**Chapter 25 Protection of Rack Storage Using In-Rack Sprinklers**

25.1 General Requirements of In-Rack Sprinklers

25.1.1 Scope

This chapter shall apply where rack storage of Class I through Class IV commodities, Group A plastic commodities, or rubber tires will be protected with in-rack sprinklers. Applicable sections shall include the following:

See Section 25.2 for the ceiling-level sprinkler design criteria applicable to designs with in-rack sprinklers.

See Section 25.3 for in-rack sprinkler characteristics.

See Section 25.4 for vertical spacing and location of in-rack sprinklers.

See Section 25.5 for horizontal location and spacing of in-rack sprinklers.

See Section 25.6 for protection of racks with solid shelves.

See Section 25.7 for horizontal barriers in combination with in-rack sprinklers.

See Section 25.8 for in-rack sprinkler arrangements and designs independent of ceiling-level sprinklers.

See Section 25.9 for in-rack sprinkler arrangements in combination with CMDA sprinklers at ceiling level.

See Section 25.10 for in-rack sprinkler arrangements in combination with CMSA sprinklers at ceiling level.

See Section 25.11 for in-rack sprinkler arrangements in combination with ESFR sprinklers at ceiling level.

See Section 25.12 for design criteria for in-rack sprinklers in combination with ceiling-level sprinklers.

25.1.2 Open Rack Storage

25.1.2.1

The in-rack sprinkler arrangements as well as the ceiling and in-rack sprinkler design criteria for rack storage in this chapter shall be based on open rack configurations as defined in 3.3.140 unless indicated otherwise.

25.1.3 In-Rack Sprinkler System

25.1.3.1 In-Rack Sprinkler System Size

The area protected by a single in-rack sprinkler system shall not exceed 40,000 ft2 (3720 m2) of floor area occupied by the racks, including aisles, regardless of the number of in-rack sprinkler levels.

25.1.3.2\* In-Rack Sprinkler System Control Valves

25.1.3.2.1

Unless the requirements of 25.1.3.2.2 or 25.1.3.2.3 are met, separate indicating control valves and drains shall be provided and arranged so that ceiling and in-rack sprinkler systems can be controlled independently.

25.1.3.2.2

A separate indicating control valve shall not be required where 20 or fewer in-rack sprinklers are supplied by any one ceiling sprinkler system.

25.1.3.2.3

The separate indicating valves shall be permitted to be arranged as sectional control valves supplied from the ceiling sprinkler system where in-rack sprinklers are required and the racks, including the adjacent aisles, occupy 8000 ft2 (740 m2) or less of the area protected by the ceiling sprinklers.

25.1.3.3\* Sprinkler Waterflow Alarm for In-Rack Sprinklers

See Section C.4.

25.1.4 Building Steel Protection

Where in-rack sprinklers are installed in accordance with this chapter, building steel shall not require special protection.

25.2 Ceiling-Level Sprinkler Design Criteria in Combination With In-Rack Sprinklers

25.2.1 General

25.2.1.1

This section shall apply to storage of Class I through Class IV and Group A plastic commodities as well as rubber tires, representing the broad range of combustibles stored in racks that are being protected by in-rack sprinklers. The requirements of Chapter 20 shall apply unless modified by this chapter. (See Section C.9.)

25.2.1.2\*

Ceiling-level sprinkler design criteria for single-, double-, and multiple-row racks in Section 25.2 shall be based on open rack configurations as defined in 3.3.140.

25.2.1.3\*

Ceiling-level sprinkler design criteria for Group A plastic commodities in this chapter shall be permitted for the protection of the same storage height and configuration of Class I, II, III, and IV commodities.

25.2.1.4

Ceiling-level sprinkler design criteria for single- and double-row rack storage of Group A plastic commodities shall be applicable where aisles are 3.5 ft (1.1 m) or greater in width.

25.2.1.5

Ceiling-level sprinkler design criteria for rack storage of Group A plastic commodities shall be protected as multiple-row racks where aisles are less than 3.5 ft (1.1 m) in width.

25.2.1.6

The minimum water supply requirements for a hydraulically designed occupancy hazard ceiling-level sprinkler system shall be determined by adding the hose stream allowance from Table 20.12.2.6 to the water supply for in-rack sprinklers determined in Section 25.12, unless indicated otherwise.

25.2.2 Miscellaneous and Low-Piled Storage

25.2.2.1 Miscellaneous Storage

25.2.2.1.1

This section shall apply to any of the following situations:

Miscellaneous rack storage of Class I through Class IV commodities up to and including 12 ft (3.7 m) in height

Miscellaneous rack storage of Group A plastic commodities up to and including 12 ft (3.7 m) in height

Miscellaneous rack storage of rubber tires up to and including 12 ft (3.7 m) in height

25.2.2.1.2

Where in-rack sprinklers are installed in accordance with Section 25.4 through Section 25.7 to protect miscellaneous rack storage of Class I through Class IV and Group A plastic commodities, as well as miscellaneous rack storage of rubber tires, up to and including 12 ft (3.7 m) in height under a maximum 32 ft (10.0 m) high ceiling, the ceiling-level sprinkler design criteria shall be in accordance with Figure 25.2.2.1.2.

FIGURE 25.2.2.1.2 CMDA Ceiling-Level Sprinkler Design Criteria for Miscellaneous Storage Protected with One Level of In-Rack Sprinklers.

25.2.2.1.3

Installation criteria as permitted by NFPA 13 and design criteria and modifiers as permitted by the density/area method of Section 19.2 for ordinary hazard Group 2 occupancies shall be applicable.

25.2.2.1.4 Hose Connections

Hose connections shall not be required for the protection of miscellaneous storage.

25.2.2.2 Low-Piled Rack Storage

25.2.2.2.1

This section shall apply to any of the following situations:

Rack storage of Class I through Class IV commodities up to and including 12 ft (3.7 m) in height

\* Rack storage of Group A plastic commodities up to and including 5 ft (1.5 m) in height

25.2.2.2.2

Where in-rack sprinklers are installed in accordance with Sections 25.4 through 25.7 to protect low-piled rack storage that does not meet the definition of miscellaneous storage, of Class I through Class IV and Group A plastic commodities, the ceiling-level design shall be in accordance with Figure 25.2.2.1.2.

25.2.2.2.3

For low-piled rack storage that does not meet the definition of miscellaneous storage, with solid shelves of Class I through Class IV commodities up to and including 12 ft (3.7 m) in height, in-rack sprinklers shall be provided in accordance with Section 25.6, and the ceiling-level sprinkler design shall be in accordance with Figure 25.2.2.1.2.

25.2.2.2.4

For low-piled rack storage that does not meet the definition of miscellaneous storage, with solid shelves of Group A plastic commodities up to and including 5 ft (1.5 m) in height, in-rack sprinklers shall be provided in accordance with Section 25.6, and the ceiling-level sprinkler design shall be in accordance with Figure 25.2.2.1.2.

25.2.3 CMDA Ceiling-Level Sprinkler Design Criteria in Combination With In-Rack Sprinklers

25.2.3.1 General

25.2.3.1.1

Ceiling-level sprinkler design criteria in combination with in-rack sprinklers for the rack storage of Class I through Class IV commodities shall be in accordance with 25.2.3.2 for storage over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height and 25.2.3.3 for storage over 25 ft (7.6 m) in height.

25.2.3.1.2

Ceiling-level sprinkler design criteria in combination with in-rack sprinklers for the rack storage of Group A plastic commodities shall be in accordance with 25.2.3.4 for storage over 5 ft (1.5 m) and up to and including 25 ft (7.6 m) in height and 25.2.3.5 for storage over 25 ft (7.6 m) in height.

25.2.3.1.3

For design densities of 0.2 gpm/ft2 (8.2 mm/min) or less, standard-response CMDA sprinklers with a K-factor of K-5.6 (80) or larger shall be permitted.

25.2.3.1.4

For design densities greater than 0.2 gpm/ft2 to 0.34 gpm/ft2 (8.2 mm/min to 13.9 mm/min), standard-response CMDA sprinklers with a nominal K-factor of K-8.0 (115) or larger shall be used.

25.2.3.1.5

For design densities greater than 0.34 gpm/ft2 (13.9 mm/min), standard-response CMDA sprinklers with a K-factor of K-11.2 (160) or larger that are listed for storage applications shall be used.

25.2.3.1.6

The requirements of 25.2.3.1.4 and 25.2.3.1.5 shall not apply to modifications to existing storage application systems, using sprinklers with K-factors of K-8.0 (115) or less.

25.2.3.1.7

The use of quick-response CMDA sprinklers for storage applications shall be permitted when listed for such use.

25.2.3.1.8

The ceiling sprinkler design figures in 25.2.3 indicate water demands for ordinary-temperature-rated and nominal high-temperature-rated CMDA sprinklers at the ceiling.

25.2.3.1.8.1

The ordinary-temperature ceiling sprinkler design densities correspond to ordinary-temperature-rated sprinklers and shall be used for sprinklers with ordinary- and intermediate-temperature classification.

25.2.3.1.8.2

The high-temperature ceiling sprinkler design densities correspond to high-temperature-rated sprinklers and shall be used for sprinklers having a high-temperature rating.

25.2.3.1.9

Ordinary- and intermediate-temperature CMDA ceiling sprinklers with K-factors of K-11.2 (K-160) or larger, where listed for storage, shall be permitted to use the densities for high-temperature sprinklers.

25.2.3.1.10 Discharge Considerations

25.2.3.1.10.1

The water supply for ceiling and in-rack sprinklers only shall be determined from the density/area requirements of Chapter 25.

25.2.3.1.10.2

The calculations shall satisfy any single point on appropriate density/area curves.

25.2.3.1.10.3

The design area shall meet the requirements of 27.2.4.2.1.

25.2.3.1.10.4

The minimum design density shall be not less than 0.15 gpm/ft2 (6.1 mm/min) after all adjustments are made.

25.2.3.2 Rack Storage of Class I Through Class IV Commodities Stored Over 12 ft (3.7 m) and Up to and Including 25 ft (7.6 m) in Height

25.2.3.2.1\* Single- And Double-Row Racks

For single- or double-row rack storage of Class I through Class IV commodities, encapsulated or nonencapsulated, stored over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, Table 25.2.3.2.1 shall be used to determine the appropriate figure for determining ceiling-level sprinkler design criteria with the provision of one level of in-rack sprinklers.

Table 25.2.3.2.1 Determining Appropriate Ceiling-Level Protection Criteria Figure for Single- or Double-Row Racks of Class I Through Class IV Commodities — Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m)

Storage Height Commodity Class Encapsulated Aisle Width\* No. of In-Rack Sprinkler Levels Appropriate Figure and Curves

ft m Figure Curves Apply Figure 25.2.3.2.4.1

Over 12 ft (3.7 m) and up to and including 20 ft (6.1 m) I No 4 1.2 1 Level 25.2.3.2.3.1(a) C and D Yes

8 2.4 A and B

Yes 4 1.2 25.2.3.2.3.1(e) C and D

8 2.4 A and B

II No 4 1.2 25.2.3.2.3.1(b) C and D

8 2.4 A and B

Yes 4 1.2 25.2.3.2.3.1(e) C and D

8 2.4 A and B

III No 4 1.2 25.2.3.2.3.1(c) C and D

8 2.4 A and B

Yes 4 1.2 25.2.3.2.3.1(f) C and D

8 2.4 A and B

IV No 4 1.2 25.2.3.2.3.1(d) C and D

8 2.4 A and B

Yes 4 1.2 25.2.3.2.3.1(g) C and D

8 2.4 A and B

Over 20 ft (6.1 m) and up to and including 22 ft (6.7 m) I No 4 1.2 1 Level 25.2.3.2.3.1(a) C and D No

8 2.4 A and B

Yes 4 1.2 25.2.3.2.3.1(e) C and D

8 2.4 A and B

II No 4 1.2 25.2.3.2.3.1(b) C and D

8 2.4 A and B

Yes 4 1.2 25.2.3.2.3.1(e) C and D

8 2.4 A and B

III No 4 1.2 25.2.3.2.3.1(c) C and D

8 2.4 A and B

Yes 4 1.2 25.2.3.2.3.1(f) C and D

8 2.4 A and B

IV No 4 1.2 25.2.3.2.3.1(d) C and D

8 2.4 A and B

Yes 4 1.2 25.2.3.2.3.1(g) C and D

8 2.4 A and B

Over 22 ft (6.7 m) and up to and including 25 ft (7.6 m) I No 4 1.2 1 Level 25.2.3.2.3.1(a) C and D No

8 2.4 A and B

Yes 4 1.2 25.2.3.2.3.1(e) C and D

8 2.4 A and B

II No 4 1.2 25.2.3.2.3.1(b) C and D

8 2.4 A and B

Yes 4 1.2 25.2.3.2.3.1(e) C and D

8 2.4 A and B

III No 4 1.2 25.2.3.2.3.1(c) C and D

8 2.4 A and B

Yes 4 1.2 25.2.3.2.3.1(f) C and D

8 2.4 A and B

IV No 4 1.2 25.2.3.2.3.1(d) C and D

8 2.4 A and B

Yes 4 1.2 25.2.3.2.3.1(g) C and D

8 2.4 A and B

\*See 25.2.3.2.1.1 for interpolation of aisle widths.

