



## Committee Input No. 402-NFPA 30-2015 [ Section No. 9.4 ]

### 9.4 Acceptable Containers.

#### 9.4.1\*

Only the following approved containers, intermediate bulk containers, and portable tanks shall be used for Class I, Class II, and Class IIIA liquids:

- (1) Metal containers, metal intermediate bulk containers, and metal portable tanks meeting the requirements of and containing products authorized by the U.S. Department of Transportation Hazardous Materials Regulations in Title 49, Code of Federal Regulations, Parts 100–199, or by Part 6 of the UN *Recommendations on the Transport of Dangerous Goods*
- (2) Plastic or metal consumer-use containers meeting the requirements of, and used within the scope of, one or more of the following specifications:
  - (a) ASTM F 852, *Standard Specification for Portable Gasoline Containers for Consumer Use*
  - (b) ASTM F 976, *Standard Specification for Portable Kerosene and Diesel Containers for Consumer Use*
- (3) Nonmetallic or metallic commercial/industrial safety cans meeting the requirements of, and used within the scope of, one or more of the following specifications:
  - (a) ANSI/UL 30, *Standard for Metal Safety Cans*
  - (b) ANSI/UL 1313, *Standard for Nonmetallic Safety Cans for Petroleum Products*
  - (c) FM Global *Approval Standard for Safety Containers and Filling, Supply, and Disposal Containers* — Class Number 6051 and 6052
- (4) Plastic containers that meet requirements set by, and contain products authorized by, the following:
  - (a) The U.S. Department of Transportation Hazardous Materials Regulations in Title 49, Code of Federal Regulations, Parts 100–199, or by Part 6 of the UN publication, *Recommendations on the Transport of Dangerous Goods*
  - (b) Items 256 or 258 of the National Motor Freight Classification (NMFC) for liquids that are not classified as hazardous by the U.S. Department of Transportation Hazardous Materials Regulations in Title 49, Code of Federal Regulations, Parts 100–199, or by Part 6 of the UN publication *Recommendations on the Transport of Dangerous Goods*
- (5) Fiber drums that meet the following:
  - (a) Requirements of Items 294 and 296 of the *National Motor Freight Classification* (NMFC) or of Rule 51 of the Uniform Freight Classification (UFC), for Types 2A, 3A, 3B-H, 3B-L, or 4A
  - (b) Requirements of, and containing liquid products authorized by, either the U.S. Department of Transportation Hazardous Materials Regulations in Title 49, Code of Federal Regulations, Chapter I, or by the U.S. Department of Transportation exemption
- (6)\* Rigid nonmetallic intermediate bulk containers that meet requirements set by, and contain products authorized by, the following:
  - (a) The U.S. Department of Transportation Hazardous Materials Regulations in Title 49, Code of Federal Regulations, Parts 100–199, or by Part 6 of the UN publication, *Recommendations on the Transport of Dangerous Goods*, for Classes 31H1, 31H2, and 31HZ1
  - (b) The *National Motor Freight Classification* (NMFC), or the International Safe Transit Association for liquids that are not classified as hazardous by the U.S. Department of Transportation Hazardous Materials Regulations in Title 49, Code of Federal Regulations, Parts 100–199, or by Part 6 of the UN publication *Recommendations on the Transport of Dangerous Goods*
- (7) Glass containers up to the capacity limits stated in [Table 9.4.3](#) and in accordance with U.S. Department of Transportation Hazardous Materials Regulations in Title 49, Code of Federal Regulations, Parts 100–199

#### 9.4.1.1

For protected storage, rigid nonmetallic intermediate bulk containers, as described in [9.4.1\(6\)](#), shall be subjected to a standard fire test that demonstrates acceptable inside storage fire performance and shall be listed and labeled.

**9.4.1.2**

Medicines, beverages, foodstuffs, cosmetics, and other common consumer products, where packaged according to commonly accepted practices for retail sales, shall be exempt from the requirements of 9.4.1 and 9.4.3.

**9.4.2**

Each portable tank or intermediate bulk container shall be provided with one or more devices installed in the top with sufficient emergency venting capacity to limit internal pressure under fire exposure conditions to a gauge pressure of 10 psi (70 kPa) or 30 percent of the bursting pressure of the portable tank, whichever is greater.

**9.4.2.1**

The total venting capacity shall be not less than that specified in 22.7.3.2 or 22.7.3.4.

**9.4.2.2**

At least one pressure-actuated vent having a minimum capacity of 6000 ft<sup>3</sup> (170 m<sup>3</sup>) of free air per hour at an absolute pressure of 14.7 psi (101 kPa) and 60°F (15.6°C) shall be used. The vent shall be set to open at not less than a gauge pressure of 5 psi (35 kPa).

**9.4.2.3**

If fusible vents are used, they shall be actuated by elements that operate at a temperature not exceeding 300°F (150°C). Where plugging of a pressure-actuated vent can occur, such as when used for paints, drying oils, and similar materials, fusible plugs or venting devices that soften to failure at a maximum of 300°F (150°C) under fire exposure shall be permitted to be used for the entire emergency venting requirement.

**9.4.3**

The maximum allowable size of a container, intermediate bulk container, or metal portable tank for Class I, Class II, and Class IIIA liquids shall not exceed that specified in Table 9.4.3.

*Exception: As provided for in Section 9.1, 9.4.3.1, 9.4.3.2, and 9.4.3.3.*

Table 9.4.3 Maximum Allowable Size — Containers, Intermediate Bulk Containers (IBCs), and Portable Tanks

Container Type	Flammable Liquids			Combustible Liquids	
	Class IA	Class IB	Class IC	Class II	Class IIIA
Glass	1 pt (0.5 L)	1 qt (1 L)	1.3 gal (5 L)	1.3 gal (5 L)	5.3 gal (20 L)
Metal (other than drums) or approved plastic	1.3 gal (5 L)	5.3 gal (20 L)	5.3 gal (20 L)	5.3 gal (20 L)	5.3 gal (20 L)
Safety cans	2.6 gal (10 L)	5.3 gal (20 L)	5.3 gal (20 L)	5.3 gal (20 L)	5.3 gal (20 L)
Metal drum (e.g., UN 1A1/1A2)	119 gal (450 L)	119 gal (450 L)	119 gal (450 L)	119 gal (450 L)	119 gal (450 L)
Approved metal portable tanks and IBCs	793 gal (3000 L)	793 gal (3000 L)	793 gal (3000 L)	793 gal (3000 L)	793 gal (3000 L)
Rigid plastic IBCs (UN 31H1 or 31H2) and composite IBCs with rigid inner receptacle (UN31HZ1)	NP	NP	NP	793 gal (3000 L)	793 gal (3000 L)
Composite IBCs with flexible inner receptacle (UN31HZ2) and DOT/UN-approved flexible IBCs	NP	NP	NP	NP	NP
Non-bulk Bag-in-Box	NP	NP	NP	NP	NP
Polyethylene UN1H1 and UN1H2, or as authorized by DOT exemption	1.3 gal (5 L)	5.3 gal (20 L)*	5.3 gal (20 L)*	119 gal (450 L)	119 gal (450 L)
Fiber drum					
NMFC or UFC Type 2A; Types 3A, 3B-H, or 3B-L; or Type 4A	NP	NP	NP	119 gal (450 L)	119 gal (450 L)

NP: Not permitted for the container categories so classified unless a fire protection system is provided that is developed in accordance with 16.3.6 and is approved for the specific container and protection against static electricity is provided.

\*See 9.4.3.1.

**9.4.3.1**

Class IB and Class IC water-miscible liquids shall be permitted to be stored in plastic containers up to 60 gal (230 L) in size, if stored and protected in accordance with Table 16.5.2.7.

**9.4.3.2**

Class IA and Class IB liquids shall be permitted to be stored in glass containers of not more than 1.3 gal (5 L) capacity if the required liquid purity (such as American Chemical Society analytical reagent grade or higher) would be affected by storage in metal containers or if the liquid can cause excessive corrosion of a metal container.

**9.4.3.3**

Leaking or damaged containers up to 60 gal (230 L) capacity shall be permitted to be stored temporarily in accordance with this chapter and Chapters 10 through 12, provided they are enclosed in overpack containers.

**9.4.3.3.1**

To be considered protected storage as defined in 9.3.4 and in accordance with Chapter 16, an overpack container shall be constructed of the same material as the leaking or damaged container.

**9.4.3.3.2**

Metal overpack containers shall be considered nonrelieving style containers.

**Submitter Information Verification**

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**Submittal Date:** Thu Sep 24 14:47:16 EDT 2015

**Committee Statement**

**Committee Statement:** The committee might have to add a reference to low pressure dispensing containers (LPDCs) depending on whether a new project to address these containers is initiated.

**Response Message:**



## Committee Input No. 209-NFPA 30-2015 [ Chapter 16 ]

### Chapter 16 Automatic Fire Protection for Inside Liquid Storage Areas

#### 16.1 Scope.

##### 16.1.1\*

This chapter shall apply to automatic fire protection systems for all inside storage of flammable and combustible liquids in containers, intermediate bulk containers, and portable tanks as specified in Section 9.4.

##### 16.1.2\*

This chapter shall not apply to Class IA flammable liquids or to unstable flammable or combustible liquids.

##### 16.1.3

Storage of liquids that is protected in accordance with the applicable requirements of this chapter shall be considered protected, as defined in 16.2.2. All other storage shall be considered unprotected unless an alternate means of protection has been approved by the authority having jurisdiction.

#### 16.2 Definitions Specific to Chapter 16.

For the purposes of this chapter, the terms in this section shall have the definitions given.

##### 16.2.1 IBC.

Where used in this chapter, *IBC* refers to intermediate bulk containers.

##### 16.2.2 Protected Storage.

Flammable and combustible liquids storage that is protected in accordance with this chapter.

##### 16.2.3\* Relieving-Style Container.

A metal container, a metal intermediate bulk container, or a metal portable tank that is equipped with at least one pressure-relieving mechanism at its top that is designed, sized, and arranged to relieve the internal pressure generated due to exposure to fire so that violent rupture is prevented.

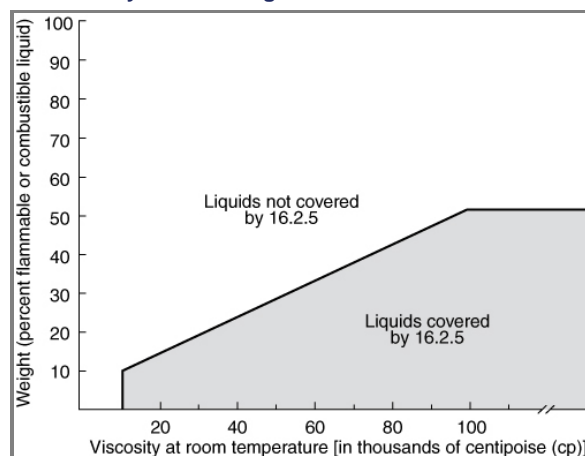
##### 16.2.4\* Unsaturated Polyester Resin (UPR).

A resin that contains up to 50 percent by weight of Class IC, Class II, or Class III liquid, but no Class IA or Class IB liquid.

##### 16.2.5 Viscous Liquid.

A liquid that gels, thickens, or solidifies when heated or whose viscosity at room temperature versus weight percent content of Class I, Class II, or Class III liquid is in the shaded portion of Figure 16.2.5.

**Figure 16.2.5 Viscous Liquid: Viscosity Versus Weight Percent Flammable or Combustible Component.**



##### 16.2.6 Water-Miscible Liquid.

A liquid that mixes in all proportions with water without the use of chemical additives, such as emulsifying agents.

#### 16.3 General Requirements.

**16.3.1**

Where different classes of liquids, container types, and storage configurations are stored in the same protected area, protection shall meet either of the following:

- (1) Requirements of this chapter for the most severe storage fire hazard present
- (2) Where areas are not physically separated by a barrier or partition capable of delaying heat from a fire in one hazard area from fusing sprinklers in an adjacent hazard area, the required protection for the more demanding hazard shall:
  - (a) Extend 20 ft (6 m) beyond its perimeter, but not less than the required minimum sprinkler design area
  - (b) Be provided with means to prevent the flow of burning liquid under emergency conditions into adjacent hazard areas
  - (c) Provide containment and drainage as required by Section 16.8

**16.3.2**

Unless otherwise specified in this chapter, single-row racks shall not be more than 4.5 ft (1.4 m) in depth and double-row racks shall not be more than 9 ft (2.8 m) in depth.

