

ESFR sprinklers shall not be permitted to protect storage on solid shelf racks unless the solid shelf racks are protected with in-rack sprinklers in accordance with Section 25.6.

23.6.2

ESFR sprinkler systems shall be designed such that the minimum operating pressure is not less than that indicated in Table 23.6.1 for type of storage, commodity, storage height, and building height involved.

23.6.3

The design area shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of three branch lines.

23.7\* Protection of Exposed Expanded Group A Plastics

23.7.1

Protection of single-, double-, and multiple-row rack storage of exposed expanded Group A plastics shall be permitted to be in accordance with 23.7.2 through 23.7.8.

23.7.2

The maximum storage height shall be 35 ft (11 m).

23.7.3

The maximum ceiling height shall be 40 ft (12 m).

23.7.4

Sprinklers shall be intermediate temperature-rated ESFR pendent sprinklers with a nominal K-factor of K-25.2 (360).

23.7.4.1

The maximum sprinkler deflector distance below the ceiling shall be 14 in. (350 mm).

23.7.5

The design area shall consist of the most hydraulically demanding area of 12 sprinklers.

23.7.6

The minimum operating pressure shall be either 30 psi (2.0 bar) or 60 psi (4.1 bar) based upon the applicable storage and ceiling height for the installation as follows:

30 psi (2.0 bar) for storage heights up to 25 ft (7.6 m) with a maximum ceiling height of 30 ft (9.1 m)

60 psi (4.1 bar) for storage heights up to 25 ft (7.6 m) with a maximum ceiling height of 40 ft (12 m)

23.7.7

The minimum aisle width shall be 8 ft (2.4 m).

23.7.8

The rack shall have a solid vertical barrier of 3/8 in. (10 mm) plywood or particleboard, .78 mm sheet metal, or equivalent, from face of rack to face of rack, spaced at a maximum of 16.5 ft (5.0 m) intervals.

23.7.8.1

The vertical barrier shall extend from a maximum of 4 in. (100 mm) above the floor to the maximum storage height.

23.7.8.2

The plan area of storage between vertical barriers and aisles shall not exceed 124 ft2 (12 m2).

23.7.8.3

The vertical barrier shall extend across the longitudinal flue.

23.7.8.4

Commodity shall be permitted to extend a nominal 4 in. (102 mm) beyond the vertical barrier at the aisle.

23.8 ESFR Protection of Rack Storage of Rubber Tires

Sprinkler discharge and area of application shall be in accordance with Table 23.8.

Table 23.8 Early Suppression Fast-Response (ESFR) Sprinklers for Protection of Rubber Tires

Piling Method Pile Height Maximum Building Height Nominal K-Factor Orientation Number of Sprinklers Minimum Operating Pressurea

ft m psi bar

Rubber tire storage, on-side or on-tread, in palletized portable racks, open portable racks, or fixed racks without solid shelves Up to 25 ft (7.6 m) 30 9.1 14.0 (200) Upright/pendent 12a 50 3.4

16.8 (240) Upright/pendent 12a 35 2.4

22.4 (320) Pendent 12a 25 1.7

25.2 (360) Pendent 12a 15 1.0

Rubber tire storage, on-side, in palletized portable racks, open portable racks, or fixed racks without solid shelves Up to 25 ft (7.6 m) 35 11 14.0 (200) Upright/pendent 12a 75 5.2

16.8 (240) Pendent 12a 52 3.6

22.4 (320) Pendent 12a 35 2.4

25.2 (360) Pendent 12a 25 1.7

On-tread, on-side, and laced tires in open portable steel racks or palletized portable racks Up to 25 ft (7.6 m) 30 9.1 14.0 (200) Pendent 20b,c 75 5.2

16.8 (240) Pendent 20b,c 52 3.6

Rubber tire storage, on-side, in palletized portable racks Up to 25 ft (7.6 m) 40 12 16.8 (240) Pendent 12 52 3.6

Rubber tire storage, on-tread, or laced in open portable steel racks Up to 25 ft (7.6 m) 40 12 25.2 (360) Pendent 12 40 2.8

On-tread, on-side, and laced tires in open portable steel racks or palletized portable racks Up to 30 ft (9.1 m) 40 12 25.2 (360) Pendent 12 75 5.2

Note: Wet systems only.

aThe shape of the design area shall be in accordance with 23.6.3.

bWhere used in this application, ESFR protection is expected to control rather than to suppress the fire.

cThe design area shall consist of the most hydraulically demanding area of 20 sprinklers, consisting of five sprinklers on each of four branch lines. The design shall include a minimum operating area of 1600 ft2 (149 m2).