25.2.3.2.1.1\*

Design densities for single- and double-row racks shall be selected to correspond to aisle width. (See Section C.15.)

(A)

For aisle widths between 4 ft (1.2 m) and 8 ft (2.4 m), the rules for 4 ft (1.2 m) wide aisles shall be used or direct linear interpolation between the densities shall be permitted.

(B)

The density given for 8 ft (2.4 m) wide aisles shall be applied to aisles wider than 8 ft (2.4 m).

(C)

The density given for 4 ft (1.2 m) wide aisles shall be applied to aisles more narrow than 4 ft (1.2 m) down to 31/2 ft (1.1 m).

(D)

Where aisles are more narrow than 31/2 ft (1.1 m), racks shall be considered multiple-row racks.

25.2.3.2.2 Multiple-Row Racks

25.2.3.2.2.1

For multiple-row racks, having a rack depth up to and including 16 ft (4.9 m) with aisles 8 ft (2.4 m) or wider, storing Class I through Class IV commodities, encapsulated or nonencapsulated, over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, Table 25.2.3.2.2.1 shall be used to determine the appropriate figure for determining ceiling-level sprinkler design criteria with the provision of in-rack sprinklers.

Table 25.2.3.2.2.1 Determining Appropriate Ceiling-Level Protection Criteria Figure for Multiple-Row Racks of Class I Through Class IV Commodities — Rack Depth Up to and Including 16 ft (4.9 m), Aisles 8 ft (2.4 m) or Wider, and Storage Height Over 12 ft (3.7 m) Up to 25 ft (7.6 m)

Storage Height Commodity Class Encapsulated No. of In-Rack Sprinkler Levels Appropriate Figure and Curves

Figure Apply Figure 25.2.3.2.4.1 Density Multiplier

Over 12 ft (3.7 m) and up to and including 15 ft (4.6 m) I No 1 Level 25.2.3.2.3.1(a) Yes 1.0

Yes 1.25

II No 25.2.3.2.3.1(b) 1.0

Yes 1.25

III No 25.2.3.2.3.1(c) 1.0

Yes 1.25

IV No 25.2.3.2.3.1(d) 1.0

Yes 1.5

Over 15 ft (4.6 m) and up to and including 20 ft (6.1 m) I No 1 Level 25.2.3.2.3.1(a) Yes 1.0

Yes 1.25

II No 25.2.3.2.3.1(b) 1.0

Yes 1.25

III No 25.2.3.2.3.1(c) 1.0

Yes 1.25

IV No 25.2.3.2.3.1(d) 1.0

Yes 1.5

Over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) I No 1 Level 25.2.3.2.3.1(a) No 1.0

Yes 1.25

II No 25.2.3.2.3.1(b) 1.0

Yes 1.25

III No 25.2.3.2.3.1(c) 1.0

Yes 1.25

IV No 2 Levels 25.2.3.2.3.1(d) 1.0

Yes 2 Levels 1.5

25.2.3.2.2.2

For multiple-row racks, having a rack depth over 16 ft (4.9 m) or aisles less than 8 ft (2.4 m) wide, storing Class I through Class IV commodities, encapsulated or nonencapsulated, over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, Table 25.2.3.2.2.2 shall be used to determine the appropriate figure for determining ceiling-level sprinkler design criteria with the provision of in-rack sprinklers.

Table 25.2.3.2.2.2 Determining Appropriate Ceiling-Level Protection Criteria Figure for Multiple-Row Racks of Class I Through Class IV Commodities — Rack Depth Over 16 ft (4.9 m) or Aisles Narrower than 8 ft (2.4 m), Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m)

Storage Height Commodity Class Encapsulated No. of In-Rack Sprinkler Levels Appropriate Figure and Curves

Figure Curves Apply Figure 25.2.3.2.4.1 Density Multiplier

Over 12 ft (3.7 m) and up to and including 15 ft (4.6 m) I No 1 Level 25.2.3.2.3.1(a) C and D Yes 1.0

Yes 1.25

II No 25.2.3.2.3.1(b) 1.0

Yes 1.25

III No 25.2.3.2.3.1(c) 1.0

Yes 1.25

IV No 25.2.3.2.3.1(d) 1.0

Yes 1.5

Over 15 ft (4.6 m) and up to and including 20 ft (6.1 m) I No 1 Level 25.2.3.2.3.1(a) C and D Yes 1.0

Yes 1.25

II No 25.2.3.2.3.1(b) 1.0

Yes 1.25

III No 25.2.3.2.3.1(c) 1.0

Yes 1.25

IV No 25.2.3.2.3.1(d) 1.0

Yes 1.5

Over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) I No 1 Level 25.2.3.2.3.1(a) C and D No 1.0

Yes 1.25

II No 25.2.3.2.3.1(b) 1.0

Yes 1.25

III No 25.2.3.2.3.1(c) 1.0

Yes 1.25

IV No 2 Levels 25.2.3.2.3.1(d) 1.0

Yes 1.5

25.2.3.2.3 Ceiling-Level Protection, Used in Combination With In-Rack Sprinklers, Criteria Figures

25.2.3.2.3.1\*

The ceiling-level sprinkler design criteria in terms of density [gpm/ft2 (mm/min)] and area of sprinkler operation [ft2 (m2) of ceiling or roof sprinklers] obtained from the appropriate density/area curves of Figure 25.2.3.2.3.1(a) through Figure 25.2.3.2.3.1(g) shall be modified as appropriate by 25.2.3.2.4. These requirements shall apply to portable racks arranged in the same manner as single-, double-, or multiple-row racks. (See Section C.14.)

FIGURE 25.2.3.2.3.1(a) CMDA Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class I Nonencapsulated Commodities — Conventional Pallets.

FIGURE 25.2.3.2.3.1(b) CMDA Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class II Nonencapsulated Commodities — Conventional Pallets.

FIGURE 25.2.3.2.3.1(c) CMDA Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class III Nonencapsulated Commodities — Conventional Pallets.

FIGURE 25.2.3.2.3.1(d) CMDA Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class IV Nonencapsulated Commodities — Conventional Pallets.

FIGURE 25.2.3.2.3.1(e) CMDA Sprinkler System Design Curves — Single- or Double-Row Racks — 20 ft (6.1 m) High Rack Storage — Class I and Class II Encapsulated Commodities — Conventional Pallets.

FIGURE 25.2.3.2.3.1(f) CMDA Sprinkler System Design Curves — Single- or Double-Row Racks — 20 ft (6.1 m) High Rack Storage — Class III Encapsulated Commodities — Conventional Pallets.

FIGURE 25.2.3.2.3.1(g) CMDA Sprinkler System Design Curves — Single- or Double-Row Racks — 20 ft (6.1 m) High Rack Storage — Class IV Encapsulated Commodities — Conventional Pallets.

25.2.3.2.4\* Ceiling Sprinkler Density Adjustments

25.2.3.2.4.1

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 12 ft (3.7 m) up to and including 20 ft (6.1 m) protected with CMDA sprinklers at ceiling level along with the minimum number of required in-rack sprinkler levels, densities obtained from design curves shall be adjusted in accordance with Figure 25.2.3.2.4.1.

FIGURE 25.2.3.2.4.1 Adjustment to Ceiling-Level Sprinkler Density Due to Storage Height.

25.2.3.2.4.2

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 12 ft (3.7 m) and up to and including 20 ft (6.1 m) in height protected with CMDA sprinklers at ceiling level along with more than one level of in-rack sprinklers, but not in every tier, densities obtained from design curves and adjusted in accordance with Figure 25.2.3.2.4.1 shall be permitted to be reduced an additional 20 percent, as indicated in Table 25.2.3.2.4.2.

Table 25.2.3.2.4.2 Adjustment to Ceiling-Level Sprinkler Density Due to Storage Height and In-Rack Sprinklers

Storage Height In-Rack Sprinklers Apply Figure 25.2.3.2.4.1 Permitted Ceiling-Level Sprinkler Density Adjustment Due to In-Rack Sprinklers

Over 12 ft (3.7 m) and up to and including 20 ft (6.1 m) Minimum required Yes None

More than required but not in every tier Yes Reduce density 20% from that for minimum in-rack sprinklers

Every tier level Yes Reduce density 40% from that for minimum in-rack sprinklers

Over 20 ft (6.1

m) and up to and including 25 ft (7.6 m)

Minimum required No None

More than required but not in every tier No Reduce density 20% from that for minimum in-rack sprinklers

Every tier

level

No Reduce density 40% from that for minimum in-rack sprinklers

25.2.3.2.4.3\*

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 12 ft (3.7 m) and up to and including 20 ft (6.1 m) in height protected with CMDA sprinklers at ceiling level along with in-rack sprinklers at each tier level, densities obtained from design curves and adjusted in accordance with Figure 25.2.3.2.4.1 shall be permitted to be reduced an additional 40 percent, as indicated in Table 25.2.3.2.4.2.

25.2.3.2.4.4

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) in height protected with CMDA sprinklers at ceiling level along with the minimum number of required in-rack sprinkler levels, densities obtained from design curves shall be used. Densities shall not be adjusted in accordance with Figure 25.2.3.2.4.1.

25.2.3.2.4.5

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) in height protected with CMDA sprinklers at ceiling level along with more than the minimum required level of in-rack sprinklers, but not in every tier, densities obtained from design curves shall be permitted to be reduced 20 percent, as indicated in Table 25.2.3.2.4.2. Densities shall not be adjusted in accordance with Figure 25.2.3.2.4.1 for storage height.

25.2.3.2.4.6

Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) in height protected with CMDA sprinklers at ceiling level along with in-rack sprinklers at each tier level, except above the top tier, densities obtained from design curves shall be permitted to be reduced 40 percent, as indicated in Table 25.2.3.2.4.2. Densities shall not be adjusted in accordance with Figure 25.2.3.2.4.1 for storage height.

25.2.3.3 Rack Storage of Class I Through Class IV Commodities Over 25 ft (7.6 m) in Height

25.2.3.3.1\* Single- And Double-Row Racks

Where in-rack sprinklers are being installed within single- and double-row racks separated by aisles at least 4 ft (1.2 m) wide and with a clearance to ceiling up to and including 10 ft (3.0 m) of Class I through Class IV commodities stored over 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level, the ceiling sprinkler designs shall be in accordance with Table 25.2.3.3.1.

Table 25.2.3.3.1 CMDA Ceiling-Level Sprinkler Design Criteria for Single- or Double-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height with Aisles 4 ft (1.2 m) or More in Width, Clearance to Ceiling Up to and Including 10 ft (3.0 m) Supplemented with In-Rack Sprinklers

Commodity Class Applicable In-Rack Sprinkler Installation Figures Encapsulated Ceiling Sprinkler Density, Clearance to Ceiling Up to 10 ft (3.0 m) Ceiling Sprinkler Operating Area

Ordinary Temperature High Temperature

gpm/ft2 mm/min gpm/ft2 mm/min ft2 m2

I 25.9.2.2.1(a)-(b) No 0.25 10.2 0.35 14.3 2000 185

Yes 0.31 12.8 0.44 17.9

I, II, III 25.9.2.2.1(c)-(g) No 0.3 12.2 0.4 16.3

Yes 0.37 15.3 0.5 20.4

I, II, III, IV 25.9.2.2.1(h)-(j) No 0.35 15.1 0.45 18.3

Yes 0.44 17.9 0.56 22.8

25.2.3.3.2 Multiple-Row Racks

Where in-rack sprinklers are being installed within multiple-row racks separated by aisles at least 4 ft (1.2 m) wide and with a clearance to ceiling up to and including 10 ft (3.0 m) of Class I through Class IV commodities stored over 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level, the ceiling sprinkler designs shall be in accordance with Table 25.2.3.3.2.