**16.3.3**

When applying the fire protection criteria of this chapter, a minimum aisle space of 6 ft (1.8 m) shall be provided between adjacent piles or adjacent rack sections, unless otherwise specified in the tables in Section 16.5.

**16.3.4**

Viscous liquids, as defined in 16.2.5, shall be permitted to be protected using one of the following:

- (1) For metal containers, the criteria for Class IIIB liquids, as determined by Figure 16.4.1(a)
- (2) For nonmetallic containers, the criteria for Class IIIB liquids, as determined by Figure 16.4.1(b)
- (3) For nonmetallic containers, the criteria for cartoned unexpanded Group A plastics in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, as indicated in Figure 16.4.1(b)

**16.3.5**

Protection systems that are designed and developed based on full-scale fire tests performed at an approved test facility or on other engineered protection schemes shall be considered an acceptable alternative to the protection criteria set forth in this chapter. Such alternative protection systems shall be approved by the authority having jurisdiction.

**16.3.6**

For relieving-style containers of greater than 6.6 gal (25 L) and up to 119 gal (450 L) capacity, the following shall apply:

- (1) The pressure-relieving mechanism shall be listed and labeled in accordance with FM Global *Approval Standard for Plastic Plugs for Steel Drums*, Class Number 6083, or equivalent.
- (2) The pressure-relieving mechanism shall not be painted, and cap seals, if used, shall be made of thermoplastic material.
- (3) For metal containers greater than 6.6 gal (25 L) capacity, the pressure-relieving mechanism shall be unobstructed or an additional pressure-relieving mechanism shall be provided.

**16.3.7**

To be considered protected by Table 16.5.2.9 and Table 16.5.2.10, rigid nonmetallic intermediate bulk containers shall be subjected to a standard fire test that demonstrates acceptable inside storage fire performance and shall be listed and labeled.

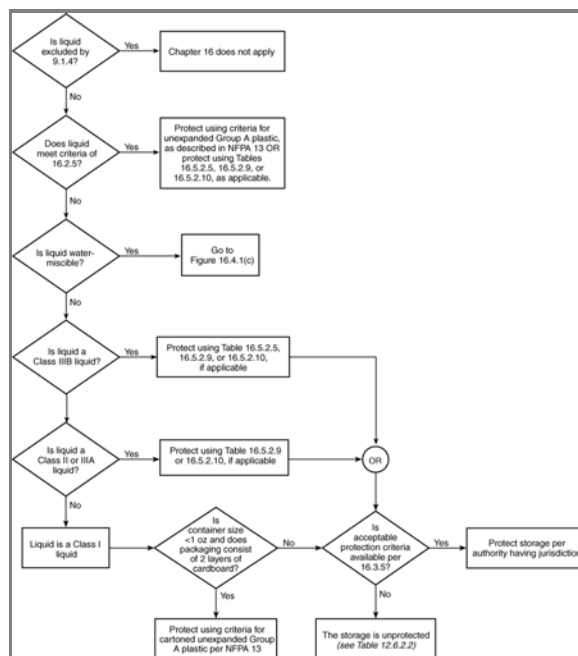
**16.4 Automatic Sprinkler and Foam-Water Sprinkler Fire Protection Systems.****16.4.1**

Where automatic sprinkler systems or low-expansion foam-water sprinkler systems are used to protect storage of liquids, Figure 16.4.1(a), Figure 16.4.1(b), or Figure 16.4.1(c), whichever is applicable, and the appropriate table in Section 16.5 shall be used to determine protection criteria.

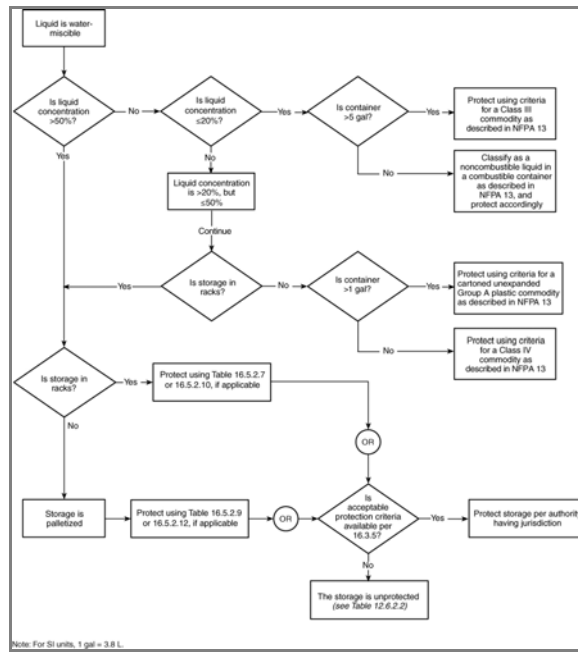
**Figure 16.4.1(a) Fire Protection Criteria Decision Tree for Miscible and Nonmiscible Flammable and Combustible Liquids in Metal Containers.**



**Figure 16.4.1(b) Fire Protection Criteria Decision Tree for Miscible and Nonmiscible Flammable and Combustible Liquids in Nonmetallic Containers.**



**Figure 16.4.1(c) Fire Protection Criteria Decision Tree for Miscible Flammable and Combustible Liquids in Nonmetallic Containers.**



#### 16.4.1.1

Figure 16.4.1(a) shall be used for miscible and nonmiscible flammable and combustible liquids in metal containers, metal portable tanks, and metal intermediate bulk containers.

#### 16.4.1.2

Figure 16.4.1(b) shall be used for miscible and nonmiscible flammable and combustible liquids in nonmetallic containers and in nonmetallic intermediate bulk containers.

#### 16.4.1.3

Figure 16.4.1(c) shall be used for water-miscible flammable and combustible liquids in nonmetallic containers and in nonmetallic intermediate bulk containers.

#### 16.4.2

Automatic sprinkler and foam-water fire protection systems shall be wet pipe, deluge, or preaction systems.

#### 16.4.2.1

If a preaction system is used, it shall be designed so that water or foam solution will immediately discharge from the sprinkler upon sprinkler actuation.

#### 16.4.2.2

A foam-water sprinkler system that meets any of the design criteria specified in the water sprinkler tables in this section shall be acceptable, provided that the system is installed in accordance with NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*.

#### 16.4.3

Water-based fire protection systems shall be inspected, tested, and maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

### 16.5 Fire Protection System Design Criteria.

#### 16.5.1 General.

Paragraphs 16.5.2.1 through 16.5.2.12 and their related tables, Table 16.5.2.1 through Table 16.5.2.12, shall be used to determine the protection criteria and storage arrangement for the applicable liquid class, container type, and storage configuration, as described in 16.5.2.1 through 16.5.2.12 and subject to the provisions of 16.5.1.

#### 16.5.1.1

Table 16.5.2.1 through Table 16.5.2.12 shall apply only to stable liquids.

#### 16.5.1.1.1

The protection criteria in Table 16.5.2.1 through Table 16.5.2.12 shall only be used with ceilings having a pitch of 2 in 12 or less.

**16.5.1.2**

When foam or foam-water fire protection systems are provided, discharge densities shall be determined based on the listing criteria of the foam discharge devices selected, the foam concentrate, the specific liquids to be protected, and the criteria in the appropriate table in this chapter. Where the discharge densities given in the tables differ from those in the listing criteria for the discharge devices, the greater of the two shall be used.

**16.5.1.3**

In-rack sprinklers shall be installed in accordance with the provisions of NFPA 13, *Standard for the Installation of Sprinkler Systems*. In addition, the following modifications shall apply:

- (1) In-rack sprinklers shall be laid out in accordance with 16.5.1.10 and Section 16.6, as applicable.
- (2) Sprinklers in multiple-level in-rack sprinkler systems shall be provided with water shields unless they are separated by horizontal barriers or are specifically listed for installation without water shields.
- (3) A vertical clear space of at least 6 in. (150 mm) shall be maintained between the sprinkler deflector and the top tier of storage.
- (4) Sprinkler discharge shall not be obstructed by horizontal rack structural members.
- (5) Where in-rack sprinklers are installed below horizontal barriers, the deflector shall be located a maximum of 7 in. (180 mm) below the barrier.
- (6) Longitudinal and transverse flue spaces of at least 6 in. (150 mm) shall be maintained between each rack load.

**16.5.1.4**

Ceiling sprinklers shall be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, and shall be permitted to have the following maximum head spacing:

- (1) Classes I, II, and IIIA liquids: 100 ft<sup>2</sup> (9.3 m<sup>2</sup>) per sprinkler
- (2) Class IIIB liquids: 120 ft<sup>2</sup> (11.1 m<sup>2</sup>) per sprinkler

**16.5.1.4.1**

Ordinary or intermediate temperature-rated K-25 extended-coverage sprinklers shall be permitted to be used as standard response high-temperature sprinklers at greater than 144 ft<sup>2</sup> (13 m<sup>2</sup>) coverage, with 12 ft (3.7 m) minimum spacing and a maximum coverage area of 196 ft<sup>2</sup> (18 m<sup>2</sup>) coverage.

**16.5.1.5**

The ceiling heights given in Table 16.5.2.1 through Table 16.5.2.12, excluding Table 16.5.2.8, shall be permitted to be increased by a maximum of 10 percent if an equivalent percent increase in ceiling sprinkler design density is provided.

**16.5.1.6**

Foam-water sprinkler systems shall be designed and installed in accordance with NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*.

**16.5.1.6.1**

Foam-water sprinkler systems shall have at least 15 minutes of foam concentrate, based on the required design flow rate.

**16.5.1.6.2\***

Foam-water sprinkler systems shall provide foam solution at the minimum required concentration with as few as four sprinklers flowing.

**16.5.1.7**

When relieving-style containers are used, both  $\frac{3}{4}$  in. (20 mm) and 2 in. (50 mm) listed and labeled pressure-relieving mechanisms are required on containers greater than 6 gal (23 L) capacity.

**16.5.1.8**

For the purposes of Section 16.5, a rigid nonmetallic intermediate bulk container is one that meets the maximum allowable capacity criteria of Table 9.4.3 and has been listed and labeled in accordance with UL 2368, *Standard for Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids*, or equivalent.



**16.5.1.9**

For the purposes of Section 16.5, the following shall apply:

- (1) 1 gal = 3.8 L; 1 ft = 0.3 m; 1 ft<sup>2</sup> = 0.09 m<sup>2</sup>
- (2) 1 gpm/ft<sup>2</sup> is equivalent to 40.7 L/min/m<sup>2</sup> or 40.7 mm/min
- (3) A gauge pressure of 1 psi is equivalent to a gauge pressure of 6.9 kPa
- (4) SR = standard response sprinkler; QR = quick response sprinkler; ESFR = early suppression fast-response sprinkler; OT = ordinary temperature; HT = high temperature
- (5) Where an ordinary-temperature sprinkler is indicated, an intermediate-temperature sprinkler shall be used where ambient conditions require.

**16.5.1.10**

For the purposes of Section 16.5, the following shall apply to the in-rack sprinkler design layouts specified in Table 16.5.2.1 through Table 16.5.2.12:

- (1) Layout 1, as referenced in Table 16.5.2.1, shall mean one line of in-rack sprinklers 8 ft (2.4 m) above the floor in the longitudinal flue space, with sprinklers spaced not more than 10 ft (3 m) on center.
- (2) Layout 2, as referenced in Table 16.5.2.1, shall mean one line of in-rack sprinklers 6 ft (1.8 m) above the floor and one line of in-rack sprinklers 12 ft (3.6 m) above the floor in the longitudinal flue space, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically.
- (3) Layout 3, as referenced in Table 16.5.2.1 and Table 16.5.2.3, shall mean one line of in-rack sprinklers in the longitudinal flue space at every storage level above the floor except above the top tier, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically, where more than one level of in-rack sprinklers is installed.
- (4) Layout 4, as referenced in Table 16.5.2.1 and Table 16.5.2.3, shall mean one line of in-rack sprinklers in the longitudinal flue space at every other storage level, except above the top tier, beginning above the first storage level, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically, where more than one level of in-rack sprinklers is installed.
- (5) Layout 5, as referenced in Table 16.5.2.1, shall mean one line of in-rack sprinklers in the longitudinal flue space at every storage level above the floor except above the top tier and face sprinklers at the first storage level at each rack upright. In-rack sprinklers shall be spaced not more than 9 ft (2.7 m) on center and shall be staggered vertically, where more than one level of in-rack sprinklers is installed.
- (6) Layout 6, as referenced in Table 16.5.2.1, shall mean one line of in-rack sprinklers in the longitudinal flue space at every other storage level above the first storage level except the top tier and face sprinklers at the first storage level at each rack upright. In-rack sprinklers shall be spaced not more than 10 ft (3 m) on center and shall be staggered vertically, where more than one level of in-rack sprinklers is installed.
- (7) Layout 7, as referenced in Table 16.5.2.8, shall be as shown in Figure 16.6.4(a).
- (8) Layout 8, as referenced in Table 16.5.2.8, shall be as shown in Figure 16.6.4(b) or Figure 16.6.4(c).
- (9) Layout 9, as referenced in Table 16.5.2.8, shall be as shown in Figure 16.6.4(d) or Figure 16.6.4(e).