23.9 Early Suppression Fast-Response (ESFR) Sprinklers for Protection of Roll Paper Storage

Where automatic sprinkler system protection utilizes ESFR sprinklers, hydraulic design criteria shall be as specified in Table 23.9. Design discharge pressure shall be applied to 12 operating sprinklers.

Table 23.9 ESFR Sprinklers for Protection of Roll Paper Storage (Maximum Height of Storage Permitted)

ESFR K-Factor Orientation System Type Pressure Building Height Heavyweight Mediumweight Tissue All Arrays

Closed Standard Open Closed Standard Open

psi bar ft m ft m ft m ft m ft m ft m ft m

14.0 (201) Upright/Pendent Wet 50 3.4 30 9.1 25 7.6 25 7.6 25 7.6 25 7.6 25 7.6 25 7.6 NA

16.8 (242) Upright/Pendent Wet 35 2.4

22.4 (322) Pendent Wet 25 1.7

25.2 (363) Pendent Wet 15 1.0

14.0 (201) Upright/Pendent Wet 75 5.2 35 11 30 9.1 30 9.1 30 9.1 NA NA NA NA

16.8 (242) Upright/Pendent Wet 52 3.6

16.8 (242) Pendent Wet 52 3.6 40 12 30 9.1 30 9.1 30 9.1 NA NA NA NA

22.4 (322) Pendent Wet 40 2.7

25.2 (363) Pendent Wet 25 1.7

22.4 (322) Pendent Wet 50 3.4 45 14 30 9.1 30 9.1 30 9.1 NA NA NA NA

25.2 (363) Pendent Wet 50 3.4

NA: Not applicable.

23.10 Plastic Motor Vehicle Components

Group A plastic automotive components and associated packaging material shall be permitted to be protected in accordance with Table 23.10.

Table 23.10 ESFR Sprinkler Design Criteria K-25.2 (360) for Portable Racks (Closed Arraya) Without Solid Shelves Containing Automotive Components

Commodity Maximum Storage Height Maximum Ceiling/Roof Height Type of System Maximum Sprinkler Spacingb Number of Design Sprinklers by Minimum Operating Pressurec Maximum Deflector Distance Below Ceilingd Hose Stream Allowance Water Supply Duration (hours)

ft m ft m ft2 m2 psi bar in. mm gpm L/min

Automotive components and associated packaging material 25 7.6 35 11 Wet 100 9.3 16 at 37 psi 16 at 2.5 bar 18 450 500 1900 2

aPortable rack array shall be tightly nested without any flue spaces.

bSprinkler spacing can exceed 100 ft2 (9 m2) where sprinklers are listed for larger spacing.

cSystem hydraulic design shall also be capable of delivering a discharge density of 0.60 gpm/ft2 (24.4 mm/min) over the most hydraulically remote 4000 ft2 (370 m2) area.

dMaximum deflector distance below ceiling shall be permitted to exceed 18 in. (450 mm) where sprinklers are listed for greater distances.

23.11 Sprinkler Design Criteria for Storage and Display of Class I Through Class IV Commodities, Cartoned Nonexpanded Group A Plastics and Nonexpanded Exposed Group A Plastics in Retail Stores

23.11.1

A sprinkler system with K-25.2 (360) ESFR sprinklers operating at a minimum pressure of 15 psi (1 bar) shall be permitted to protect single- and double-row racks with solid displays without the use of in-rack sprinklers in retail sales floors where the following conditions are met:

Storage height shall not exceed 20 ft (6.1 m).

Solid veneered particleboard/plywood displays shall be permissible, provided that all flues are maintained and only one display is installed per bay.

A single display shall be permitted to have one or two solid horizontal or slanted members, and a solid back.

Maximum roof height shall be 30 ft (9.14 m) in the protected area.

Aisle widths shall be a minimum of 6 ft (1.8 m).

Minimum transverse flue spaces of 3 in. every 10 ft (76 mm every 3.05 m) horizontally shall be provided.

Minimum longitudinal flue spaces of 6 in. (150 mm) shall be provided for double-row racks.

Maximum roof height shall be 30 ft (9.1 m) in the protected area.

Maximum storage height shall be 22 ft (6.7 m).

Aisle widths shall be a minimum of 8 ft (2.4 m).