Table 25.2.3.3.2 CMDA Ceiling-Level Sprinkler Design Criteria for Multiple-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height, Clearance to Ceiling Up to and Including 10 ft (3.0 m) Supplemented with In-Rack Sprinklers

Commodity Class Encapsulated Maximum Allowable Storage Height Above Top In-Rack Sprinkler Level Ceiling Sprinkler Density, Clearance to Ceiling Up to 10 ft (3.0 m) Ceiling Sprinkler Operating Area

Ordinary Temperature High Temperature

ft m gpm/ft2 mm/min gpm/ft2 mm/min ft2 m2

I No 10 3.0 0.25 10.2 0.35 14.3 2000 185

Yes 0.31 12.6 0.44 17.9

I, II, III No 10 3.0 0.3 12.2 0.4 16.3

Yes 0.37 15.1 0.5 20.4

I, II, III, IV No 5 1.5 0.35 14.3 0.45 18.3

Yes 0.44 17.9 0.56 22.8

25.2.3.4 Rack Storage of Group A Plastic Commodities Stored Over 5 ft (1.5 m) and Up to and Including 25 ft (7.6 m) in Height

25.2.3.4.1 Cartoned Group A Plastic Commodities

25.2.3.4.1.1

Where rack storage of cartoned Group A plastic commodities, encapsulated or nonencapsulated, having a clearance to ceiling up to and including 10 ft (3.0 m) is protected by in-rack sprinklers, ceiling-level sprinkler designs in terms of density [gpm/ft2 (mm/min)] and area of operation [ft2 (m2)] shall be selected from Figure 25.9.3.1(a) through Figure 25.9.3.1(e).

25.2.3.4.1.2

Linear interpolation of design densities and areas of application shall be permitted between storage heights with the same clearance to ceiling.

25.2.3.4.1.3

No interpolation between clearance to ceiling shall be permitted.

25.2.3.4.2 Exposed Nonexpanded Group A Plastic Commodities

Where in-rack sprinkler protection is installed to protect rack storage of exposed nonexpanded Group A plastic commodities, encapsulated or nonencapsulated, stored over 5 ft (1.5 m) and up to and including 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level, the ceiling sprinkler design shall be in accordance with one of the following:

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(a) for storage up to 10 ft (3.0 m) high in a building up to 20 ft (6.1 m) high, the ceiling-level sprinkler design shall be a minimum 0.45 gpm/ft2 (18.3 mm/min) density over a 2000 ft2 (185 m2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(b) for storage up to 10 ft (3.0 m) high in a building up to 20 ft (6.1 m) high, the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft2 (12.2 mm/min) density over a 2000 ft2 (185 m2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(c) for storage up to 15 ft (4.6 m) high in a building up to 25 ft (7.6 m) high, the ceiling-level sprinkler design shall be a minimum 0.45 gpm/ft2 (18.3 mm/min) density over a 2000 ft2 (185 m2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(d) for storage up to 15 ft (4.6 m) high in a building up to 25 ft (7.6 m) high, the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft2 (12.2 mm/min) density over a 2000 ft2 (185 m2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(e) for storage up to 20 ft (6.1 m) high in a building up to 25 ft (7.6 m) high, the ceiling-level sprinkler design shall be a minimum 0.6 gpm/ft2 (24.5 mm/min) density over a 2000 ft2 (185 m2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(f) for storage up to 20 ft (6.1 m) high in a building up to 25 ft (7.6 m) high, the ceiling-level sprinkler design shall be a minimum 0.45 gpm/ft2 (18.3 mm/min) density over a 2000 ft2 (185 m2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(g) for storage up to 20 ft (6.1 m) high in a building up to 30 ft (9.1 m) high, the ceiling-level sprinkler design shall be a minimum 0.8 gpm/ft2 (32.6 mm/min) density over a 1500 ft2 (140 m2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(h) for storage up to 20 ft (6.1 m) high in a building up to 30 ft (9.1 m) high, the ceiling-level sprinkler design shall be a minimum 0.6 gpm/ft2 (24.5 mm/min) density over a 1500 ft2 (140 m2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(i) for storage up to 20 ft (6.1 m) high in a building up to 30 ft (9.1 m) high, the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft2 (12.2 mm/min) density over a 2000 ft2 (185 m2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(j) for storage up to 25 ft (7.6 m) high in a building up to 35 ft (11 m) high, the ceiling-level sprinkler design shall be a minimum 0.8 gpm/ft2 (32.6 mm/min) density over a 1500 ft2 (140 m2) demand area.

Where in-rack sprinklers are installed in accordance with Figure 25.9.3.3(k) for storage up to 25 ft (7.6 m) high in a building up to 35 ft (11 m) high, the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft2 (12.2 mm/min) density over a 2000 ft2 (185 m2) demand area.

25.2.3.5\* Rack Storage of Group A Plastic Commodities Stored Over 25 ft (7.6 m) in Height

Where rack storage of Group A plastic commodities, encapsulated or nonencapsulated, over 25 ft (7.6 m) in height are protected by in-rack sprinklers in accordance with 25.9.4, ceiling-level sprinkler designs, in terms of density [gpm/ft2 (mm/min)] and area of operation [ft2 (m2)], shall be selected from Table 25.2.3.5 based on the storage height of commodity above the top level of in-rack sprinklers.

Table 25.2.3.5 CMDA Ceiling-Level Sprinkler Design Criteria for Rack Storage of Group A Plastic Commodities with Storage Over 25 ft (7.6 m) in Height, Clearance to Ceiling Up to and Including 10 ft (3.0 m) Supplemented with In-Rack Sprinklers

Storage Height Above Top Level of In-Rack Sprinklers Ceiling-Level Sprinkler Design Criteria

ft m gpm/ft2 over ft2 mm/min over m2

Up to and including 5 ft Up to and including 1.5 m 0.30/2000 12.2/185 m2

Over 5 ft and up to and including 10 ft Over 1.5 m and up to and including 3.0 m 0.45/2000 18.3/185 m2

25.2.3.6 Rack Storage of Rubber Tires Stored Over 12 ft (3.7 m) in Height

25.2.3.6.1 General

The requirements of Chapter 20 shall apply unless modified in this section.

25.2.3.6.2 Ceiling Systems

Where rack storage of rubber tires on pallets, either on-side or on-tread, over 5 ft (1.5 m) and up to and including 20 ft (6.1 m) in height protected by CMDA sprinklers at ceiling level with a maximum clearance to ceiling of 10 ft (3.0 m) along with one level of in-rack sprinklers, the ceiling-level sprinkler system design density and area of application shall be a minimum 0.40 gpm/ft2 (16.3 mm/min) density over a 3000 ft2 (280 m2) demand area. (See A.21.6.)

25.2.3.6.3 Reduced-Discharge Density

Where high-expansion foam systems are installed in accordance with NFPA 11 to protect rack storage of rubber tires, either on-side or on-tread, over 5 ft (1.5 m) and up to and including 20 ft (6.1 m) in height protected by CMDA sprinklers at ceiling level with a maximum clearance to ceiling of 10 ft (3.0 m) and one level of in-rack sprinklers, the ceiling-level sprinkler system design density shall be permitted to be reduced from 0.40 gpm/ft2 (16.3 mm/min) to 0.24 gpm/ft2 (9.8 mm/min).

25.2.3.6.4 Water Supplies

Total water supplies shall be capable of providing flow for automatic sprinklers, hose streams, and foam systems (if provided) for the duration required in Table 20.12.2.6.

25.2.4 CMSA Ceiling-Level Sprinkler Design Criteria in Combination With In-Rack Sprinklers

25.2.4.1 General

25.2.4.1.1 Open Wood Joist Construction With CMSA Sprinklers at Ceiling Level

25.2.4.1.1.1

Where CMSA sprinklers are installed under open wood joist construction, firestopping in accordance with 25.2.4.1.1.2 shall be provided or the minimum operating pressure of the sprinklers shall be 50 psi (3.4 bar) for a K-11.2 (160) sprinkler or 22 psi (1.5 bar) for a K-16.8 (240) sprinkler.

25.2.4.1.1.2

Where each joist channel of open wood joist construction is fully firestopped to its full depth at intervals not exceeding 20 ft (6.1 m), the lower pressures specified in Table 25.2.4.2.1 shall be permitted to be used.

25.2.4.1.2 Preaction Systems for CMSA Sprinklers

For the purpose of using Table 25.2.4.2.1, preaction systems shall be classified as dry pipe systems.

25.2.4.2 Rack Storage of Class I Through Class IV Commodities

25.2.4.2.1

Where rack storage of Class I through Class IV commodities is protected by CMSA sprinklers at ceiling level along with one level of in-rack sprinklers, the ceiling-level sprinkler design criteria shall be in accordance with Table 25.2.4.2.1.

Table 25.2.4.2.1 CMSA Ceiling-Level Sprinkler Design Criteria for Rack Storage of Class I Through Class IV Commodities (Encapsulated and Nonencapsulated) Supplemented with In-Rack Sprinklers

Storage Arrangement Commodity Class Maximum Storage Height Maximum Ceiling/Roof Height K-Factor/Orientation Type of System No. of Ceiling Sprinklers in the Design No. of Required Levels of In-Rack Sprinklers Minimum Ceiling Sprinkler Operating Pressure

ft m ft m psi bar

Single-,

double-, and multiple-row racks (no open-top containers)

I or II 30 9.1 35 11 11.2 (160) Upright Wet 20 One level 25 1.7

Dry 30 One level 25 1.7

16.8 (240) Upright Wet 20 One level 15 1

Dry 30 One level 15 1

III 25 7.6 30 9.1 11.2 (160) Upright Wet 15 One level 25 1.7

Dry 25 One level 25 1.7

16.8 (240) Upright Dry 25 One level 15 1

35 11 11.2 (160) Upright Wet 15 One level 25 1.7

Dry 25 One level 25 1.7

16.8 (240) Upright Wet 15 One level 15 1

Dry 25 One level 15 1

IV 25 7.6 30 9.1 11.2 (160) Upright Wet 15 One level 50 3.4

35 11 11.2 (160) Upright Wet 20 One level 50 3.4

15 One level 75 5.2

16.8 (240) Upright Wet 20 One level 22 1.5

15 One level 35 2.4

25.2.4.2.2

Protection shall be provided as specified in Table 25.2.4.2.1 or appropriate NFPA standards in terms of minimum operating pressure and the number of ceiling-level sprinklers to be included in the design area.

25.2.4.3 Rack Storage of Group A Plastic Commodities

25.2.4.3.1

Where rack storage of nonexpanded, cartoned and exposed, Group A plastic commodities is protected by CMSA sprinklers at ceiling level along with one level of in-rack sprinklers, the ceiling-level sprinkler system design criteria shall be in accordance with Table 25.2.4.3.1.

Table 25.2.4.3.1 CMSA Ceiling-Level Sprinkler Design Criteria for Rack Storage of Group A Plastic Commodities Stored Up to and Including 25 ft (7.6 m) in Height Supplemented with In-Rack Sprinklers

Storage Arrangement Commodity Class Maximum Storage Height Maximum Ceiling/Roof Height K-Factor/Orientation Type of System No. of Ceiling Sprinklers in the Design No. of Required Levels of In-Rack Sprinklers Minimum Ceiling Sprinkler Operating Pressure

ft m ft m psi bar

Single-, double-, and multiple-row racks (no open-top containers) Cartoned nonexpanded plastics and exposed nonexpanded plastics 25 7.6 30 9.1 11.2 (160) upright Wet 15 One level 50 3.4

35 11 11.2 (160) upright Wet 30 One level 50 3.4

Wet 20 One level 75 5.2

16.8 (240) upright Wet 30 One level 22 1.5

Wet 20 One level 35 2.4

25.2.4.3.2

Protection shall be provided as specified in Table 25.2.4.3.1 or appropriate NFPA standards in terms of minimum operating pressure and the number of ceiling-level sprinklers to be included in the design area.