**16.5.1.11**

The "Fire Test Ref." number given for each entry in Table 16.5.2.1 through Table 16.5.2.12 shall be used to identify in Section D.2 the information on the fire tests on which the protection criteria for that entry are based.

**16.5.1.12**

The water supply shall be sufficient to meet the fixed fire protection demand plus a total of at least 500 gpm (1900 L/min) for inside and outside hose connections for at least 2 hours, unless otherwise specified in this chapter.

**16.5.2 Specific Design Criteria.**

**16.5.2.1**

Table 16.5.2.1 shall apply to the following:

- (1) Automatic sprinkler protection
- (2) Single- or double-row rack storage
- (3) Nonmiscible liquids and miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
- (4) Metal containers, metal portable tanks, metal intermediate bulk containers
- (5) Relieving- or nonrelieving-style containers

Table 16.5.2.1 Design Criteria for Sprinkler Protection of Single- and Double-Row Rack Storage of Liquids in Metal Containers, Portable Tanks, and IBCs

Container Style and Capacity (gal)	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection				In-Rack Sprinkler Protection				Fire Test Ref. [See Table D.2(a)]	
			Sprinkler		Design		Sprinkler		Minimum Discharge Flow (gpm)	Layout (See 16.5.1.10)		Notes
			Type	Response	Density (gpm/ft <sup>2</sup> )	Area (ft <sup>2</sup> )	Type	Response				
<b>NONRELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA</b>												
≤1	16	30	K≥11.2	QR (HT)	0.60	2000	K≥5.6	QR(OT)	30	1	1, 2, 7	1
	20	30	K≥11.2	SR or QR (HT)	0.60	2000	K≥5.6	QR(OT)	30	2	1, 2, 7	2
≤5	25	30	K≥8.0	SR or QR (HT)	0.30	3000	K≥5.6	QR(OT)	30	3	1, 7	3
>5 and ≤60	25	30	K≥11.2	SR (HT)	0.40	3000	K≥5.6	QR or SR(OT)	30	5	1, 7	5
<b>NONRELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB</b>												
≤5	40	50	K≥8.0	SR or QR (HT)	0.30	2000	K≥5.6	QR(OT)	30	4	1, 3, 7	4
>5 and ≤60	40	50	K≥8.0	SR (HT)	0.30	3000	K≥5.6	QR(OT)	30	4	1, 3, 7	6
<b>RELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA</b>												
≤5	14	18	K≥11.2	pendent QR (HT) only	0.65	2000	No in-rack sprinklers required			4	7	
	25	30	K≥8.0	SR or QR (HT)	0.30	3000	K≥5.6	QR(OT)	30	4, 7	1, 5	8
>5 and ≤60	25	30	K≥11.2	SR (HT)	0.60	3000	K≥5.6	QR(OT)	30	6, 7	1	10
Portable tanks and IBCs	25	30	K≥11.2	SR (HT)	0.60	3000	K≥5.6	QR or SR(OT)	30	5, 7	1	12
<b>RELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB</b>												
≤ 5 gal	40	50	K≥8.0	SR or QR (HT)	0.30	2000	K≥5.6	QR(OT)	30	4, 7	1	9
>5 and ≤60	40	50	K≥8.0	SR (HT)	0.30	3000	K≥5.6	QR(OT)	30	4, 7	1, 3	11
Portable tanks and IBCs	40	50	K≥8.0	SR (HT)	0.30	3000	K≥5.6	QR(OT)	30	4, 7	1, 6	13

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft<sup>2</sup> = 0.09 m<sup>2</sup>, 1 gpm/ft<sup>2</sup> = 40.7 L/min/m<sup>2</sup> = 40.7 mm/min.

For definitions of abbreviations used in the Response column, see 16.5.1.9(4). See also 16.5.1.9(5).

Notes:

(1) In-rack sprinkler design shall be based on the following:

(a) Where one level of in-rack sprinklers is installed, the design shall include the 8 most hydraulically remote sprinklers.

(b) Where two levels of in-rack sprinklers are installed, the design shall include the 6 most hydraulically remote sprinklers on each level.

- (c) Where three or more levels of in-rack sprinklers are installed, the design shall include the 6 most hydraulically remote sprinklers on the top three levels.
- (2) Protection for uncartoned or case-cut nonsolid shelf display up to 6.5 ft (2 m) and storage above on pallets in racking and stored on shelf materials, including open wire mesh, or 2 in. × 6 in. (50 mm × 150 mm) wooden slats, spaced a minimum of 2 in. (50 mm) apart.
- (3) Increase ceiling density to 0.60 if more than one level of storage exists above the top level of in-rack sprinklers.
- (4) Double-row racks limited to maximum 6 ft (1.8 m) width.
- (5) For K=8.0 and larger ceiling sprinklers, increase ceiling density to 0.60 over 2000 ft<sup>2</sup> if more than one level of storage exists above the top level of in-rack sprinklers.
- (6) Reduce in-rack sprinkler spacing to maximum 9 ft (2.7 m) centers.
- (7) The minimum in-rack discharge pressure shall not be less than 10 psi.

**16.5.2.2**

Table 16.5.2.2 shall apply to the following:

- (1) Automatic sprinkler protection
- (2) Palletized or stacked storage
- (3) Nonmiscible liquids and miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
- (4) Metal containers, metal portable tanks, metal intermediate bulk containers
- (5) Relieving- or nonrelieving-style containers

Table 16.5.2.2 Design Criteria for Sprinkler Protection of Palletized and Stacked Storage of Liquids in Metal Containers, Portable Tanks, and IBCs

<u>Container Style and Capacity (gal)</u>	<u>Maximum Storage Height (ft)</u>	<u>Maximum Ceiling Height (ft)</u>	<u>Ceiling Sprinkler Protection</u>				<u>Fire Test Ref. [See Table D.2(b)]</u>	
			<u>Sprinkler</u>		<u>Design</u>			
			<u>Type</u>	<u>Response</u>	<u>Density (gpm/ft<sup>2</sup>)</u>	<u>Area (ft<sup>2</sup>)</u>		<u>Notes</u>
<b>NONRELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA</b>								
≤5	4	18	K≥8.0	SR or QR (HT)	0.21	1500	1	1
	5	18	K≥8.0	SR or QR (HT)	0.30	3000	—	2
	6.5	30	K≥11.2	QR (HT)	0.45	3000	—	3
>5 and ≤60	5	18	K≥11.2	SR (HT)	0.40	3000	—	4
<b>NONRELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB</b>								
≤5	18	30	K≥8.0	SR or QR (HT)	0.25	3000	—	5
>5 and ≤60	10	20	K≥8.0	SR (HT)	0.25	3000	—	6
	18	30	K≥8.0	SR (HT)	0.35	3000	—	7
<b>RELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA</b>								
≤5	12	30	K≥11.2 pendent only	QR (HT)	0.60	3000	2	8
>5 and ≤60	5	30	K≥11.2	SR (HT)	0.40	3000	—	9
	6.5	30	K≥11.2	SR (HT)	0.60	3000	3	10
Portable tanks and IBCs	1-high	30	K≥8.0	SR (HT)	0.30	3000	—	14
	2-high	30	K≥11.2	SR (HT)	0.60	3000	—	15
<b>RELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB</b>								
≤5	18	30	K≥8.0	SR or QR (HT)	0.25	3000	—	11
>5 and ≤60	10	20	K≥8.0	SR (HT)	0.25	3000	—	12
	18	30	K≥8.0	SR (HT)	0.35	3000	—	13
Portable tanks and IBCs	1-high	30	K≥8.0	SR (HT)	0.25	3000	—	16
	2-high	30	K≥11.2	SR (HT)	0.50	3000	—	17

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft<sup>2</sup> = 0.09 m<sup>2</sup>, 1 gpm/ft<sup>2</sup> = 40.7 L/min/m<sup>2</sup> = 40.7 mm/min.

For definitions of abbreviations used in the Response column, see 16.5.1.9(4). See also 16.5.1.9(5).

Notes:

- (1) Minimum hose stream demand can be reduced to 250 gpm for 2 hours.
- (2) Sprinklers must also be hydraulically calculated to provide a density of 0.80 gpm/ft<sup>2</sup> over 1000 ft<sup>2</sup>.
- (3) Drums must be placed on open slatted pallet, not nested, to allow pressure relief from drums on lower levels.

**16.5.2.3**

Table 16.5.2.3 shall apply to the following:

- (1) Foam-water sprinkler protection
- (2) Single- or double-row rack storage
- (3) Nonmiscible liquids and miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
- (4) Metal containers, metal portable tanks, metal intermediate bulk containers
- (5) Relieving- or nonrelieving-style containers

Table 16.5.2.3 Design Criteria for Foam-Water Sprinkler Protection of Single- or Double-Row Rack Storage of Liquids in Metal Containers, Portable Tanks, and IBCs

Container Style and Capacity (gal)	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection				In-Rack Sprinkler Protection				Fire Test Ref. [See Table D.2(c)]	
			Sprinkler		Design		Sprinkler		Minimum Discharge Flow (gpm)	Layout (See 16.5.1.10)		Notes
			Type	Response	Density (gpm/ft <sup>2</sup> )	Area (ft <sup>2</sup> )	Type	Response				
<b>NONRELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA</b>												
≤5	25	30	K≥8.0	SR or QR (HT)	0.30	2000	K≥5.6	QR or SR (OT)	30	3	1, 2, 4, 5	1
>5 and ≤60	25	30	K≥8.0	SR (HT)	0.30	3000	K≥5.6	QR or SR (OT)	30	3	1, 3, 4, 5	2
<b>NONRELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB</b>												
≤60	40	50	K≥8.0	SR (HT)	0.30	2000	K≥5.6	QR or SR (OT)	30	4	1, 5	3
<b>RELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA</b>												
≤5	25	30	K≥8.0	SR or QR (HT)	0.30	2000	K≥5.6	QR or SR (OT)	30	4	1, 2, 4, 5	4
>5 and ≤60, portable tanks and IBCs	25	30	K≥8.0	SR (HT)	0.30	3000	K≥5.6		30	4	1, 3, 4, 5	5
<b>RELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB</b>												
≤60	40	50	K≥8.0	SR (HT)	0.30	2000	K≥5.6	QR or SR (OT)	30	4	1, 5	6

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft<sup>2</sup> = 0.09 m<sup>2</sup>, 1 gpm/ft<sup>2</sup> = 40.7 L/min/m<sup>2</sup> = 40.7 mm/min.

For definitions of abbreviations used in the Response column, see 16.5.1.9(4). See also 16.5.1.9(5).

Notes:

- (1) In-rack sprinkler design based on the 6 most hydraulically remote sprinklers in each of the upper three levels.
- (2) Design area can be reduced to 1500 ft<sup>2</sup> when using a preprimed foam-water system installed in accordance with NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, and maintained according to NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.
- (3) Design area can be reduced to 2000 ft<sup>2</sup> when using a preprimed foam-water system installed in accordance with NFPA 16 and maintained according to NFPA 25.
- (4) In-rack sprinkler hydraulic design can be reduced to three sprinklers operating per level, with three levels operating simultaneously, when using a preprimed foam-water sprinkler system designed in accordance with NFPA 16 and maintained in accordance with NFPA 25.

The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 10 psi.