Minimum transverse flue spaces of 3 in. every 10 ft (75 mm every 3 m) horizontally shall be provided.

Minimum longitudinal flue spaces of 6 in. (150 mm) shall be provided for double-row racks.

Storage in the aisle shall be permissible, provided the aisle storage is no more than 4 ft (1.2 m) high and a minimum clear aisle of 4 ft (1.2 m) is maintained.

23.12 Protection of High Bay Records Storage

23.12.1\* Mobile High Bay Records Storage

The requirements in this section shall be permitted to apply to ceiling-only sprinkler protection of paper products, including paper files, magazines, books, and similar paper documents in corrugated containers either closed or open top, to include corrugated totes, with no more than 5 percent plastics stored in mobile shelving units greater than 12 ft (3.7 m) and up to 34 ft (10 m) high and up to 30 shelving units (storage tiers) high, when the shelving unit structure meets all of the requirements in 23.12.3.

23.12.2 Fixed High Bay Records Storage

High bay record storage shall be permitted to be fixed in place when meeting the limitations of 23.12.1 and 23.12.3.

23.12.3

A wet pipe sprinkler system with nominal K-25.2 (360) ESFR sprinklers operating at a minimum of 40 psi (2.7 bar) shall be provided. The shelving units shall be subject to the following limitations:

Back-to-back storage shelving units each no greater than 36 in. (900 mm) deep separated by longitudinal flue space not less than 6 in. (150 mm) wide.

Solid steel shelving units not exceeding 54 in. (1350 mm) wide separated by steel barriers mechanically fastened to upright steel framing that forms a transverse flue space not less than 3 in. (75 mm) wide.

Upright steel framing not completely blocking transverse flue space between adjacent shelving units.

Noncombustible shelving backstops and side shelf supports, also referred to as side box guides, projecting not less than 3 in. (75 mm) above the shelves and that prevent stored commodities from encroaching into transverse and longitudinal flue spaces.

Solid steel shelving not greater than 18 in. (450 mm) on centers vertically.

Solid steel tops over top shelving units except at tops of transverse and longitudinal flue spaces.

Open-ended, hollow tubular steel vertical (upright) shelving columns at top of shelving system.

Shelving system framing and power tracks not exceeding 3 in. (75 mm) in width and not less than 1 ft (300 mm) on centers and not less than 6 in. (150 mm) below sprinkler deflectors.

Minimum clearance of 36 in. (900 mm) above top solid steel cover over top storage shelf to the sprinkler deflector.

Mobile shelving systems arranged to shift automatically to a uniform nominal 6 in. (150 mm) clearance clear space between mobile carriages supporting back-to-back shelving units. Systems shall be arranged to initiate the shifting 60 seconds after activation of ceiling-mounted smoke detectors or upon sprinkler flow, whichever is first. Shelving system carriage electrical motors shall be listed and integral to the mobile carriage systems for normal functions and shall not be required to have emergency power back-up.

23.13 Slatted Shelves

23.13.1\*

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 23.13.1 are not met. (See Section C.20.)

23.13.2

A wet pipe system that is designed to provide K-14.0 (200) ESFR sprinklers operating at a minimum of 50 psi (3.4 bar), K-16.8 (240) sprinklers operating at a minimum of 32 psi (2.2 bar), or K-25.2 (360) ESFR sprinklers operating at a minimum of 15 psi (1.0 bar) shall be permitted to protect single- and double-row racks with slatted rack shelving racks where all of the following conditions are met:

Sprinklers shall be K-14.0 (200), K-16.8 (240), or K-25.2 (360) ESFR.

The protected commodities shall be limited to Class I through Class IV, Group B plastics, Group C plastics, cartoned (expanded and nonexpanded) Group A plastics, and exposed (nonexpanded) Group A plastics.

Slats in slatted rack shelving shall be a minimum nominal 2 in. (50 mm) thick by maximum nominal 6 in. (150 mm) wide with the slats held in place by spacers that maintain a minimum 2 in. (50 mm) opening between each slat.

Longitudinal flue spaces shall not be required.

Transverse flue spaces at least 3 in. (75 mm) wide shall be provided at least every 10 ft (3.0 m) horizontally.

The aisle widths shall be at least 71/2 ft (2.3 m).

The maximum storage height shall be 20 ft (6.1 m).

Solid plywood or similar materials shall not be placed on the slatted shelves so that they block the 2 in. (50 mm) spaces between slats, nor shall they be placed on the wire mesh shelves.