25.2.5 ESFR Ceiling-Level Sprinkler Design Criteria in Combination With In-Rack Sprinklers

25.2.5.1 Rack Storage of Class I Through Class IV and Group A Plastic Commodities

25.2.5.1.1

Where rack storage of Class I through Class IV and Group A plastic commodities is protected by ESFR sprinklers at ceiling level along with one level of in-rack sprinklers, the ceiling-level sprinkler design criteria shall be in accordance with Table 25.2.5.1.1.

Table 25.2.5.1.1 ESFR Ceiling-Level Sprinkler Design Criteria for Rack Storage of Class I Through Class IV and Group A Plastic Commodities (Encapsulated and Nonencapsulated) Supplemented with In-Rack Sprinklers

Storage Arrangement Commodity Class Maximum Storage Height Maximum Ceiling/Roof Height K-Factor Orientation No. of Ceiling Sprinklers in the Design No. of Required Levels of In-Rack Sprinklers Minimum Ceiling Sprinkler Operating Pressure

ft m ft m psi bar

Single-, double-, and multiple-row racks (no open-top containers) Class I, II, III or IV, encapsulated or nonencapsulated, cartoned nonexpanded and exposed nonexpanded plastics 25 7.6 45 14 14.0 (200) Pendent 12 One level 90 6.2

16.8 (240) Pendent 12 One level 63 4.3

25.2.5.1.2

ESFR sprinkler systems, when supplemented with in-rack sprinklers, shall be designed such that the minimum operating pressure is not less than that indicated in Table 25.2.5.1.1 for type of storage, commodity, storage height, and building height involved.

25.2.5.1.3

The design area applicable to the ceiling-level design options listed in Table 25.2.5.1.1 shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of 4 sprinklers on each of three branch lines.

25.3 In-Rack Sprinkler Characteristics

25.3.1

In-rack sprinklers shall be pendent or upright, standard- or quick-response, ordinary-temperature-rated and have a nominal K-factor of K-5.6 (80), K-8.0 (115), or K-11.2 (160).

25.3.2

In-rack sprinklers protecting open rack storage where ESFR sprinklers are installed at ceiling level shall be quick-response, ordinary-temperature-rated, and either K-8.0 (115) or K-11.2 (160).

25.3.3

In-rack sprinklers with intermediate- and high-temperature ratings shall be used near heat sources as required by 9.4.2.

25.3.4

In-rack sprinklers shall be permitted to have a different RTI rating from the ceiling sprinklers under which they are installed.

25.3.5 In-Rack Sprinkler Water Shields

25.3.5.1 In-Rack Sprinkler Water Shields for Storage of Class I Through Class IV Commodities

Water shields shall be provided directly above in-rack sprinklers, or listed intermediate level/rack storage sprinklers shall be used where there is more than one level, if not shielded by horizontal barriers. (See Section C.3.)

25.3.5.2 In-Rack Sprinkler Water Shields for Group A Plastic Storage

Where in-rack sprinklers are not shielded by horizontal barriers, water shields shall be provided above the sprinklers, or listed intermediate level/rack storage sprinklers shall be used.

25.4 Vertical Spacing and Location of In-Rack Sprinklers

25.4.1

In-rack sprinklers shall not be required to meet the obstruction criteria and clearance from storage requirements of Section 9.5.

25.4.2

A minimum 6 in. (150 mm) vertical clear space shall be maintained between in-rack sprinkler deflectors and the top of storage located below them.

25.4.2.1\*

Where in-rack sprinklers are being installed within single- and double-row racks of Class I through Class IV commodities up to and including 20 ft (6.1 m) in height, the vertical clear space of in-rack sprinkler deflectors with respect to the top of storage located below them shall be permitted to be less than 6 in. (150 mm). (See Section C.16.)

25.4.3

In-rack sprinkler discharge shall not be obstructed by horizontal rack members.

25.4.4\*

Where one level of in-rack sprinklers are required by the guidelines of this chapter and the vertical location of the in-rack sprinklers is not indicated in an applicable figure, in-rack sprinklers shall be installed at the first tier level at or above one-half of the highest expected storage height.

25.4.5

Where two levels of in-rack sprinklers are required by the guidelines of this chapter and the vertical location of the in-rack sprinklers is not indicated in an applicable figure, in-rack sprinklers shall be installed at the first tier level at or above one-third and two-thirds of the highest expected storage height.

25.4.6 Maximum Storage Height Above Top In-Rack Sprinkler Level

25.4.6.1

Where in-rack sprinklers are required for single- and double-row rack storage of Class I through Class IV commodities over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, storage above the top level of in-rack sprinklers shall not exceed 10 ft (3.0 m).

25.4.6.2

Where in-rack sprinklers are required for multiple-row rack storage of Class I through Class IV commodities over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, storage above the top level of in-rack sprinklers shall not exceed 10 ft (3.0 m) for Class I, Class II, or Class III commodities or 5 ft (1.5 m) for Class IV commodities.

25.4.6.3

Where in-rack sprinklers are required for rack storage of Group A plastic commodities over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, storage above the top level of in-rack sprinklers shall not exceed 10 ft (3.0 m).

25.4.7 Staggering of In-Rack Sprinklers for Class I Through Class IV Commodities Over 25 ft (7.6 m) in Height

25.4.7.1

Where single-, double-, and multiple-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, in-rack sprinklers shall be staggered vertically where installed in accordance with Table 25.9.2.1.1, Figure 25.9.2.2.1(a) through Figure 25.9.2.2.1(j), and Figure 25.9.2.1.1(a) through Figure 25.9.2.1.1(e).

25.5 Horizontal Location and Spacing of In-Rack Sprinklers

25.5.1 Horizontal Location of In-Rack Sprinklers

25.5.1.1

In-rack sprinklers shall not be required to meet the obstruction criteria and clearance from storage requirements of Section 9.5.

25.5.1.2\*

Where in-rack sprinklers are installed in longitudinal flues, they shall be located at an intersection of transverse and longitudinal flues while not exceeding the maximum horizontal spacing rules.

25.5.1.3

Where horizontal distances between transverse flues exceed the maximum allowable horizontal linear spacing for in-rack sprinklers, in-rack sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional in-rack sprinklers shall be installed between transverse flues to meet the maximum allowable horizontal linear spacing rules for in-rack sprinklers.

25.5.1.4

Where no transverse flues exist, horizontal spacing of in-rack sprinklers shall not exceed the maximum allowable spacing rules.

25.5.1.5

Where in-rack sprinklers are installed to protect a higher-hazard commodity that occupies only a portion of the length of a rack, in-rack sprinklers shall be extended a minimum of 8 ft (2.4 m) or one bay, whichever is greater, in each direction along the rack on either side of the higher hazard. The in-rack sprinklers protecting the higher hazard shall not be required to extend across the aisle.

25.5.1.6\*

Where rack storage is over 25 ft (7.6 m) in height, in-rack sprinklers shall be a minimum 3 in. (75 mm) radially from the side of rack uprights.

25.5.1.6.1

Where rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m), in-rack sprinklers shall be permitted to be installed horizontally without regard to rack uprights. (See Section C.17.)

25.5.1.7

Where rack storage is over 25 ft (7.6 m) in height and requires face sprinklers, the face sprinklers shall be located within the rack a minimum 3 in. (75 mm) from rack uprights and no more than 18 in. (450 mm) from the aisle face of storage.

25.5.1.8

Where single- and double-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, in-rack sprinklers shall be staggered horizontally where installed in accordance with Table 25.9.2.1.1 and Figure 25.9.2.1.1(a) through Figure 25.9.2.1.1(e) for single-row racks or Table 25.9.2.2.1 and Figure 25.9.2.2.1(a) through Figure 25.9.2.2.1(j) for double-row racks.

25.5.1.9

Where multiple-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, in-rack sprinklers shall be staggered horizontally where installed in accordance with Table 25.9.2.3.1 and Figure 25.9.2.3.1(a) through Figure 25.9.2.3.1(c).

25.5.1.10

Where rack storage of Group A plastic commodities is over 25 ft (7.6 m) in height, in-rack sprinklers in longitudinal flues shall be installed with the deflector located at or below the bottom of horizontal load beams or above or below other adjacent horizontal rack members.

25.5.2 Horizontal Spacing of In-Rack Sprinklers

25.5.2.1 General

25.5.2.1.1

Unless specified elsewhere in this standard, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with 25.5.2.1.2 through 25.5.2.1.4.

25.5.2.1.2

In-rack sprinklers shall be permitted to be installed horizontally less than 6 ft (1.8 m) apart.

25.5.2.1.3

For rack storage of rubber tires, the maximum allowable horizontal spacing of in-rack sprinklers shall be 8 ft (2.4 m).

25.5.2.1.4

The maximum allowable horizontal spacing of in-rack sprinklers for Class IV and Group A plastic commodities in miscellaneous, low-piled, and rack storage shall be 10 ft (3.0 m).

25.5.2.2 CMDA Sprinklers Installed at Ceiling Level

25.5.2.2.1\*

Where single- and double-row rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Table 25.5.2.2.1.

Table 25.5.2.2.1 In-Rack Sprinkler Horizontal Spacing for Class I, II, III, and IV Commodities Stored in Single- or Double-Row Racks Up to 25 ft (7.6 m) in Height Protected by CMDA Sprinklers at Ceiling Level

Commodity Class Aisle Width Encapsulated Maximum Allowable Linear Spacing

ft m ft m

I, II 8 2.4 No 12 3.7

Yes 8 2.4

4 1.2 No 12 3.7

Yes 8 2.4

III 8 2.4 No 12 3.7

Yes 8 2.4

4 1.2 No 10 3

Yes 8 2.4

IV 8 2.4 No 10 3

Yes 8 2.4

4 1.2 No 10 3

Yes 8 2.4

25.5.2.2.2

Where multiple-row rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Table 25.5.2.2.2.

(A)

The rack plan view shall be considered in determining the area covered by each sprinkler.

(B)

The aisles shall not be included in area calculations.

Table 25.5.2.2.2 In-Rack Sprinkler Horizontal Spacing for Class I, II, III, and IV Commodities Stored in Multiple-Row Racks Up to 25 ft (7.6 m) in Height Protected by Control Mode Density/Area Sprinklers at Ceiling Level

Commodity Class Linear Spacing Area Spacing

ft m ft2 m2

I, II, III 12 3.7 100 9.3

IV 8 2.4 80 9

25.5.2.2.3\*

For horizontal spacing of in-rack sprinklers not addressed by 25.5.2.2.1 or 25.5.2.2.2, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Table 25.5.2.2.3.

Table 25.5.2.2.3 Horizontal Spacing for In-Rack Sprinklers in Combination with CMDA Ceiling Sprinklers That Are Represented by Figures

Commodity Class Storage Rack Type Storage Height Applicable Table and/or Figure for Horizontal Spacing of In-Rack Sprinklers

ft m

Class I through IV Single-row Over 25 Over 7.6 Table 25.9.2.1.1 and Figures 25.9.2.1.1(a)-(e)

Double-row Over 25 Over 7.6 Table 25.9.2.2.1 and Figures 25.9.2.2.1(a)-(j)

Multiple-row Over 25 Over 7.6 Table 25.9.2.3.1 and Figures 25.9.2.3.1(a)-(c)

Group A plastics Single-, double-, and multiple-row Up to 25 Up to 7.6 Figures 25.9.3.1(a)-(e)

Group A plastics, cartoned Single-row Over 25 Over 7.6 Figures 25.9.4.1.1(a)-(d)

Double-row Over 25 Over 7.6 Figures 25.9.4.2.1(a)-(c)

Multiple-row Over 25 Over 7.6 Figures 25.9.4.3.1(a)-(f)

Group A plastics,

exposed nonexpanded

Single-row, maximum 3 ft (0.9 m) deep Over 25 Over 7.6 Figure 25.9.4.1.3

Multiple-row Over 25 Over 7.6 Figures 25.9.4.3.1(a)-(f)

25.5.2.3 CMSA Sprinklers Installed at Ceiling Level

25.5.2.3.1

Where rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m) in height and protected by CMSA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be 8 ft (2.4 m).

25.5.2.3.2

Where rack storage of plastic commodities is up to and including 25 ft (7.6 m) in height and protected by CMSA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).

25.5.2.3.3

Where rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMSA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).