**16.5.2.4**

Table 16.5.2.4 shall apply to the following:

- (1) Foam-water sprinkler protection
- (2) Palletized or stacked storage
- (3) Nonmiscible liquids and miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
- (4) Metal containers, metal portable tanks, metal intermediate bulk containers
- (5) Relieving- or nonrelieving-style containers

Table 16.5.2.4 Design Criteria for Foam-Water Sprinkler Protection of Palletized and Stacked Storage of Liquids in Metal Containers, Portable Tanks, and IBCs

<u>Container Style and Capacity</u> (gal)	<u>Maximum Storage Height</u> (ft)	<u>Maximum Ceiling Height</u> (ft)	<u>Ceiling Sprinkler Protection</u>					<u>Fire Test Ref.</u> [See Table D.2(d)]
			<u>Sprinkler</u>		<u>Design</u>		<u>Notes</u>	
			<u>Type</u>	<u>Response</u>	<u>Density</u> (gpm/ft <sup>2</sup> )	<u>Area</u> (ft <sup>2</sup> )		
<b>NONRELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA</b>								
≤5, cartoned	11	30	K≥11.2	SR or QR (HT)	0.40	3000	1	1
≤5, uncartoned	12	30	K≥8.0	SR or QR (HT)	0.30	3000	1	2
>5 and ≤60	5 (1-high)	30	K≥8.0	SR (HT)	0.30	3000	1	3
<b>RELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA</b>								
>5 and ≤60	6.5 (2-high)	30	K≥8.0	SR (HT)	0.30	3000	2, 3	4
	10 (3-high)	33	K≥11.2	SR (HT)	0.45	3000	2, 3	6
	13.75 (4-high)	33	K≥11.2	SR (HT)	0.60	3000	2, 3	7
Portable tanks and IBCs	1- or 2-high	30	K≥8.0	SR (HT)	0.30	3000		5

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft<sup>2</sup> = 0.09 m<sup>2</sup>, 1 gpm/ft<sup>2</sup> = 40.7 L/min/m<sup>2</sup> = 40.7 mm/min.

For definitions of abbreviations used in the Response column, see 16.5.1.9(4). See also 16.5.1.9(5).

Notes:

(1) Design area can be reduced to 2000 ft<sup>2</sup> when using a preprimed foam-water system installed in accordance with NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, and maintained according to NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

(2) Both ¾ in. (20 mm) and 2 in. (50 mm) listed pressure-relieving mechanisms are required on containers greater than 6 gal (23 L) capacity.

(3) Drums placed on open slatted pallet, not nested, to allow pressure relief from drums on lower levels.

**16.5.2.5**

Table 16.5.2.5 shall apply to the following:

- (1) Automatic sprinkler protection
- (2) Single-, double-, or multiple-row rack storage
- (3) Class IIIB nonmiscible liquids and Class IIIB miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
- (4) Nonmetallic containers or intermediate bulk containers
- (5) Cartoned or uncartoned

Table 16.5.2.5 Design Criteria for Sprinkler Protection of Single-, Double-, and Multiple-Row Rack Storage of Class IIIB Liquids

<u>Closed-Cup Flash Point</u> (°F)	<u>Container or IBC Capacity</u> (gal)	<u>Packaging</u>	<u>Maximum Storage Height</u> (ft)	<u>Maximum Ceiling Height</u> (ft)	<u>Minimum Aisle Width (ft)</u>	<u>Rack Depth</u> (ft)	<u>Sprinkler Protection</u>		<u>Fire Test Ref. [See Table D.2(e)]</u>
							<u>Ceiling Sprinkler Type</u>	<u>Design</u>	
≥200	≤5	Plastic containers, cartoned or uncartoned	Unlimited	Unlimited	4	Any	Any	See 16.6.1, Fire Protection System Design Scheme "A"	1
≥375	≤275	Flexible plastic liner within a composite continuously wound corrugated paperboard intermediate bulk container (See Note 1)	28	30	8	Any	Any	See 16.6.3, Fire Protection System Design Scheme "C"	2
≥375	≤6	Flexible plastic liner within a composite corrugated paperboard box	Unlimited	Unlimited	8	Any	Any	See 16.6.3, Fire Protection System Design Scheme "C"	2

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 200°F = 93°C, 375°F = 190°C.

Note: Construction of intermediate bulk container to be a minimum of 8 layers of paperboard, with a minimum nominal thickness of 1 ½ in. (38 mm) at the center of any side panel.



**16.5.2.6**

Table 16.5.2.6 shall apply to the following:

- (1) Automatic sprinkler protection
- (2) Shelf storage
- (3) Nonmiscible liquids and miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
- (4) Nonrelieving-style metal containers

Table 16.5.2.6 Design Criteria for Sprinkler Protection of Shelf Storage of Liquids in Metal Containers

<u>Container Style and Capacity</u> (gal)	<u>Maximum Storage Height</u> (ft)	<u>Maximum Ceiling Height</u> (ft)	<u>Ceiling Sprinkler Protection</u>					<u>Fire Test Ref. [See Table D.2(f)]</u>
			<u>Sprinkler</u>		<u>Design</u>			
			<u>Type</u>	<u>Response</u>	<u>Density</u> (gpm/ft <sup>2</sup> )	<u>Area</u> (ft <sup>2</sup> )	<u>Notes</u>	
≤1 nonrelieving style	6	18	K≥5.6	SR or QR (HT)	0.19	1500	1, 2	1

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft<sup>2</sup> = 0.09 m<sup>2</sup>, 1 gpm/ft<sup>2</sup> = 40.7 L/min/m<sup>2</sup> = 40.7 mm/min.

For definitions of abbreviations used in the Response column, see 16.5.1.9(4). See also 16.5.1.9(5).

Notes:

- (1) Protection limited to mercantile shelving that is 2 ft (600 mm) or less in depth per side, with backing between each side.
- (2) Minimum hose stream demand can be reduced to 250 gpm for 2 hours.
- (3) The minimum aisle width shall not be less than 5 ft (1.5 m).

**16.5.2.7**

Table 16.5.2.7 shall apply to the following:

- (1) Automatic sprinkler protection
- (2) Single- or double-row rack storage
- (3) Water-miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
- (4) Glass or plastic containers
- (5) Cartoned or uncartoned
- (6) Minimum 8 ft (2.4 m) aisle width

Table 16.5.2.7 Design Criteria for Sprinkler Protection of Single- and Double-Row Rack Storage of Water-Miscible Liquids in Glass or Plastic Containers

<u>Container Style and Capacity</u>	<u>Maximum Storage Height</u> (ft)	<u>Maximum Ceiling Height</u> (ft)	<u>Ceiling Sprinkler Protection</u>			<u>Fire Test Ref. [See Table D.2(g)]</u>
			<u>Ceiling Sprinkler Protection</u>	<u>In-Rack Sprinklers</u>	<u>Notes</u>	
16 oz, cartoned	Unlimited	Unlimited	See 16.6.1, Fire Protection System Design Scheme "A"	See 16.6.1, Fire Protection System Design Scheme "A"	1, 2	3
≤1 gal, cartoned	Unlimited	Unlimited	See 16.6.2, Fire Protection System Design Scheme "B"	See 16.6.2, Fire Protection System Design Scheme "B"	1, 2	1
≤60 gal, cartoned or uncartoned	25	30	See 16.6.2, Fire Protection System Design Scheme "B"	See 16.6.2, Fire Protection System Design Scheme "B"	1, 2	2

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m.

Notes:

- (1) Minimum aisle width in all cases is 8 ft (2.4 m).
- (2) Maximum rack depth in all cases is 9 ft (2.7 m).

**16.5.2.8**

Table 16.5.2.8 shall apply to the following:

- (1) Automatic sprinkler protection
- (2) Single- or double-row rack storage or palletized storage
- (3) Nonmiscible liquids and miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
- (4) Relieving-style metal containers

Table 16.5.2.8 Design Criteria for Single-Row Rack, Double-Row Rack, and Palletized Storage of Liquids in Relieving-Style Metal Containers

Container Style and Capacity (gal)	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection		In-Rack Sprinkler Protection				Fire Test Ref. [See Table D.2(h)]	
			Sprinkler Type	Design (Number of Sprinklers @ Stated Pressure)	Sprinkler Type	Response	Minimum Dishcharge Flow	Layout (See 16.5.1.10 & 16.6.4)		Notes
<b>LIQUID CLASSES IB, IC, II, IIIA, IIIB</b>										
<b>RACK STORAGE with MAXIMUM 6 ft RACK DEPTH and MINIMUM 7.5 ft AISLE WIDTH</b>										
≤5, cartoned or uncartoned	14	24	Pendent ESFR K≥14.0 (OT)	12 @ 50 psi	K = 11.2	QR (OT) QR (OT)	36 gpm	7	1, 2, 3, 4, 5, 6, 7	1
				12 @ 25 psi						No in-rack sprinklers required
<b>LIQUID CLASSES IB, IC, II, IIIA, IIIB</b>										
<b>RACK STORAGE with MAXIMUM 9 ft RACK DEPTH and 8 ft MINIMUM AISLE WIDTH</b>										
≤1, cartoned only	20	30	Pendent ESFR K≥14.0 (OT)	12 @ 75 psi		No in-rack sprinklers required		—		3
≤1, cartoned only	25	30	Pendent ESFR K≥14.0 (OT)	12 @ 50 psi	K = 8.0	QR (OT)	31 gpm	8	1, 2, 5, 7	4
≤5, cartoned or uncartoned	25	30	Pendent ESFR K≥14.0 (OT)	12 @ 75 psi	K = 8.0	QR (OT)	44 gpm	9	1, 2, 5, 7	5
<b>LIQUID CLASSES IB, IC, II, IIIA, IIIB PALLETIZED STORAGE with MINIMUM 7.5 ft AISLE WIDTH</b>										
≤1, cartoned only	8	30	Pendent ESFR K≥14.0 (OT)	12 @ 50 psi						6
≤5, cartoned or uncartoned	12	30	Pendent ESFR K≥14.0 (OT)	12 @ 75 psi						7

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 psi = 6.9 kPa.

For definitions of abbreviations used in the Response column, see 16.5.1.9(4). See also 16.5.1.9(5).

Notes:

(1) The in-rack sprinkler water demand shall be based on the simultaneous operation of the most hydraulically remote sprinklers as follows:

- (a) Seven sprinklers where only one level of in-rack sprinklers is installed.
- (b) Fourteen sprinklers (seven on each of the two top levels) where more than one level of in-rack sprinklers is

installed.

- (2) The in-rack sprinkler water demand should be balanced with the ceiling sprinkler water demand at their point of connection.
- (3) One-gallon and 1-quart containers are not required to be relieving style.
- (4) Provide minimum 3 in. transverse flue at rack uprights.
- (5) For Class IIIB liquids, see also Table 16.5.2.5.
- (6) Racks can have open-mesh wire intermediate shelving on lower levels.
- (7) The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 10 psi.

#### 16.5.2.9

Table 16.5.2.9 shall apply to the following:

- (1) Automatic sprinkler protection
- (2) Palletized storage
- (3) Class II and Class III nonmiscible and Class II and Class III miscible liquids
- (4) Listed and labeled rigid nonmetallic intermediate bulk containers

Table 16.5.2.9 Design Criteria for Sprinkler Protection of Palletized Storage of Class II and Class III Liquids in Listed and Labeled Rigid Nonmetallic IBCs

<u>Maximum Capacity</u> (gal)	<u>Maximum Storage Height</u>	<u>Maximum Ceiling Height</u> (ft)	<u>Ceiling Sprinkler Protection</u>				<u>Fire Test Ref.</u> [See Table D.2(i)]	
			<u>Sprinkler</u>		<u>Design</u>			
			<u>Type</u>	<u>Response</u>	<u>Density</u> (gpm/ft <sup>2</sup> )	<u>Area</u> (ft <sup>2</sup> )		<u>Notes</u>
793	1-high	30	K≥11.2	SR (HT)	0.45	3000	1, 2, 4	1
793	2-high	30	K≥11.2	SR (HT)	0.60	3000	1, 2, 3, 4	2

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 gpm/ft<sup>2</sup> = 40.7 L/min/m<sup>2</sup> = 40.7 mm/min, 1 ft<sup>2</sup> = 0.9 m<sup>2</sup>.

For definitions of abbreviations used in the Response column, see 16.5.1.9(4). See also 16.5.1.9(5).

Notes:

- (1) Foam-water sprinkler protection shall be permitted to be substituted for water sprinkler protection, provided the same design criteria are used.
- (2) Rigid nonmetallic intermediate bulk containers shall be listed and labeled in accordance with UL 2368, *Standard for Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids*; FM Class 6020, *Approval Standard for Intermediate Bulk Containers*; or an equivalent test procedure.
- (3) The sprinkler operating gauge pressure shall be a minimum 30 psi (207 kPa).