25.5.2.4 ESFR Sprinklers Installed at Ceiling Level

Where rack storage is protected by ESFR sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).

25.6 Protection of Racks With Solid Shelves

25.6.1 General

The requirements in this chapter for the installation of in-rack sprinklers shall apply to racks with solid shelves except as modified in this section.

25.6.2

Ceiling-level sprinkler design criteria for CMDA, CMSA, and ESFR sprinklers shall be an applicable option for open racks combined with in-rack sprinklers installed in accordance with the criteria for solid shelving.

25.6.3 Vertical Spacing and Location of In-Rack Sprinklers in Racks With Solid Shelves

25.6.3.1

Where CMDA sprinklers are at ceiling level protecting racks with solid shelving that exceeds 20 ft2 (1.9 m2) in area but not 64 ft2 (5.9 m2), in-rack sprinklers shall not be required below every shelf but shall be installed below shelves at intermediate levels not more than 6 ft (1.8 m) apart vertically. (See Section C.11.)

25.6.3.2

Where CMDA sprinklers are at ceiling level protecting racks with solid shelving that exceeds 64 ft2 (5.9 m2) in area or where the levels of storage exceed 6 ft (1.8 m), in-rack sprinklers shall be installed below each level of shelving.

25.6.3.3

Where CMSA sprinklers are at ceiling level and protect racks with solid shelving, in-rack sprinklers shall be installed beneath all tiers under the highest solid shelf.

25.6.3.4

Where ESFR sprinklers are at ceiling level and protect racks with solid shelving, in-rack sprinklers shall be installed beneath all tiers under the highest solid shelf.

25.6.3.5

Where racks with solid shelves obstruct only a portion of an open rack, in-rack sprinklers shall be installed vertically as follows:

In accordance with 25.6.3.1 and 25.6.3.2 where CMDA sprinklers are installed at ceiling level

In accordance with 25.6.3.3 where CMSA sprinklers are installed at ceiling level

In accordance with 25.6.3.4 where ESFR sprinklers are installed at ceiling level

25.6.4 Horizontal Location and Spacing of In-Rack Sprinklers in Racks With Solid Shelves

25.6.4.1

Where racks with solid shelves contain storage of Class I through Class IV commodities, the maximum allowable horizontal spacing of in-rack sprinklers shall be 10 ft (3.0 m).

25.6.4.2

Where racks with solid shelves contain storage of Group A plastic commodities, the maximum allowable horizontal spacing of in-rack sprinklers shall be 5 ft (1.5 m).

25.6.4.3

Where racks with solid shelves obstruct only a portion of an open rack, in-rack sprinklers shall be extended beyond the end of the solid shelf a minimum of 4 ft (1.2 m) to the nearest flue space intersection.

25.7 Horizontal Barriers in Combination With In-Rack Sprinklers

25.7.1\*

Where required by sections of this chapter, horizontal barriers used in combination with in-rack sprinklers to impede vertical fire development shall be constructed of sheet metal, wood, or similar material and shall extend the full length and depth of the rack.

25.7.2

Barriers shall be fitted within 2 in. (50 mm) horizontally around rack uprights.

25.8 Alternative In-Rack Sprinkler Protection Options That Are Independent of the Ceiling Sprinkler Design

25.8.1 In-Rack Sprinkler Protection for Class I Through Class IV and Group A Plastic Commodities That Are Independent of the Ceiling Sprinkler Design, Option 1

25.8.1.1

Where Class I, II, III, IV, and Group A plastic commodities are protected in accordance with the guidelines of this section, the in-rack sprinkler system shall not be required to be hydraulically balanced with the ceiling-level sprinkler system.

25.8.1.2

Where a storage rack will not be solely dedicated to the in-rack sprinkler system outlined in this section, either of the following shall apply:

Extend the protection outlined in this section horizontally one pallet load in all directions beyond the commodity storage area that is being protected by the alternative in-rack sprinkler arrangement.

Install a vertical barrier to segregate the commodities that are being protected by the alternative in-rack sprinkler arrangement.

25.8.1.3

Where a storage rack is partially protected by the in-rack sprinkler system outlined in this section, commodities that can be protected by the ceiling-level sprinkler system shall be permitted to be stored vertically above and horizontally adjacent to the portions of the storage rack protected in accordance with this section.

25.8.1.4 Horizontal Barriers for Alternative In-Rack Sprinkler Protection Option 1

25.8.1.4.1

The barrier shall be constructed of minimum 22 gauge (.78 mm) sheet metal or of minimum 3/8 in. (10 mm) plywood.

25.8.1.4.2

The barrier shall span horizontally to both aisle faces of the rack, covering up all flue spaces of the rack bays in which they are installed.

25.8.1.4.3

A maximum 3 in. (75 mm) wide horizontal gap shall be permitted at rack uprights or other equipment that would create an opening, such as vertical in-rack sprinkler pipe drops.

25.8.1.4.4

Where the dedicated storage is in open racks, horizontal barriers shall be installed at vertical increments not exceeding 12 ft (3.6 m).

25.8.1.4.5

Where the dedicated storage is in racks with solid shelves, horizontal barriers shall be installed at every tier level of the dedicated storage rack.

25.8.1.5

In-rack sprinklers shall be quick-response, minimum K-8.0 (K-115) installed as close to the underside of the horizontal barrier as possible.

25.8.1.6 Alternative In-Rack Sprinkler Protection Option 1 for Single-Row Racks

25.8.1.6.1

For single-row racks, in-rack sprinklers shall be installed beneath horizontal barriers at each rack upright and within the rack bay as shown in Figure 25.8.1.6.1.

FIGURE 25.8.1.6.1 Alternative In-Rack Sprinkler Protection Option 1 for Single-Row Racks.

25.8.1.6.2

The maximum allowable horizontal spacing between in-rack sprinklers shall not exceed 5 ft (1.5 m).

25.8.1.7 Alternative In-Rack Sprinkler Protection Option 1 for Double-Row Racks

25.8.1.7.1

For double-row racks, in-rack sprinklers shall be installed beneath horizontal barriers at each rack upright within the longitudinal flue space and at the face of the rack as well as at the face of each rack bay as shown in Figure 25.8.1.7.1.

FIGURE 25.8.1.7.1 Alternative In-Rack Sprinkler Protection Option 1 for Double-Row Racks.

25.8.1.7.2

The maximum allowable horizontal spacing between in-rack sprinklers shall not exceed 5 ft (1.5 m) at the rack face and 10 ft (3.0 m) within the longitudinal flue space.

25.8.1.8 Alternative In-Rack Sprinkler Protection Option 1 for Multiple-Row Racks

25.8.1.8.1

For multiple-row racks, an alternating in-rack sprinkler arrangement shall be installed within adjacent transverse flue spaces and with sprinklers at the face of each flue space as shown in Figure 25.8.1.8.1.

FIGURE 25.8.1.8.1 Alternative In-Rack Sprinkler Protection Option 1 for Multiple-Row Racks.

25.8.1.8.2

The maximum allowable horizontal spacing between in-rack sprinklers at the face and at each alternating rack bay shall not exceed 5 ft (1.5 m) and shall not exceed 10 ft (3.0 m) between in-rack sprinklers at every other rack bay.

25.8.1.9 In-Rack Sprinkler System Design

The in-rack sprinkler system design outlined in this section shall be based on a minimum flow of 60 gpm (230 L/min) from the most remote six in-rack sprinklers for single-row racks or the most remote eight in-rack sprinklers for both double-row and multiple-row racks.

25.8.1.10 Ceiling-Level Sprinkler System Design

The ceiling-level sprinkler system shall be designed based on the highest commodity hazard not protected by the in-rack sprinkler system outlined in this section.

25.8.2 In-Rack Sprinkler Protection for Class I Through Class IV and Group A Plastic Commodities That Are Independent of the Ceiling Sprinkler Design, Option 2

25.8.2.1

Protection of closed-top Class I through Class IV and Group A plastic commodities (i.e., no open-top containers) stored on single-, double-, or multiple-row racks without solid shelves shall be permitted to be protected in accordance with this section.

25.8.2.2

In-rack sprinkler systems shall be wet-pipe only.

25.8.2.3

In-rack sprinklers shall be ESFR, pendent, and ordinary-temperature-rated.

25.8.2.3.1

Minimum K-14.0 (K-200) ESFR sprinklers shall be installed where the minimum required flow is 100 gpm (380 L/min) or less.

25.8.2.3.2

Minimum K-22.4 (K-320) ESFR sprinklers shall be installed where the minimum required flow exceeds 100 gpm (380 L/min).

25.8.2.4

Depending on the type of storage rack being protected, in-rack sprinklers shall be positioned horizontally in accordance with Figure 25.8.2.4(a) through Figure 25.8.2.4(f) and the following:

The minimum horizontal distance between in-rack sprinklers shall be 27 in. (700 mm), with the maximum horizontal distance being 4.5 ft (1.4 m), unless shown otherwise in the applicable figures.

Except as shown in Figure 25.8.2.4(c), all in-rack sprinklers shall be located within the footprint of the rack structure.

All face sprinklers shall be positioned so that the horizontal distance between the face of the storage rack and the outer edge of storage, if it protrudes into the storage aisle, does not exceed 18 in. (450 mm).

FIGURE 25.8.2.4(a) Plan View of In-Rack Sprinkler Arrangement for Open Single-Row Racks Up to 3 ft (0.9 m) Deep.

FIGURE 25.8.2.4(b) Plan View of In-Rack Sprinkler Arrangement for Open Single-Row Racks Up to 6 ft (1.8 m) Deep.

FIGURE 25.8.2.4(c) Plan View of In-Rack Sprinkler Arrangement for Open Single-Row Racks Up to 6 ft (1.8 m) Deep Located Against a Wall.

FIGURE 25.8.2.4(d) Plan View of In-Rack Sprinkler Arrangement for Open Double-Row Racks Up to 9 ft (2.7 m) Deep.

FIGURE 25.8.2.4(e) Plan View of In-Rack Sprinkler Arrangement for Open Double-Row Racks Up to 12 ft (3.7 m) Deep.

FIGURE 25.8.2.4(f) Plan View of In-Rack Sprinkler Arrangement for Open Multiple-Row Racks.

25.8.2.5

The maximum allowable vertical distance between in-rack sprinklers for cartoned expanded Group A plastics, exposed nonexpanded Group A plastics, and exposed expanded Group A plastics shall be 30 ft (9.1 m).

25.8.2.5.1

The maximum allowable vertical distance between in-rack sprinklers for Class I through Class IV and cartoned nonexpanded Group A plastics shall be 40 ft (12.2 m).

25.8.2.5.2

A minimum 6 in. (150 mm) vertical distance between the top of storage and the in-rack sprinkler deflector shall be maintained.

25.8.2.6

Regardless of the number of in-rack sprinkler levels installed, the number of sprinkler levels for the in-rack sprinkler system design shall be based on the single most hydraulically remote in-rack sprinkler level and the minimum number of in-rack sprinklers for this level in accordance with Table 25.8.2.6.

Table 25.8.2.6 Number of Sprinklers in the In-Rack Sprinkler Design

IRAS Installation Arrangement; Figure Number of Sprinklers in the In-Rack Design

Class I Through IV and Cartoned Group A Plastics Exposed Group A Plastics

Single-row racks up to 3 ft (0.9 m) deep; Figure 25.8.2.4(a) 4 4

Single-row racks up to 6 ft (1.8 m) deep; Figures 25.8.2.4(b) and 25.8.2.4(c) 5 5

Double- and multiple-row racks; Figures 25.8.2(d), 25.8.2.4(e)

and 25.8.2.4(f)

6 6 and 6\*

\*This represents 6 sprinklers in the most remote rack as well as 6 sprinklers in the nearest adjacent rack. See Figures 25.8.2.4(d), 25.8.2.4(e), and 25.8.2.4(f) to determine which 6 sprinklers to account for in the in-rack sprinkler design for double- and multiple-row racks.

25.8.2.7

The minimum flow required in the system design shall be from the most remote in-rack sprinkler in accordance with Table 25.8.2.7.