**16.5.2.10**

Table 16.5.2.10 shall apply to the following:

- (1) Automatic sprinkler protection
- (2) Single- or double-row rack storage
- (3) Class II and Class III nonmiscible and Class II and Class III miscible liquids
- (4) Listed and labeled rigid nonmetallic intermediate bulk containers

Table 16.5.2.10 Design Criteria for Sprinkler Protection of Single- and Double-Row Rack Storage of Class II and Class III Liquids in Listed and Labeled Rigid Nonmetallic IBCs

<u>Maximum Capacity</u> (gal)	<u>Maximum Storage Height</u> (ft)	<u>Maximum Ceiling Height</u> (ft)	<u>Ceiling Sprinkler Protection</u>			<u>Fire Test Ref.</u> [See Table D.2(j)]
			<u>Sprinkler Type</u>	<u>Design</u>	<u>Notes</u>	
793	25	30	Standard spray	See 16.6.2, Fire Protection System Design Scheme "B"	1, 2, 3, 4	1

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m.

Notes:

- (1) Rigid nonmetallic intermediate bulk containers are listed and labeled in accordance with UL 2368, *Standard for Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids*, or an equivalent test procedure.
- (2) Maximum rack depth is 9 ft (2.7 m).
- (3) Minimum aisle width is 8 ft (2.4 m).

**16.5.2.11**

Table 16.5.2.11 shall apply to the following:

- (1) Automatic sprinkler protection
- (2) Palletized or stacked storage
- (3) Unsaturated polyester resins (UPRs) with not more than 50 percent by weight of Class IC, II, or IIIA liquid
- (4) Metal containers; nonrelieving style allowed only up to 6 gal (23 L)

Table 16.5.2.11 Design Criteria for Sprinkler Protection of Palletized or Stacked Storage of Unsaturated Polyester Resins in Metal Containers

<u>Capacity</u> (gal)	<u>Maximum Storage Height</u> (ft)	<u>Maximum Ceiling Height</u> (ft)	<u>Ceiling Sprinkler Protection</u>				<u>Fire Test Ref.</u> [See Table D.2(k)]	
			<u>Sprinkler</u>		<u>Design</u>			
			<u>Type</u>	<u>Response</u>	<u>Density</u> (gpm/ft <sup>2</sup> )	<u>Area</u> (ft <sup>2</sup> )		<u>Notes</u>
>5 and <60	10	33	K $\geq$ 11.2	SR (HT or OT)	0.45	3000	1, 2, 3	1

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft<sup>2</sup> = 0.09 m<sup>2</sup>, 1 gpm/ft<sup>2</sup> = 40.7 L/min/m<sup>2</sup> = 40.7 mm/min.

For definitions of abbreviations used in the Response column, see 16.5.1.9(4). See also 16.5.1.9(5).

Notes:

- (1) Drums placed on open, slatted pallet, not nested, to allow pressure relief from drums on lower levels.
- (2) Storage areas containing unsaturated polyester resin (UPR) should not be located in the same spill containment area or drainage path of other Class I or Class II liquids, unless protected as required for such other liquids.
- (3) Both ¾ in. (20 mm) and 2 in. (50 mm) listed and labeled pressure-relieving devices are required on containers that exceed 6 gal (23 L) capacity.

**16.5.2.12**

Table 16.5.2.12 shall apply to the following:

- (1) Automatic sprinkler protection
- (2) Palletized or stacked storage
- (3) Miscible liquids with concentration of flammable or combustible components no greater than 80 percent by volume
- (4) Glass or plastic containers

Table 16.5.2.12 Design Criteria for Sprinkler Protection of Palletized or Stacked Storage of Miscible Liquids in Glass or Plastic Containers

<b>Ceiling Sprinkler Protection</b>								
<u>Container Style and Capacity</u>	<u>Maximum Storage Height (ft)</u>	<u>Maximum Ceiling Height (ft)</u>	<u>Sprinkler</u>		<u>Design</u>		<u>Fire Test Ref. [See Table D.2(I)]</u>	
			<u>Type</u>	<u>Response</u>	<u>Density (gpm/ft<sup>2</sup>)</u>	<u>Area (ft<sup>2</sup>)</u>		<u>Notes</u>
≤8 oz	5	38	K ≥ 11.2	QR (OT)	0.47	2000	—	P60 and P61

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft<sup>2</sup> = 0.09 m<sup>2</sup>, 1 gpm/ft<sup>2</sup> = 40.7 L/min/m<sup>2</sup> = 40.7 mm/min.

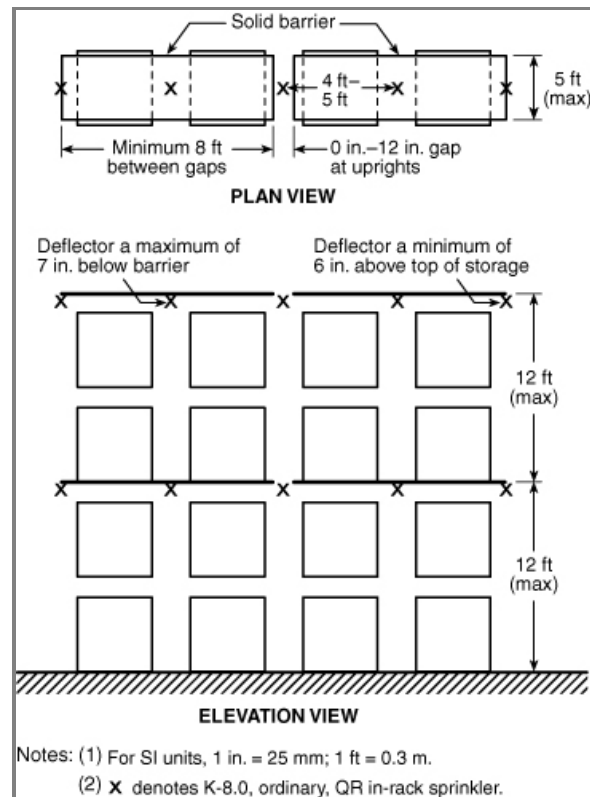
For definitions of abbreviations used in the Response column, see 16.5.1.9(4). See also 16.5.1.9(5).

**16.6** Fire Protection System Design Schemes.**16.6.1** Fire Protection System Design Scheme "A."

**16.6.1.1**

Horizontal barriers of plywood having a minimum thickness of  $\frac{3}{8}$  in. (10 mm) or of sheet metal of minimum 22 gauge thickness shall be installed in accordance with Figure 16.6.1.1(a), Figure 16.6.1.1(b), or Figure 16.6.1.1(c), whichever is applicable. All liquid storage shall be located beneath a barrier. [See also 16.6.1.9 for liquids with flash points equal to or greater than 450°F (230°C).]

**Figure 16.6.1.1(a) Single-Row Rack Sprinkler Layout for Design Scheme "A."**



**Figure 16.6.1.1(b) Double-Row Rack Sprinkler Layout for Design Scheme "A."**



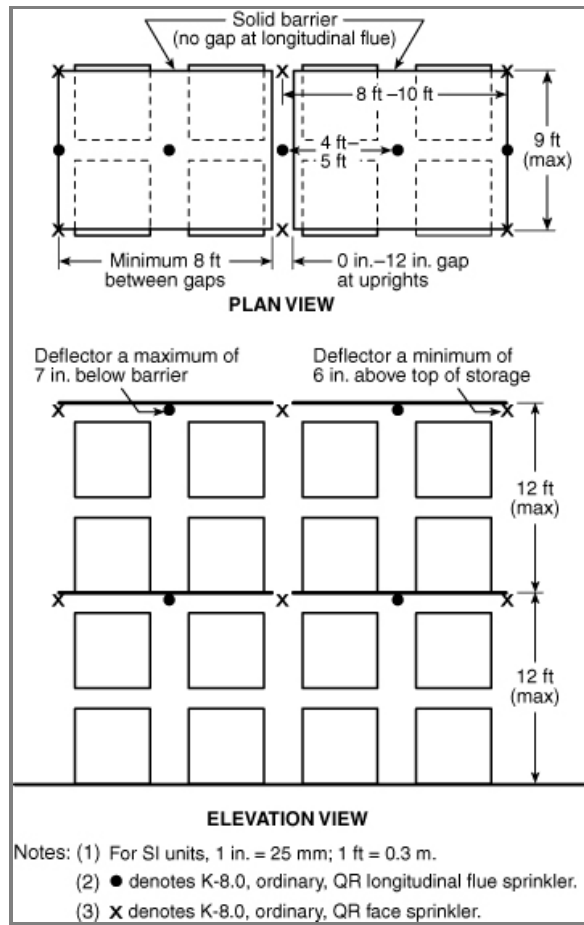
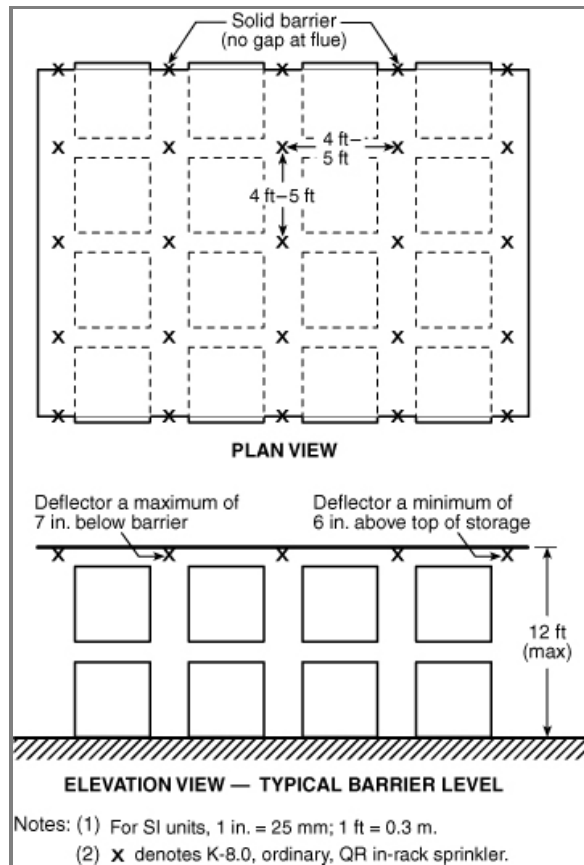


Figure 16.6.1.1(c) Multiple-Row Rack Sprinkler Layout for Design Scheme "A."



**16.6.1.2**

In-rack sprinklers shall be installed in accordance with [Figure 16.6.1.1\(a\)](#), [Figure 16.6.1.1\(b\)](#), or [Figure 16.6.1.1\(c\)](#), whichever is applicable.

**16.6.1.3**

Vertical barriers shall not be provided between in-rack sprinklers.

**16.6.1.4**

In-rack sprinklers shall meet the following requirements:

- (1) In-rack sprinklers shall be ordinary temperature-rated quick-response sprinklers and shall have a nominal K-factor equal to or greater than 8.0. Intermediate-temperature sprinklers shall be used where ambient conditions require.
- (2) In-rack sprinklers shall be installed below each barrier level.
- (3) In-rack sprinklers shall provide a minimum operating flow of 57 gpm out of each of the hydraulically most remote six sprinklers (three on two lines) if one barrier level is provided, or out of each of the hydraulically most remote eight sprinklers (four on two lines) if two or more barrier levels are provided. The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 10 psi.

**16.6.1.5\***

Where adjacent rack bays are not dedicated to storage of liquids, the barrier and in-rack sprinkler protection shall be extended at least 8 ft (2.4 m) beyond the area devoted to liquid storage. In addition, barrier and in-rack sprinkler protection shall be provided for any rack across the aisle within 8 ft (2.4 m) of the perimeter of the liquid storage in accordance with [16.6.1](#).

**16.6.1.6**

Ceiling sprinkler demand shall not be included in the hydraulic calculations for in-rack sprinklers.

**16.6.1.7**

Water demand at point of supply shall be calculated separately for in-rack and ceiling sprinklers and shall be based on the greater demand.

**16.6.1.8**

Ceiling sprinklers shall meet the following requirements:

- (1) Ceiling sprinkler protection shall be designed to protect the surrounding occupancy.
- (2) Any sprinkler type shall be acceptable.
- (3) If standard spray sprinklers are used, they shall be capable of providing not less than 0.20 gpm/ft<sup>2</sup> over 3000 ft<sup>2</sup> (8 mm/min over 270 m<sup>2</sup>).
- (4) If the liquid storage does not extend to the full height of the rack, protection for commodities stored above the top horizontal barrier shall meet the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, for the commodities stored, based on the full height of the rack.

**16.6.1.9**

Barriers shall not be required for liquids with closed-cup flash points of 450°F (230°C) or greater. If barriers are omitted, the following shall apply:

- (1) Ceiling sprinkler protection shall provide a minimum density of 0.3 gpm/ft<sup>2</sup> over the most hydraulically remote 2000 ft<sup>2</sup> (12 mm/min over 180 m<sup>2</sup>) using ordinary -temperature, standard-response sprinklers. Sprinklers shall have a nominal K-factor equal to or greater than 8.0. Intermediate-temperature sprinklers shall be used where ambient conditions require.
- (2) The ceiling sprinkler water demand and the in-rack water demand shall be balanced at their point of connection.
- (3) The sprinklers located at the rack face shall be staggered vertically.

**16.6.1.10**

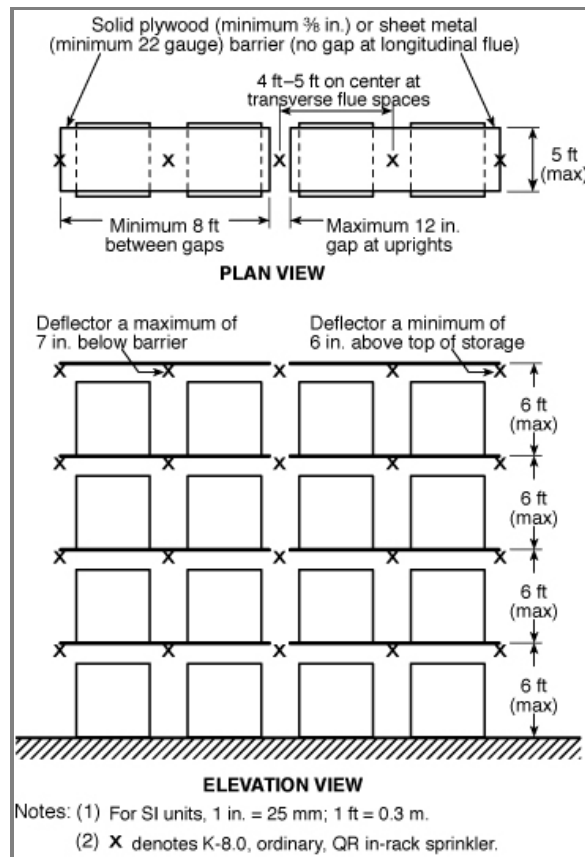
A 500 gpm (1900 L/min) hose stream allowance shall be provided.

**16.6.2 Fire Protection System Design Scheme "B."**

**16.6.2.1**

Horizontal barriers of plywood having a minimum thickness of  $\frac{3}{8}$  in. (10 mm) or of sheet metal of minimum 22 gauge thickness shall be installed in accordance with Figure 16.6.2.1(a), Figure 16.6.2.1(b), or Figure 16.6.2.1(c), whichever is applicable. All liquid storage shall be located beneath a barrier.

**Figure 16.6.2.1(a) Single-Row Rack Sprinkler Layout for Design Scheme "B" — Sprinklers in Center of Rack.**



**Figure 16.6.2.1(b) Single-Row Rack Sprinkler Layout for Design Scheme "B" — Sprinklers on Face of Rack.**

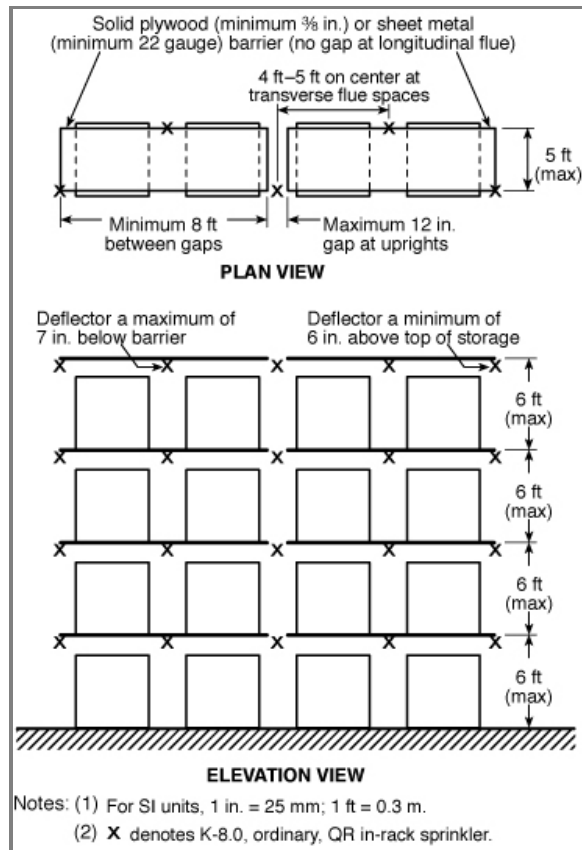
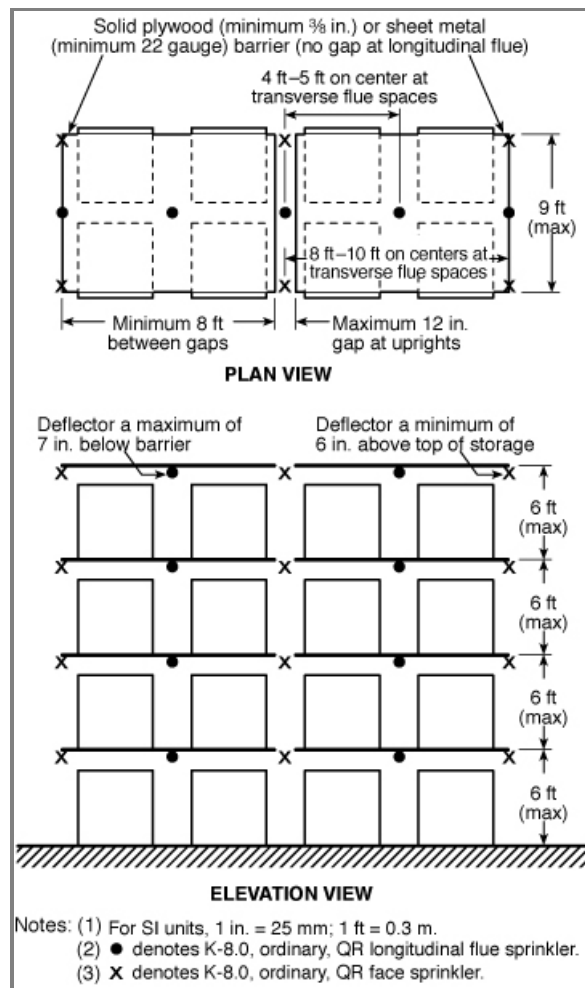


Figure 16.6.2.1(c) Double-Row Rack Sprinkler Layout for Design Scheme "B."



#### 16.6.2.2

In-rack sprinklers shall be installed in accordance with Figure 16.6.2.1(a), Figure 16.6.2.1(b), or Figure 16.6.2.1(c), whichever is applicable.

#### 16.6.2.3

Vertical barriers shall not be provided between in-rack sprinklers.

#### 16.6.2.4

In-rack sprinklers shall meet the following requirements:

- (1) In-rack sprinklers shall be ordinary temperature-rated quick-response sprinklers and shall have a nominal K-factor equal to or greater than 8.0. Intermediate-temperature sprinklers shall be used where ambient conditions require.
- (2) In-rack sprinklers shall be installed below each barrier level.
- (3) For containers that do not exceed 60 gal (230 L) capacity and where there is only one horizontal barrier, in-rack sprinklers shall provide a minimum discharge flow of 57 gpm out of each of the hydraulically most remote six sprinklers (three on two lines) if one barrier level is provided, or out of each of the hydraulically most remote eight sprinklers (four on two lines) if two or more barrier levels are provided. The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 10 psi.
- (4) For containers that exceed 60 gal (230 L) capacity, but do not exceed 793 gal (3000 L), in-rack sprinklers shall provide a minimum discharge flow of 57 gpm out of each of the hydraulically most remote 12 sprinklers, six each on two lines. The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 10 psi.

**16.6.2.5**

If there are adjacent rack bays that are not dedicated to storage of liquids, the barrier and in-rack sprinkler protection shall be extended beyond the area devoted to liquid storage as follows:

- (1) For containers that do not exceed 1 gal (3.8 L) capacity, protection shall be extended at least 8 ft (2.4 m) beyond the area devoted to liquid storage. In addition, adjacent racks across the aisles on each side of the liquid storage shall be protected in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, for the commodity stored.
- (2) For containers that exceed 1 gal (3.8 L) capacity, but do not exceed 793 gal (3000 L), protection shall be extended at least 8 ft (2.4 m) beyond the area devoted to liquid storage. In addition, protection shall be provided for any rack across the aisle within 8 ft (2.4 m) of the perimeter of the liquid storage in accordance with [16.6.2](#).

**16.6.2.6**

Ceiling sprinklers for containers that do not exceed 1 gal (3.8 L) capacity shall meet the following requirements:

- (1) Ceiling sprinklers shall be designed to protect the surrounding occupancy.
- (2) Ceiling sprinkler water demand shall not be included in the hydraulic calculations for the in-rack sprinkler protection.
- (3) Water demand at the point of supply shall be calculated separately for in-rack and ceiling sprinklers and shall be based on the greater of the two.
- (4) Any sprinkler type shall be acceptable for the ceiling sprinkler protection.
- (5) If standard spray sprinklers are used, they shall be capable of providing not less than 0.20 gpm/ft<sup>2</sup> over 3000 ft<sup>2</sup> (8 L/min over 270 m<sup>2</sup>).
- (6) If the liquid storage does not extend to the full height of the rack, protection for commodities stored above the top horizontal barrier shall meet the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, for the commodities stored, based on the full height of the rack.

**16.6.2.7**

Ceiling sprinklers for containers that exceed 1 gal (3.8 L) capacity, but do not exceed 60 gal (230 L), shall meet the following requirements:

- (1) Ceiling sprinkler protection shall provide a minimum density of 0.45 gpm/ft<sup>2</sup> (18.3 mm/min) over the most hydraulically remote 3000 ft<sup>2</sup> (270 m<sup>2</sup>), using high-temperature, standard-response sprinklers of nominal K-factor of 11.2 or greater. Other types of sprinklers shall not be used.
- (2) Ceiling sprinkler water demand and the in-rack sprinkler demand shall be balanced at the point of connection.

**16.6.2.8**

Ceiling sprinklers for containers that exceed 60 gal (230 L) capacity, but do not exceed 793 gal (3000 L), shall meet the following requirements:

- (1) Ceiling sprinklers shall be designed to provide a minimum density of 0.60 gpm/ft<sup>2</sup> over 3000 ft<sup>2</sup> (24 mm/min over the most remote 270 m<sup>2</sup>), using high-temperature-rated, standard-response sprinklers of nominal K-factor of 11.2 or greater. Other types of sprinklers shall not be used.
- (2) Ceiling sprinkler water demand and the in-rack sprinkler demand shall be balanced at the point of connection.

**16.6.2.9**

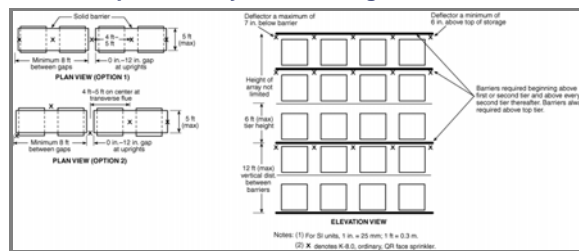
A 500 gpm (1900 L/min) hose stream allowance shall be provided.

**16.6.3 Fire Protection System Design Scheme "C."**

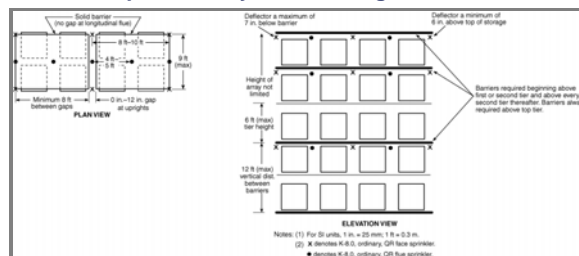
**16.6.3.1**

Horizontal barriers of plywood having a minimum thickness of  $\frac{3}{8}$  in. (10 mm) or of sheet metal of minimum 22 gauge thickness shall be installed in accordance with Figure 16.6.3.1(a), Figure 16.6.3.1(b), or Figure 16.6.3.1(c), whichever is applicable. All liquid storage shall be located beneath a barrier.