Table 25.8.2.7 Minimum Flow in the In-Rack Sprinkler Design

Maximum Vertical IRAS Installation Increment, ft (m) Commodity Hazard Min. K-Factor Minimum Flow from Most Remote IRAS, gpm (L/min)

30 (9.1) Class I through IV and cartoned nonexpanded Group A plastic 14.0 (200) 65 (250)

Cartoned expanded Group A plastic 14.0 (200) 100 (380)

Exposed Group A plastic 22.4 (320) 120 (455)

40 (12.2) Class I through Class IV and cartoned nonexpanded Group A plastic 22.4 (320) 120 (455)

25.8.2.8

A hose stream allowance per Table 20.12.2.6 shall be included as part of the in-rack sprinkler system design.

25.8.2.9

The water supply requirements shall be available for a minimum duration as required in Table 20.12.2.6.

25.8.2.10

The water supply for the in-rack sprinkler system shall be capable of providing the required in-rack sprinkler system design obtained from 25.8.2 independent of the design requirements of the ceiling sprinkler system protecting this same area.

25.8.2.11

The ceiling sprinkler system shall be designed and installed in accordance with the guidelines outlined in Chapters 21, 22, or 23, depending on the commodity hazard and the ceiling-level sprinkler, except as modified in 25.8.2.

25.8.2.11.1\*

Where the in-rack sprinkler system is designed and installed in accordance with 25.8.2, the top level of in-rack sprinklers shall be considered to be a floor for design purposes of the ceiling sprinkler system.

25.8.2.12

The water supply for the ceiling system shall be capable of providing the required ceiling sprinkler system design obtained from Chapters 21, 22, or 23 independent of the design requirements of the in-rack sprinkler system obtained from 25.8.2 and protecting this same area.

25.8.3 In-Rack Sprinkler Protection for Class I Through Class IV and Group A Plastic Commodities That Are Independent of the Ceiling Sprinkler Design, Option 3

25.8.3.1

Class I through Class IV and Group A plastic commodities requiring a greater level of protection than is available from the overhead sprinkler system shall be permitted to be protected in accordance with this section.

25.8.3.1.1

Where the storage rack will not be solely dedicated to the storage of commodities requiring a greater level of protection than is available from the overhead sprinkler system, either of the following shall apply:

Extend the protection prescribed by this section horizontally one pallet load in all directions beyond the commodity storage area requiring the higher level of protection.

Install a vertical barrier to segregate the commodities requiring the higher level of protection from any adjacent commodities.

25.8.3.1.2

Commodities that can be protected by the ceiling-level sprinkler system shall be permitted to be stored vertically above and horizontally adjacent to the portions of the storage rack equipped as prescribed by this section.

25.8.3.2 Horizontal Barriers

Horizontal barriers shall be installed at every tier level of the dedicated storage rack where the rack is equipped with solid shelves.

25.8.3.2.1

Where dedicated storage of Class I through IV and cartoned Group A plastic commodity is in open racks, horizontal barriers shall be installed at vertical increments not exceeding 30 ft (9.1 m).

25.8.3.2.2

Where dedicated storage of exposed Group A plastic commodity is in open racks, horizontal barriers shall be installed at vertical increments not exceeding 20 ft (6.1 m).

25.8.3.2.3

The barriers shall span horizontally so that all flue spaces within the rack bay are covered.

25.8.3.2.4

A maximum 3 in. (75 mm) wide gap shall be permitted at rack uprights.

25.8.3.2.5

The solid barrier shall be installed on a horizontal plane within a rack, beneath which in-rack sprinklers shall be installed, as follows:

The barrier shall be constructed of minimum 22 gauge (.78 mm) sheet metal or of minimum 3/8 in. (10 mm) plywood.

The barrier shall extend to both ends and both aisle faces of the racks covering up both the longitudinal and transverse flue spaces of the rack bays in which they are installed.

The barrier shall be fitted to within 3 in. (75 mm) of any vertical rack member or other equipment that would create an opening, such as vertical in-rack sprinkler pipe drops.

25.8.3.3 In-Rack Sprinklers

Intermediate-temperature extended-coverage CMDA pendent storage sprinklers with a nominal K-factor of K-25.2 (360) shall be installed beneath each horizontal barrier. The deflector of the sprinkler shall be located as close to the underside of the horizontal barrier as possible with the deflector a minimum of 6 in. (150 mm) above the top of the commodity.

25.8.3.3.1 Single-Row Racks

(A)

For single-row racks, sprinklers shall be installed at each rack mid-bay as shown in Figure 25.8.3.3.1(A)(a) for Class I through Class IV and cartoned Group A plastic commodity and Figure 25.8.3.3.1(A)(b) for exposed Group A plastic commodity.

(B)

The maximum linear spacing between sprinklers shall not exceed 10 ft (3.1 m).

FIGURE 25.8.3.3.1(A)(a) Alternative In-Rack Sprinkler Protection for Class I Through Class IV and Cartoned Group A Plastic Commodities in Single-Row Racks, Option 3.

FIGURE 25.8.3.3.1(A)(b) Alternative In-Rack Sprinkler Protection for Exposed Group A Plastic Commodities in Single-Row Racks, Option 3.

25.8.3.3.2 Double-Row Racks

(A)

For double-row racks, sprinklers shall be installed within the longitudinal flue space at each rack mid-bay as shown in Figure 25.8.3.3.2(A)(a) for Class I through Class IV and cartoned Group A plastic commodity and Figure 25.8.3.3.2(A)(b) for exposed Group A plastic commodity.

(B)

The maximum linear spacing between sprinklers shall not exceed 10 ft (3.1 m).

FIGURE 25.8.3.3.2(A)(a) Alternative In-Rack Sprinkler Protection for Class I Through Class IV and Cartoned Group A Plastic Commodities in Double-Row Racks, Option 3.

FIGURE 25.8.3.3.2(A)(b) Alternative In-Rack Sprinkler Protection for Exposed Group A Plastic Commodities in Double-Row Racks, Option 3.

25.8.3.3.3 Multiple-Row Racks

(A)

For multiple-row racks with an overall depth between aisles not exceeding 15 ft 6 in. (4.7 m), an alternating sprinkler arrangement shall be installed within adjacent transverse flue spaces as shown in Figure 25.8.3.3.3(A)(a) for Class I through Class IV and cartoned Group A plastic commodity and Figure 25.8.3.3.3(A)(b) for exposed Group A plastic commodity.

(B)

The maximum linear spacing between sprinklers at the face shall not exceed 10 ft (3.1 m) and shall not exceed 10 ft (3.1 m) between sprinklers at every other bay.

FIGURE 25.8.3.3.3(A)(a) Alternative In-Rack Sprinkler Protection for Class I Through Class IV and Cartoned Group A Plastic Commodities in Multiple-Row Racks, Option 3.

FIGURE 25.8.3.3.3(A)(b) Alternative In-Rack Sprinkler Protection for Exposed Group A Plastic Commodities in Multiple-Row Racks, Option 3.

25.8.3.4

The design of the in-rack sprinkler system shall be based on a minimum flow of 138 gpm (520 L/min) from each of the four most remote sprinklers for single-row and double-row racks or each of the eight most remote in-rack sprinklers (three at each face and two in-between) for multiple-row racks.

25.8.3.5

The in-rack sprinkler demand shall not be required to be hydraulically balanced with the ceiling-level sprinkler system.

25.8.3.6

Ceiling Sprinkler System. The ceiling-level sprinkler system shall be designed based on the highest commodity hazard not protected by the criteria prescribed by this section.

25.9 In-Rack Sprinkler Arrangements in Combination With CMDA Sprinklers at Ceiling Level

25.9.1 Rack Storage of Class I Through Class IV Commodities Up to and Including 25 ft (7.6 m) in Height

The in-rack arrangements for rack storage up to and including 25 ft (7.6 m) in height shall be in accordance with the guidelines outlined in Sections 25.4 through 25.7 as applicable.

25.9.2 Rack Storage of Class I Through Class IV Commodities Over 25 ft (7.6 m) in Height

25.9.2.1 Single-Row Racks

25.9.2.1.1\*

In single-row racks with a maximum of 10 ft (3.0 m) between the top of storage and the ceiling, in-rack sprinklers shall be installed in accordance with Table 25.9.2.1.1 and Figure 25.9.2.1.1(a) through Figure 25.9.2.1.1(e).

Table 25.9.2.1.1 Single-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height with Aisles 4 ft (1.2 m) or More in Width Protected by CMDA Sprinklers at Ceiling Level

Commodity Class In-Rack Sprinklers Approximate Vertical Spacing at Tier Nearest the Vertical Distance and Maximum Horizontal Spacinga, b Figure Maximum Storage Height Stagger

Center of Rackc, d

I, II, III Vertical 20 ft (6.1 m), Horizontal 5 ft (1.5 m) 25.9.2.1.1(a) Higher than 25 ft (7.6 m) No

Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m) with horizontal barriers 25.9.2.1.1(b) No

I, II, III, IV Vertical 15 ft (4.6 m), Horizontal 5 ft (1.5 m) 25.9.2.1.1(c) No

Vertical 15 ft (4.6 m), Horizontal 10 ft (3.0 m) with horizontal barriers 25.9.2.1.1(d) No

Vertical 10 ft (3.0 m), Horizontal 10 ft (3.0 m) 25.9.2.1.1(e) Yes

aWater shields required.

bAll in-rack sprinkler spacing dimensions start from the floor.

cInstall sprinklers at least 3 in. (75 mm) from uprights.

dIn Figure 25.9.2.1.1(a) through Figure 25.9.2.1.1(e), each square represents a storage cube that measures 4 ft to 5 ft (1.2 m to 1.5 m) on aside. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there can be one load to six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.1.1(a) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.1.1(b) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.1.1(c) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.1.1(d) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2.

Notes:

For all storage heights, sprinklers shall be installed in every other tier and staggered as indicated.

Symbol Δ or × indicates sprinklers on vertical or horizontal stagger.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.1.1(e) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3.

25.9.2.1.2

Where a single-row rack is located against a wall, the in-rack sprinkler arrangement shall be permitted to be in accordance with Figure 25.9.2.2.1(a) through Figure 25.9.2.2.1(j).

25.9.2.1.3

Where in-rack sprinkler arrangement figures for single-row racks show in-rack sprinklers in transverse flue spaces centered between the rack faces, it shall be permitted to position these in-rack sprinklers in the transverse flue at any point between the load faces.

25.9.2.2 Double-Row Racks

25.9.2.2.1\*

In double-row racks with a maximum of 10 ft (3.0 m) between the top of storage and the ceiling, in-rack sprinklers shall be installed in accordance with Table 25.9.2.2.1 and Figure 25.9.2.2.1(a) through Figure 25.9.2.2.1(j).

Notes:

Symbol x indicates in-rack sprinklers.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.2.1(a) In-Rack Sprinkler Arrangement, Class I Commodities, Storage Height 25 ft to Maximum 30 ft (7.6 m to Maximum 9.1 m).

Notes:

Sprinklers labeled 1 (the selected array from Table 25.9.2.2.1) shall be required where loads labeled A or B represent top of storage.

Sprinklers labeled 1 and 2 shall be required where loads labeled C or D represent top of storage.

Sprinklers labeled 1 and 3 shall be required where loads labeled E or F represent top of storage.

For storage higher than represented by loads labeled F, the cycle defined by Notes 2 and 3 is repeated, with stagger as indicated.

Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.2.1(b) In-Rack Sprinkler Arrangement, Class I Commodities, Storage Height Over 25 ft (7.6 m).

Notes:

Alternate location of in-rack sprinklers. Sprinklers shall be permitted to be installed above loads A and C or above loads B and D.

Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.2.1(c) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height 25 ft to Maximum 30 ft (7.6 m to Maximum 9.1 m).

Notes:

Sprinklers labeled 1 shall be required where loads labeled A represent the top of storage.

Sprinklers labeled 1 and 2 shall be required where loads labeled B or C represent top of storage.

Sprinklers labeled 1, 2, and 3 shall be required where loads labeled D or E represent top of storage.

Sprinklers labeled 1, 2, 3, and 4 shall be required where loads labeled F or G represent top of storage.

Sprinklers labeled 1, 2, 3, 4, and 5 shall be required where loads labeled H represent top of storage.

For storage higher than represented by loads labeled H, the cycle defined by Notes 3, 4, and 5 is repeated with stagger as indicated.

The indicated face sprinklers shall be permitted to be omitted where commodity consists of unwrapped or unpackaged metal parts on wood pallets.

Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.2.1(d) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 1.

Notes:

Sprinklers labeled 1 (the selected array from Table 25.9.2.2.1) shall be required where loads labeled A or B represent top of storage.