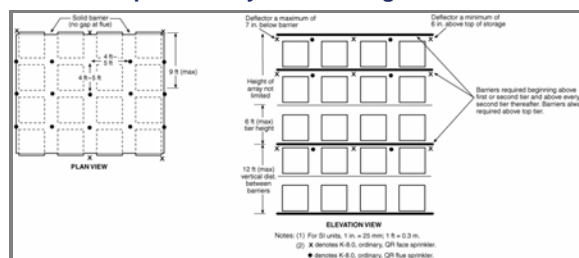
**Figure 16.6.3.1(a) Single-Row Rack Sprinkler Layout for Design Scheme "C."**



**Figure 16.6.3.1(b) Double-Row Rack Sprinkler Layout for Design Scheme "C."**



**Figure 16.6.3.1(c) Multiple-Row Rack Sprinkler Layout for Design Scheme "C."**

**16.6.3.2**

Vertical baffles shall not be installed between in-rack sprinklers.

**16.6.3.3**

In-rack sprinklers shall meet the following requirements:

- (1) In-rack sprinklers shall be ordinary temperature-rated, quick-response sprinklers. Sprinklers shall have a nominal K-factor equal to or greater than 8.0. An intermediate-temperature sprinkler shall be used where ambient conditions require.
- (2) In-rack sprinklers shall be installed below each barrier level.
- (3) In-rack sprinklers shall provide a minimum discharge flow of 30 gpm out of each of the hydraulically most remote six sprinklers (three on two lines) if one barrier level is provided, or out of each of the hydraulically most remote eight sprinklers (four on two lines) if two or more barrier levels are provided. The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 10 psi.

**16.6.3.4**

If there are adjacent bays of in-rack arrays that are not dedicated to storage of liquids, the barrier and in-rack sprinkler protection shall be extended at least 8 ft (2.4 m) beyond the area devoted to liquid storage.

**16.6.3.5**

Ceiling sprinkler demand shall not be included in the hydraulic calculations for in-rack sprinklers.

**16.6.3.6**

Water demand at point of supply shall be calculated separately for in-rack and ceiling sprinklers and shall be based on the greater demand.



**16.6.3.7**

Ceiling sprinklers shall meet the following requirements:

- (1) Ceiling sprinkler protection shall be designed to protect the surrounding occupancy.
- (2) Any sprinkler type shall be acceptable.
- (3) If standard spray sprinklers are used, they shall be capable of providing not less than 0.20 gpm/ft<sup>2</sup> over 3000 ft<sup>2</sup> (8 mm/min over 270 m<sup>2</sup>).
- (4) If the liquid storage does not extend to the full height of the rack, protection for commodities stored above the top horizontal barrier shall meet the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, for the commodities stored, based on the full height of the rack.

**16.6.3.8**

A 500 gpm (1900 L/min) hose stream allowance shall be provided.

**16.6.4** In-Rack Sprinkler Layouts for Table 16.5.2.8.

Where indicated in Table 16.5.2.8, in-rack sprinklers shall be as follows:

- (1) Where Layout 7 is required, in-rack sprinklers shall be installed in accordance with Figure 16.6.4(a).
- (2) Where Layout 8 is required, in-rack sprinklers shall be installed in accordance with Figure 16.6.4(b) or Figure 16.6.4(c).
- (3) Where Layout 9 is required, in-rack sprinklers shall be installed in accordance with Figure 16.6.4(d) or Figure 16.6.4(e), whichever is applicable.

Figure 16.6.4(a) Double-Row Rack Sprinkler Layout 7.

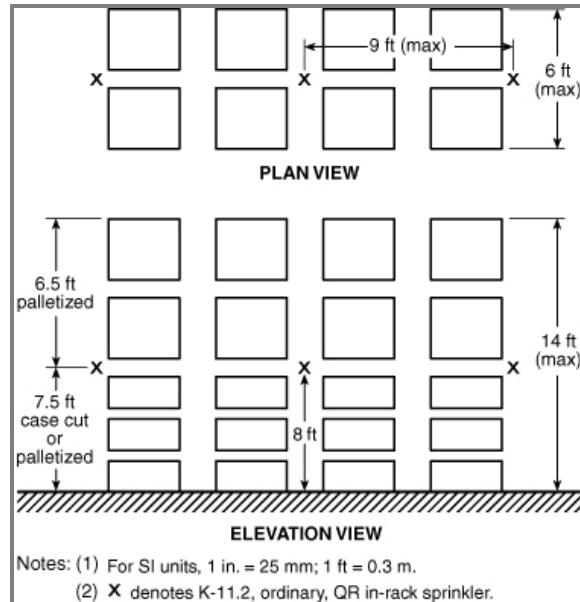


Figure 16.6.4(b) Double-Row Rack Sprinkler Layout 8 — Option #1.

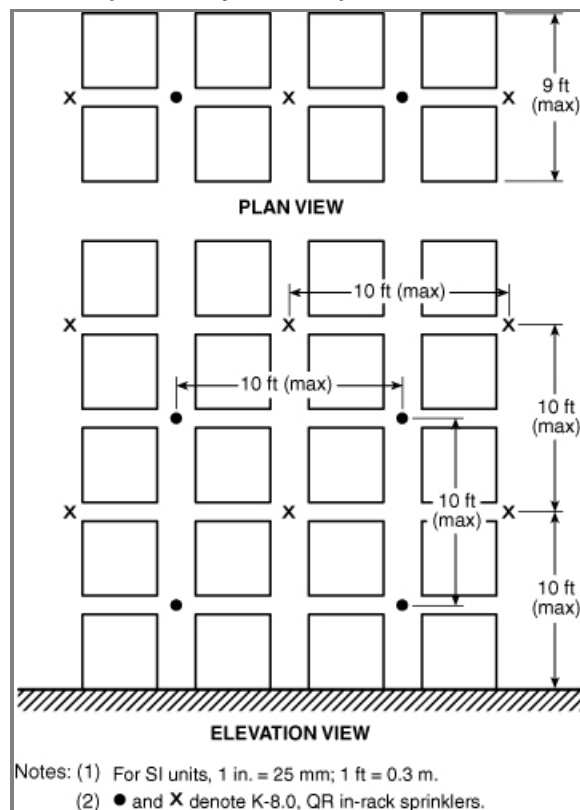


Figure 16.6.4(c) Double-Row Rack Sprinkler Layout 8 — Option #2.

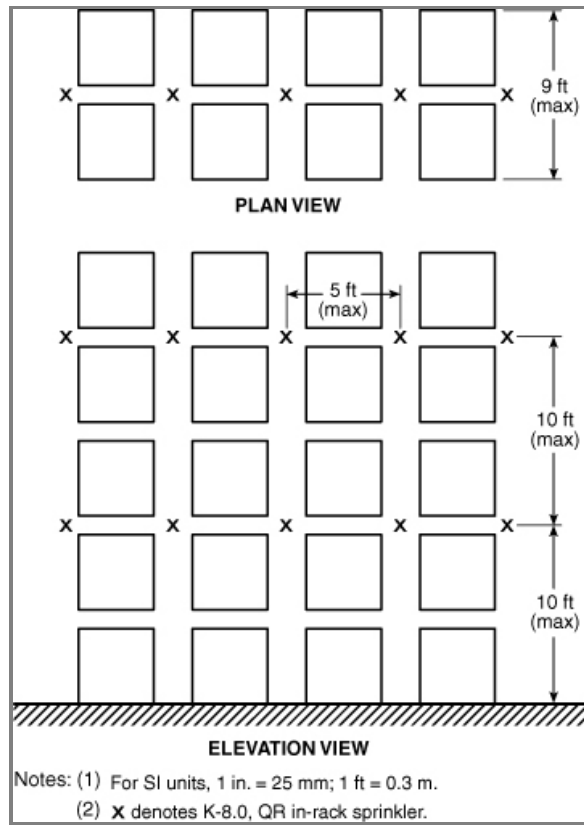


Figure 16.6.4(d) Double-Row Rack Sprinkler Layout 9 — Option #1.

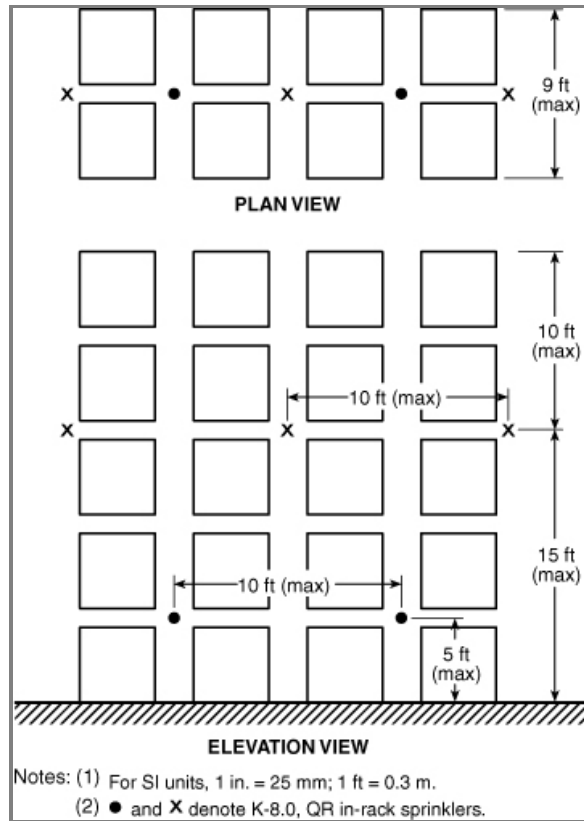
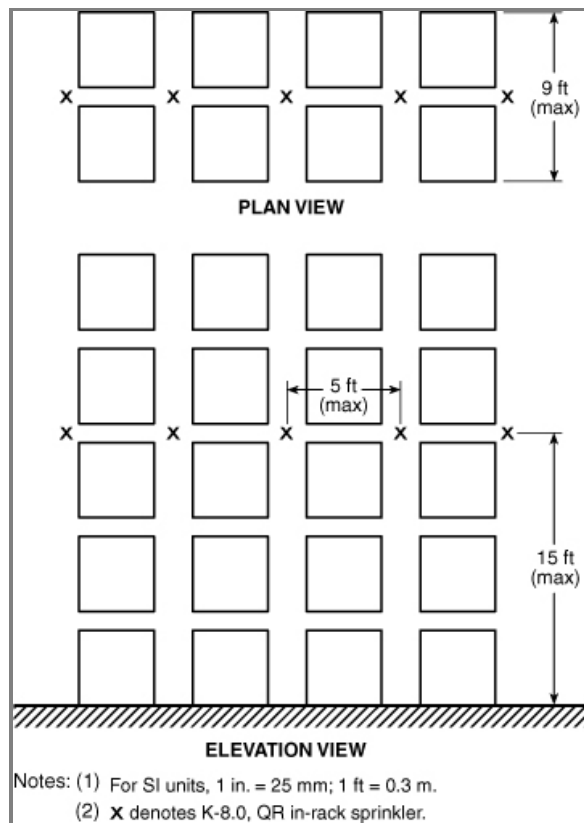


Figure 16.6.4(e) Double-Row Rack Sprinkler Layout 9 — Option #2.



#### 16.7 Water Supply.

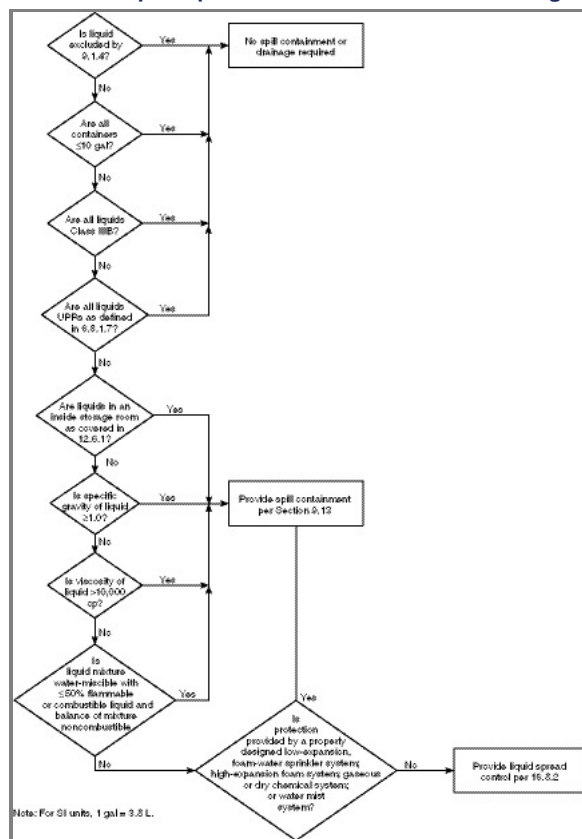
Water supplies for automatic sprinklers, other water-based protection systems, hose streams, and hydrants shall be capable of supplying the anticipated water flow demand for a minimum of 2 hours.