Sprinklers labeled 1 and 2 shall be required where loads labeled C or D represent top of storage.

Sprinklers labeled 1 and 3 shall be required where loads labeled E or F represent top of storage.

For storage higher than represented by loads labeled F, the cycle defined by Notes 2 and 3 is repeated, with stagger as indicated.

Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.2.1(e) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 2.

Notes:

Sprinklers labeled 1 (the selected array from Table 25.9.2.2.1) shall be required where loads labeled A or B represent top of storage.

Sprinklers labeled 1 and 2 shall be required where loads labeled C or D represent top of storage.

Sprinklers labeled 1 and 3 shall be required where loads labeled E represent top of storage.

Sprinklers labeled 1 and 4 shall be required where loads labeled F or G represent top of storage.

For storage higher than represented by loads labeled G, the cycle defined by Notes 2, 3, and 4 is repeated.

Symbol x indicates face and in-rack sprinklers.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.2.1(f) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 3.

Notes:

Sprinklers labeled 1 (the selected array from Table 25.9.2.2.1) shall be required where loads labeled A or B represent top of storage.

Sprinklers labeled 1 and 2 shall be required where loads labeled C or D represent top of storage.

Sprinklers labeled 1 and 3 shall be required where loads labeled E or F represent top of storage.

For storage higher than represented by loads labeled F, the cycle defined by Notes 2 and 3 is repeated.

Symbols o, Δ, and x indicate sprinklers on vertical or horizontal stagger.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.2.1(g) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 4.

Notes:

Sprinklers labeled 1 (the selected array from Table 25.9.2.2.1) shall be required where loads labeled A or B represent top of storage.

Sprinklers labeled 1 and 2 shall be required where loads labeled C or D represent top of storage.

Sprinklers labeled 1, 2, and 3 shall be required where loads labeled E or F represent top of storage.

Sprinklers labeled 1, 2, 3, and 4 shall be required where loads labeled G represent top of storage.

Sprinklers labeled 1, 2, 3, 4, and 5 shall be required where loads labeled H represent top of storage.

Sprinklers labeled 1, 2, 3, 4, and 6 (not 5) shall be required where loads labeled I or J represent top of storage.

Sprinklers labeled 1, 2, 3, 4, 6, and 7 shall be required where loads labeled K represent top of storage.

Sprinklers labeled 1, 2, 3, 4, 6, and 8 shall be required where loads labeled L represent top of storage.

Sprinklers labeled 1, 2, 3, 4, 6, 8, and 9 shall be required where loads labeled M or N represent top of storage.

For storage higher than represented by loads labeled N, the cycle defined by Notes 1 through 9 is repeated, with stagger as indicated. In the cycle, loads labeled M are equivalent to loads labeled A.

Symbols o, x, and Δ indicate sprinklers on vertical or horizontal stagger.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.2.1(h) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Storage Height Over 25 ft (7.6 m) — Option 1.

Notes:

Sprinklers labeled 1 (the selected array from Table 25.9.2.2.1) shall be required where loads labeled A or B represent top of storage.

Sprinklers labeled 1 and 2 shall be required where loads labeled C or D represent top of storage.

Sprinklers labeled 1 and 3 shall be required where loads labeled E or F represent top of storage.

For storage higher than represented by loads labeled F, the cycle defined by Notes 2 and 3 is repeated.

Symbol x indicates face and in-rack sprinklers.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.2.1(i) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Storage Height Over 25 ft(7.6 m) — Option 2.

Notes:

Sprinklers labeled 1 (the selected array from Table 25.9.2.2.1) shall be required where loads labeled A or B represent top of storage.

Sprinklers labeled 1 and 2 and barrier labeled 1 shall be required where loads labeled C represent top of storage.

Sprinklers and barriers labeled 1 and 3 shall be required where loads labeled D or E represent top of storage.

For storage higher than represented by loads labeled E, the cycle defined by Notes 2 and 3 is repeated.

Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.

Symbol o indicates longitudinal flue space sprinklers.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.2.1(j) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Storage Height Over 25 ft (7.6 m) — Option 3.

Table 25.9.2.2.1 Double-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height with Aisles 4 ft (1.2 m) or More in Width Protected by CMDA Sprinklers at Ceiling Level

Commodity Class In-Rack Sprinklers Approximate Vertical Spacing at Tier Nearest the Vertical Distance and Maximum Horizontal Spacinga,b Figure Maximum Storage Height Stagger

Longitudinal Fluec Faced,e

I Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m) under horizontal barriers None 25.9.2.2.1(a) 30 ft (9.1 m) No

Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m) Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m) 25.9.2.2.1(b) Higher than 25 ft (7.6 m) Yes

I, II, III Vertical at 10 ft (3.0 m) or at 15 ft (4.6 m) and at 25 ft (7.6 m) None 25.9.2.2.1(c) 30 ft (9.1 m) Yes

Vertical 10 ft (3.0 m), Horizontal 10 ft (3.0 m) Vertical 30 ft (9.1 m), Horizontal 10 ft (3.0 m) 25.9.2.2.1(d) Higher than 25 ft (7.6 m) Yes

Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m) Vertical 20 ft (6.1 m), Horizontal 5 ft (1.5 m) 25.9.2.2.1(e) Yes

Vertical 25 ft (7.6 m), Horizontal 5 ft (1.5 m) Vertical 25 ft (7.6 m), Horizontal 5 ft (1.5 m) 25.9.2.2.1(f) No

Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m) under horizontal barriers with two lines of staggered in-rack sprinklers 25.9.2.2.1(g) Yes

I, II, III, IV Vertical 15 ft (4.6 m), Horizontal 10 ft (3.0 m) Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m) 25.9.2.2.1(h) Yes

Vertical 20 ft (6.1 m), Horizontal 5 ft (1.5 m) Vertical 20 ft (6.1 m), Horizontal 5 ft (1.5 m) 25.9.2.2.1(i) No

Vertical 15 ft (4.6 m), Horizontal 10 ft (3.0 m) under horizontal barriers with two lines of staggered in-rack sprinklers 25.9.2.2.1(j) Yes

aWater shields required.

bAll in-rack sprinkler spacing dimensions start from the floor.

cInstall sprinklers at least 3 in. (75 mm) from uprights.

dFace sprinklers shall not be required for a Class I commodity consisting of noncombustible products on wood pallets (without combustible containers), except for arrays shown in Figure 25.9.2.2.1(g) and Figure 25.9.2.2.1(j).

eIn Figure 25.9.2.2.1(a) through Figure 25.9.2.2.1(j), each square represents a storage cube that measures 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there can be one load to six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

25.9.2.3 Multiple-Row Racks

25.9.2.3.1\*

In multiple-row racks with a maximum of 10 ft (3.0 m) between the top of storage and the ceiling, in-rack sprinklers shall be in accordance with Table 25.9.2.3.1 and Figure 25.9.2.3.1(a) through Figure 25.9.2.3.1(c).

Notes:

Sprinklers labeled 1 shall be required if loads labeled A represent top of storage.

Sprinklers labeled 1 and 2 shall be required if loads labeled B or C represent top of storage.

Sprinklers labeled 1 and 3 shall be required if loads labeled D or E represent top of storage.

For storage higher than represented by loads labeled E, the cycle defined by Notes 2 and 3 is repeated, with stagger as indicated.

Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.3.1(a) In-Rack Sprinkler Arrangement, Class I Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m).

Notes:

Sprinklers labeled 1 and 2 shall be required if loads labeled A represent top of storage.

Sprinklers labeled 1 and 3 shall be required if loads labeled B or C represent top of storage.

For storage higher than represented by loads labeled C, the cycle defined by Notes 2 and 3 is repeated, with stagger as indicated.

Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.3.1(b) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m).

Notes:

Sprinklers labeled 1, 2, and 3 shall be required if loads labeled A represent top of storage.

Sprinklers labeled 1, 2, and 4 shall be required if loads labeled B represent top of storage.

For storage higher than represented by loads labeled B, the cycle defined by Notes 1 and 2 is repeated, with stagger as indicated.

Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.2.3.1(c) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m).

Table 25.9.2.3.1 Multiple-Row Racks of Nonencapsulated Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height Protected by CMDA Sprinklers at Ceiling Level

Commodity Class In-Rack Sprinklersa,b,c Stagger Figure Maximum Allowable Storage Height Above Top In-Rack Sprinkler Level

Maximum Vertical Spacing Maximum Horizontal Spacing in a Flue Maximum Horizontal Spacing across Flue

ft m ft m ft m ft m

I 20 6.1 12 3.7 10 3 Between adjacent flues 25.9.2.3.1(a) 10 3

I, II, III 15 4.6 10 3 10 3 25.9.2.3.1(b) 10 3

I, II, III, IV 10 3 10 3 10 3 25.9.2.3.1(c) 5 1.5

aAll four rack faces shall be protected by sprinklers located within the racks and no more than 18 in. (450 mm) from the faces, as indicated in Figure 25.9.2.3.1(a) through Figure 25.9.2.3.1(c). It shall not be required for each sprinkler level to protect all faces.

bAll in-rack sprinkler spacing dimensions start from the floor.

cIn Figure 25.9.2.3.1(a) through Figure 25.9.2.3.1(c), each square represents a storage cube that measures 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there can be one load to six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

25.9.3 Rack Storage of Group A Plastic Commodities Up to and Including 25 ft (7.6 m) in Height

25.9.3.1

Where rack storage of cartoned Group A plastic commodities, encapsulated or nonencapsulated, having a clearance to ceiling up to and including 10 ft (3.1 m) require in-rack sprinklers, in-rack sprinkler arrangements shall be selected from Figure 25.9.3.1(a) through Figure 25.9.3.1(e).

Notes:

Single level of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed as indicated in the transverse flue spaces.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.3.1(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to 15 ft (4.6 m) in Height with Up to 10 ft (3.0 m) Clearance to Ceiling.

Notes:

Single level of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed as indicated in the transverse flue spaces.

Single level of in-rack sprinklers [K-8.0 (115) operating at 15 psi (1.0 bar) minimum or K-5.6 (80) operating at 30 psi (2.1 bar) minimum] installed on 4 ft to 5 ft (1.2 m to 1.5 m) spacings located, as indicated, in the longitudinal flue space at the intersection of every transverse flue space.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.3.1(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to 20 ft (6.1 m) in Height with <5 ft (1.5 m) Clearance to Ceiling.

Notes:

Single level of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed as indicated in the transverse flue spaces.

Two levels of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed as indicated and staggered in the transverse flue space.

Single level of in-rack sprinklers [K-8 (115) operating at 15 psi (1.0 bar) or K-5.6 (80) operating at 30 psi (2.1 bar) minimum] installed on 4 ft to 5 ft (1.2 m to 1.5 m) spacings located, as indicated, in the longitudinal flue space at the intersection of every transverse flue space.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.3.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to 20 ft (6.1 m) in Height with 5 ft to 10 ft (1.5 m to 3.0 m) Clearance to Ceiling.

Notes:

Single level of in-rack sprinklers [K-8.0 (115) operating at 15 psi (1.0 bar) minimum or K-5.6 (80) operating at 30 psi (2.1 bar) minimum] installed on 4 ft to 5 ft (1.2 m to 1.5 m) spacings located, as indicated, in the longitudinal flue space at the intersection of every transverse flue space.

Two levels of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed as indicated and staggered in the transverse flue space.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.3.1(d) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to 25 ft (7.6 m) in Height with <5 ft (1.5 m) Clearance to Ceiling.

Notes:

Two levels of in-rack sprinklers [K-5.6 (80) or K-8.0 (115) operating at 15 psi (1.0 bar) minimum] installed on 8 ft to 10 ft (2.4 m to 3.0 m) spacings located as indicated and staggered in the transverse flue space.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.3.1(e) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to 25 ft (7.6 m) in Height with 5 ft to 10 ft (1.5 m to 3.0 m) Clearance to Ceiling.

25.9.3.2\*

Notes in each figure shall be permitted to clarify options.

25.9.3.3\*

Where rack storage of exposed nonexpanded Group A plastic commodities, encapsulated or nonencapsulated, require in-rack sprinklers, in-rack sprinkler arrangements shall be selected from Figure 25.9.3.3(a) through Figure 25.9.3.3(k).

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.3.3(a) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building — Option 1.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.3.3(b) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building — Option 2.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.3.3(c) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 15 ft (4.6 m) in Height in Up to a 25 ft (7.6 m) High Building — Option 1.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.3.3(d) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 15 ft (4.6 m) in Height in Up to a 25 ft (7.6 m) High Building — Option 2.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.3.3(e) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 25 ft (7.6 m) High Building — Option 1.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.3.3(f) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 25 ft (7.6 m) High Building — Option 2.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.3.3(g) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building — Option 1.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.3.3(h) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building — Option 2.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Sprinklers labeled 1 and 3, 2 and 3, or 2 and 4 shall be required when the storage height exceeds 15 ft (4.6 m) but does not exceed 20 ft (6.1 m)

FIGURE 25.9.3.3(i) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building — Option 3.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.3.3(j) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 25 ft (7.6 m) in Height in Up to a 35 ft (11 m) High Building — Option 1

.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.3.3(k) In-Rack Sprinkler Arrangement, Exposed Nonexpanded Group A Plastic Commodities Up to 25 ft (7.6 m) in Height in Up to a 35 ft (11 m) High Building — Option 2.

25.9.4 Rack Storage of Group A Plastic Commodities Over 25 ft (7.6 m) in Height

25.9.4.1 Single-Row Racks

25.9.4.1.1

Where single-row rack storage of cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height, in-rack sprinklers shall be arranged in accordance with one of the options in Figure 25.9.4.1.1(a) through Figure 25.9.4.1.1(d).

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.4.1.1(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.4.1.1(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.4.1.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.4.1.1(d) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 4.

25.9.4.1.2

Where a single-row rack of cartoned Group A plastic commodities is located against a wall, the in-rack sprinkler arrangement shall be permitted to be in accordance with Figure 25.9.4.2.1(a) or Figure 25.9.4.2.1(b).

25.9.4.1.3

Where single-row rack storage of exposed nonexpanded Group A plastic commodities, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and the rack depth is a maximum 3 ft (0.9 m), in-rack sprinklers shall be arranged in accordance with Figure 25.9.4.1.3.

FIGURE 25.9.4.1.3 In-Rack Sprinkler Arrangement, Exposed, Nonexpanded Group A Plastic Commodities, Single-Row Racks Up to 3 ft (0.9 m) Deep, Storage Height Over 25 ft (7.6 m).

25.9.4.1.3.1

The highest level of in-rack sprinklers shall not be more than 10 ft (3.0 m) below the top of storage.

25.9.4.1.3.2

Where Figure 25.9.4.1.3 is used, aisles shall be at least 4 ft (1.2 m) wide and the ceiling sprinklers shall be designed for a minimum discharge density of 0.45 gpm/ft2 over 2000 ft2 (18.3 mm/min over 185 m2).

25.9.4.1.4

Where single-row rack storage of exposed nonexpanded Group A plastic commodities, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and the rack depth is greater than 3 ft (0.9 m), in-rack sprinklers shall be arranged in accordance with Section 25.8.

25.9.4.2 Double-Row Racks

25.9.4.2.1

Where double-row rack storage of cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height, in-rack sprinklers shall be arranged in accordance with one of the options in Figure 25.9.4.2.1(a) or Figure 25.9.4.2.1(b). Figure 25.9.4.2.1(c) shall be permitted to be used as an option for double-row racks up to 9 ft (2.7 m) deep.

Notes:

Sprinklers and barriers labeled 1 shall be required where loads labeled A or B represent top of storage.

Sprinklers labeled 1 and 2 and barriers labeled 1 shall be required where loads labeled C represent top of storage.

Sprinklers and barriers labeled 1 and 3 shall be required where loads labeled D or E represent top of storage.

For storage higher than represented by loads labeled E, the cycle defined by Notes 2 and 3 is repeated.

Symbol Δ or x indicates face sprinklers on vertical or horizontal stagger.

Symbol o indicates longitudinal flue space sprinklers.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.4.2.1(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Double-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.

Notes:

Sprinklers labeled 1 shall be required where loads labeled A or B represent top of storage.

Sprinklers labeled 1 and 2 shall be required where loads labeled C represent top of storage.

Sprinklers labeled 1 and 3 shall be required where loads labeled D or E represent top of storage.

For storage higher than loads labeled F, the cycle defined by Notes 2 and 3 is repeated.

Symbol x indicates face and in-rack sprinklers.

Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.4.2.1(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Double-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2.

FIGURE 25.9.4.2.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Double-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3.

25.9.4.2.2\*

Where double-row rack storage of exposed nonexpanded Group A plastic commodities, whether encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and has minimum 4 ft (1.2 m) wide aisles, in-rack sprinklers shall be arranged in accordance with Section 25.8.

25.9.4.2.3

Protection of Group A plastic commodities that are exposed and nonexpanded, whether encapsulated or nonencapsulated racks and with a clearance to ceiling up to and including 10 ft (3.1 m), shall be permitted to only use in-rack sprinkler arrangements that are specifically permitted to be used with exposed nonexpanded Group A plastic commodities.

25.9.4.3 Multiple-Row Racks

25.9.4.3.1\*

Where multiple-row rack storage of exposed nonexpanded Group A plastic commodities, encapsulated or nonencapsulated, or cartoned Group A plastic commodities, expanded or nonexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height, in-rack sprinklers shall be arranged in accordance with one of the options in Figure 25.9.4.3.1(a) through Figure 25.9.4.3.1(f).

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.4.3.1(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1 [10 ft (3.0 m) Maximum Spacing].

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.4.3.1(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2 [10 ft (3.0 m) Maximum Spacing].

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.4.3.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1 [5 ft (1.5 m) Maximum Spacing].

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.4.3.1(d) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2 [5 ft (1.5 m) Maximum Spacing].

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.4.3.1(e) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3 [5 ft (1.5 m) Maximum Spacing].

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

FIGURE 25.9.4.3.1(f) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 4 [5 ft (1.5 m) Maximum Spacing].

25.9.5 In-Rack Sprinkler Arrangements Due to Excessive Clearance

25.9.5.1

Where the clearance to ceiling for rack storage of Class 1 through Class IV commodities up to and including 25 ft (7.6 m) in height protected by CMDA ceiling-level sprinklers exceeds 20 ft (6.1 m) and the ceiling-level protection is not capable of providing the protection needed for the storage height that would result in a clearance to ceiling of 20 ft (6.1 m), one level of supplemental, quick-response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection shall be installed.

25.9.5.2

Where the clearance to ceiling for rack storage of Group A plastic commodities up to and including 25 ft (7.6 m) in height protected by CMDA ceiling-level sprinklers exceeds 10 ft (3.0 m), and the ceiling-level protection is not capable of providing the protection needed for the storage height that would result in a clearance to ceiling of 10 ft (3.0 m), one level of supplemental, quick-response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection shall be installed.

25.9.5.3

Where the clearance to ceiling exceeds 10 ft (3.0 m) for rack storage over 25 ft (7.6 m) in height, and the ceiling-level protection is not capable of providing the protection needed for the storage height that would result in a clearance to ceiling of 10 ft (3.0 m), one level of supplemental, quick-response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection shall be installed.

25.9.5.4

Where the supplemental in-rack sprinkler protection has been installed in accordance with this section, the ceiling-level sprinkler system design shall be based on the storage height that results in an acceptable clearance to ceiling.

25.9.5.5

Where in-rack sprinklers are required for the actual storage height based on a theoretical acceptable clearance to ceiling, in-rack sprinklers shall be installed as indicated by that criteria and supplemented as outlined in this section.

25.9.6 Rack Storage of Rubber Tires Up to and Including 20 ft (6.1 m) in Height

The in-rack arrangements for rack storage of rubber tires, either on-side or on-tread, up to and including 20 ft (6.1 m) in height shall be in accordance with the guidelines outlined in Sections 25.4 through 25.7 as applicable.

25.10 In-Rack Sprinkler Arrangements in Combination With CMSA Sprinklers at Ceiling Level

25.10.1\* Rack Storage of Class I Through Class IV and Group A Plastic Commodities

The in-rack arrangements for rack storage of Class I through Class IV and Group A plastic commodities protected by CMSA sprinklers at ceiling level shall be in accordance with the guidelines outlined in Sections 25.4 through 25.7 as applicable.

25.11 In-Rack Sprinkler Arrangements in Combination With ESFR Sprinklers at Ceiling Level

25.11.1 Rack Storage of Class I Through Class IV and Group A Plastic Commodities

The in-rack arrangements for rack storage of Class I through Class IV and Group A plastic commodities protected by ESFR sprinklers at ceiling level shall be in accordance with the guidelines outlined in Sections 25.4 through 25.7 as applicable.

25.12 Design Criteria for In-Rack Sprinklers in Combination With Ceiling-Level Sprinklers

25.12.1 General

25.12.1.1

In-rack sprinkler design criteria for Group A plastic commodities shall be permitted for the protection of the same storage height and configuration of Class I, II, III, and IV commodities.

25.12.1.2

Pipe sizing of an in-rack sprinkler system shall be permitted to be based on hydraulic calculations and not restricted by any pipe schedule.

25.12.1.3

Where in-rack sprinklers are being installed to protect a storage rack and, due to the length of the rack, fewer in-rack sprinklers will be installed than the number of in-rack sprinklers specified in the in-rack design, the in-rack sprinkler design shall be based on only those in-rack sprinklers installed within the protected rack.

25.12.1.4

Where in-rack sprinkler arrangements have been installed in accordance with this chapter, except for Section 25.8, the flow and pressure requirements of both the ceiling and in-rack sprinkler systems over the same protected area shall be hydraulically balanced together to the higher sprinkler system pressure requirement at their point of connection.

25.12.1.5

The minimum water supply requirements for a hydraulically designed occupancy hazard automatic in-rack sprinkler system shall be determined by adding the hose stream allowance from Table 20.12.2.6 to the water supply for ceiling-level sprinklers determined in Section 25.2, unless indicated otherwise.

25.12.2 Number of Operating In-Rack Sprinklers

25.12.2.1

The number of in-rack sprinklers in the design of the in-rack sprinkler system shall be in accordance with Table 25.12.2.1.

Table 25.12.2.1 In-Rack Sprinkler System Design: Number of In-Rack Sprinklers

Type of Storage Commodity Class Rack Type Ceiling Sprinkler Type No. of Required In-Rack Sprinkler Levels No. of In-Rack Sprinklers in the Design

Miscellaneous Class I through IV, Group A plastics, and rubber tires Any Any Any 4

Class I through III Solid shelf Any One 6

Any More than one 10 (5 on each of the top two levels)

Open CMDA One 6

CMDA More than one 10 (5 on each of the top two levels)

Class I through IV Open CMSA One 8

Class I through IV and Group A plastics Open ESFR One 8

Class IV Open CMDA More than one 10 (5 on each of the top two levels)

Class IV and Group A plastics Solid shelf Any One 8

More than one 14 (7 on each of the top two levels)

Open CMDA One 8

More than one 14 (7 on each of the top two levels)

Group A plastics Open CMSA One 8

CMDA One 12

25.12.3 In-Rack Sprinkler Flow/Pressure

25.12.3.1

The required flow or pressure required from the most remote in-rack sprinkler in the design of the in-rack sprinkler system shall be in accordance with Table 25.12.3.1.

Table 25.12.3.1 In-Rack Sprinkler System Design: Minimum Required Flow/Pressure from In-Rack Sprinklers

Type of Storage Commodity Class Rack Type Ceiling Sprinkler Type Storage Height Minimum Design Flow/Pressure for In-Rack Sprinklers

ft m

Miscellaneous Class I through IV, Group A plastics, and rubber tires Any Any Any Any 15 psi (1.0 bar)

Storage not meeting the definition of miscellaneous Class I through IV Open CMDA Up to 25 Up to 7.6 15 psi (1.0 bar)

CMSA Any Any 15 psi (1.0 bar)

Class I through IV and Group A plastics Open CMDA Over 25 Over 7.6 30 gpm (115 L/min)

ESFR Any Any 60 gpm (230 L/min)

Solid shelves Any Any Any 30 gpm (115 L/min)

Group A plastics Open CMDA Up to 25 Up to 7.6 15 psi (1.0 bar)

CMSA Up to 25 Up to 7.6 15 psi (1.0 bar)

Rubber tires Open CMDA Any Any 30 psi (2.1 bar)