#### 16.8 Containment, Drainage, and Spill Control.

**16.8.1**

Containment or containment and drainage shall be provided in accordance with Figure 16.8.1, when protection systems are installed in accordance with the provisions of this chapter.

**Figure 16.8.1 Spill Containment and Liquid Spread Control for Protected Storage.**

**16.8.2\***

Where control of the spread of liquid is required, means to limit the spread of liquid to an area not greater than the design discharge area of the ceiling sprinkler system shall be provided.

**16.9 Other Automatic Fire Protection Systems.**

Alternate fire protection systems, such as automatic water spray systems, automatic water mist systems, high-expansion foam systems, dry chemical extinguishing systems, alternate sprinkler system configurations, or combinations of systems shall be permitted if approved by the authority having jurisdiction. Such alternate systems shall be designed and installed in accordance with the appropriate NFPA standard and with manufacturer's recommendations for the system(s) selected.

**Submitter Information Verification**

**Submitter Full Name:** Jenna Shapiro

**Organization:** [ Not Specified ]

**Street Address:**

**City:**

**State:**

**Zip:**

**Submission Date:** Wed Sep 09 18:52:05 EDT 2015

**Committee Statement**

**Committee Statement:** The following issues are being assigned to the protection criteria task group:

- 1) How to address minimal quantity storage of liquids in general purpose warehouses, versus quantities allowed by table 9.6.1 (MAQs)

- 2) Review and confirmation of the accuracy of all footnotes and notes to tables 16.5.2.1 through 16.5.2.12
- 3) Protection criteria for small metal containers
- 4) Review of 16.5.1.6 with respect to design conformance of foam-water sprinkler systems with NFPA 16
- 5) How to address non-listed IBCs
- 6) New protection criteria for drums as proposed by PIs 66-70 (see CI 213)
- 7) Review of protection schemes in section 16.6 to ensure the hydraulic calculations are valid (see CI 207)
- 8) Definitions of "protected storage" and "unprotected storage" specific to chapter 16 (see CI 1)
- 9) Possible definition of "rack section" and possible revised definition of "container"

**Response  
Message:**



## Committee Input No. 213-NFPA 30-2015 [ Section No. 16.5.1 ]

### 16.5.1 General.

Paragraphs [16.5.2.1](#) through [16.5.2.42 13](#) and their related tables, [Table 16.5.2.1](#) through [Table 16.5.2.42 13](#), shall be used to determine the protection criteria and storage arrangement for the applicable liquid class, container type, and storage configuration, as described in [16.5.2.1](#) through [16.5.2.42 13](#) and subject to the provisions of [16.5.1](#).

#### 16.5.1.1

[Table 16.5.2.1](#) through [Table 16.5.2.42 13](#) shall apply only to stable liquids.

##### 16.5.1.1.1

The protection criteria in [Table 16.5.2.1](#) through [Table 16.5.2.12](#) shall only be used with ceilings having a pitch of 2 in 12 or less.

#### 16.5.1.2

When foam or foam-water fire protection systems are provided, discharge densities shall be determined based on the listing criteria of the foam discharge devices selected, the foam concentrate, the specific liquids to be protected, and the criteria in the appropriate table in this chapter. Where the discharge densities given in the tables differ from those in the listing criteria for the discharge devices, the greater of the two shall be used.

#### 16.5.1.3

In-rack sprinklers shall be installed in accordance with the provisions of NFPA 13, *Standard for the Installation of Sprinkler Systems*. In addition, the following modifications shall apply:

- (1) In-rack sprinklers shall be laid out in accordance with [16.5.1.10](#) and Section [16.6](#), as applicable.
- (2) Sprinklers in multiple-level in-rack sprinkler systems shall be provided with water shields unless they are separated by horizontal barriers or are specifically listed for installation without water shields.
- (3) A vertical clear space of at least 6 in. (150 mm) shall be maintained between the sprinkler deflector and the top tier of storage.
- (4) Sprinkler discharge shall not be obstructed by horizontal rack structural members.
- (5) Where in-rack sprinklers are installed below horizontal barriers, the deflector shall be located a maximum of 7 in. (180 mm) below the barrier.
- (6) Longitudinal and transverse flue spaces of at least 6 in. (150 mm) shall be maintained between each rack load.

#### 16.5.1.4

Ceiling sprinklers shall be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, and shall be permitted to have the following maximum head spacing:

- (1) Classes I, II, and IIIA liquids: 100 ft<sup>2</sup> (9.3 m<sup>2</sup>) per sprinkler
- (2) Class IIIB liquids: 120 ft<sup>2</sup> (11.1 m<sup>2</sup>) per sprinkler

##### 16.5.1.4.1

Ordinary or intermediate temperature-rated K-25 extended-coverage sprinklers shall be permitted to be used as standard response high-temperature sprinklers at greater than 144 ft<sup>2</sup> (13 m<sup>2</sup>) coverage, with 12 ft (3.7 m) minimum spacing and a maximum coverage area of 196 ft<sup>2</sup> (18 m<sup>2</sup>) coverage.

#### 16.5.1.5

The ceiling heights given in [Table 16.5.2.1](#) through [Table 16.5.2.12](#), excluding [Table 16.5.2.8](#), shall be permitted to be increased by a maximum of 10 percent if an equivalent percent increase in ceiling sprinkler design density is provided.

#### 16.5.1.6

Foam-water sprinkler systems shall be designed and installed in accordance with NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*.

##### 16.5.1.6.1

Foam-water sprinkler systems shall have at least 15 minutes of foam concentrate, based on the required design flow rate.



#### 16.5.1.6.2 \*

Foam-water sprinkler systems shall provide foam solution at the minimum required concentration with as few as four sprinklers flowing.

#### 16.5.1.7

When relieving-style containers are used, both  $\frac{3}{4}$  in. (20 mm) and 2 in. (50 mm) listed and labeled pressure-relieving mechanisms are required on containers greater than 6 gal (23 L) capacity.

#### 16.5.1.8

For the purposes of Section 16.5, a rigid nonmetallic intermediate bulk container is one that meets the maximum allowable capacity criteria of Table 9.4.3 and has been listed and labeled in accordance with UL 2368, *Standard for Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids*, or equivalent.

#### 16.5.1.9

For the purposes of Section 16.5, the following shall apply:

- (1) 1 gal = 3.8 L; 1 ft = 0.3 m; 1 ft<sup>2</sup> = 0.09 m<sup>2</sup>
- (2) 1 gpm/ft<sup>2</sup> is equivalent to 40.7 L/min/m<sup>2</sup> or 40.7 mm/min
- (3) A gauge pressure of 1 psi is equivalent to a gauge pressure of 6.9 kPa
- (4) SR = standard response sprinkler; QR = quick response sprinkler; ESFR = early suppression fast-response sprinkler; OT = ordinary temperature; HT = high temperature
- (5) Where an ordinary-temperature sprinkler is indicated, an intermediate-temperature sprinkler shall be used where ambient conditions require.

#### 16.5.1.10

For the purposes of Section 16.5, the following shall apply to the in-rack sprinkler design layouts specified in Table 16.5.2.1 through Table 16.5.2.12:

- (1) Layout 1, as referenced in Table 16.5.2.1, shall mean one line of in-rack sprinklers 8 ft (2.4 m) above the floor in the longitudinal flue space, with sprinklers spaced not more than 10 ft (3 m) on center.
- (2) Layout 2, as referenced in Table 16.5.2.1, shall mean one line of in-rack sprinklers 6 ft (1.8 m) above the floor and one line of in-rack sprinklers 12 ft (3.6 m) above the floor in the longitudinal flue space, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically.
- (3) Layout 3, as referenced in Table 16.5.2.1 and Table 16.5.2.3, shall mean one line of in-rack sprinklers in the longitudinal flue space at every storage level above the floor except above the top tier, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically, where more than one level of in-rack sprinklers is installed.
- (4) Layout 4, as referenced in Table 16.5.2.1 and Table 16.5.2.3, shall mean one line of in-rack sprinklers in the longitudinal flue space at every other storage level, except above the top tier, beginning above the first storage level, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically, where more than one level of in-rack sprinklers is installed.
- (5) Layout 5, as referenced in Table 16.5.2.1, shall mean one line of in-rack sprinklers in the longitudinal flue space at every storage level above the floor except above the top tier and face sprinklers at the first storage level at each rack upright. In-rack sprinklers shall be spaced not more than 9 ft (2.7 m) on center and shall be staggered vertically, where more than one level of in-rack sprinklers is installed.
- (6) Layout 6, as referenced in Table 16.5.2.1, shall mean one line of in-rack sprinklers in the longitudinal flue space at every other storage level above the first storage level except the top tier and face sprinklers at the first storage level at each rack upright. In-rack sprinklers shall be spaced not more than 10 ft (3 m) on center and shall be staggered vertically, where more than one level of in-rack sprinklers is installed.
- (7) Layout 7, as referenced in Table 16.5.2.8, shall be as shown in Figure 16.6.4(a).
- (8) Layout 8, as referenced in Table 16.5.2.8, shall be as shown in Figure 16.6.4(b) or Figure 16.6.4(c).
- (9) Layout 9, as referenced in Table 16.5.2.8, shall be as shown in Figure 16.6.4(d) or Figure 16.6.4(e).

#### 16.5.1.11

The "Fire Test Ref." number given for each entry in Table 16.5.2.1 through Table 16.5.2.12 shall be used to identify in Section D.2 the or D.3 the information on the fire tests on which the protection criteria for that entry are based.

#### 16.5.1.12

The water supply shall be sufficient to meet the fixed fire protection demand plus a total of at least 500 gpm (1900 L/min) for inside and outside hose connections for at least 2 hours, unless otherwise specified in this chapter.

## Submitter Information Verification

**Submitter Full Name:** Janna Shapiro  
**Organization:** [ Not Specified ]  
**Street Address:**  
**City:**  
**State:**  
**Zip:**  
**Submittal Date:** Tue Sep 15 11:12:53 EDT 2015

## Committee Statement

**Committee Statement:** The technical committee has reviewed the series of PIs related to this issue and has several questions that appear to be unresolved. These include:

1. What is the rationale for the ignition scenario?
2. How is the protection extrapolated to unlimited storage height and building height?
3. Why is the ceiling protection not balanced with in-racks given container sizes are 55 gal?
4. How did they determine the number of in-rack sprinklers to be included in the design area?
5. Why was the clearance between the deflector and top of storage decreased from what was tested?
6. What is the rationale for the number of empty drums vs full drums?

The task group would also like the opportunity to review any videos of the test(s) that would support the submitter's conclusions.

This has been referred to the protection criteria task group for evaluation and action.

## Response Message:

[Public Input No. 66-NFPA 30-2015 \[Section No. 16.5.1\]](#)

[Public Input No. 68-NFPA 30-2015 \[New Section after 16.6.3.8\]](#)

[Public Input No. 69-NFPA 30-2015 \[New Section after D.2\]](#)

[Public Input No. 70-NFPA 30-2015 \[Section No. 16.4.1 \[Excluding any Sub-Sections\]\]](#)

[Public Input No. 67-NFPA 30-2015 \[New Section after 16.5.2.12\]](#)



## Task Group Committee Input No. 207-NFPA 30-2015 [ New Section after A.16.6.1.5 ]

A.16.6.2.4(3) The design area requirements for containers that do not exceed 60 gal (230 L) in capacity specify using a set number of hydraulically remote sprinklers on "two lines". It is not always clear in the Design Scheme "B" options illustrated in FIGURE 16.6.2.1(a) through FIGURE 16.6.2.1(c) how this requirement should be applied. FIGURE A.16.6.2.4(a) through FIGURE A.16.6.2.4(c) illustrate permissible design areas for three sprinklers on two lines as required when one barrier level is provided. Similar configurations should be used for four sprinklers on two lines as required when two or more barrier levels are provided.

A.16.6.2.4(4) Design area configurations similar to those illustrated in A.16.6.2.4(4) should be used for six sprinklers on two lines as required when containers exceed 60 gal (230 L) but do not exceed 793 gal (3000 L).

### Submitter Information Verification

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**Submittal Date:** Wed Sep 09 16:31:09 EDT 2015

### Committee Statement

**Committee Statement:** The committee is proposing no action at this time on PIs 96 & 97 because the action proposed does not appear to address the full concern raised by the submitter. The committee agrees that modification to the hydraulic design requirements might be needed. This issue will be assigned to the task group on protection criteria, who will look at all protection schemes in section 16.6 and ensure the hydraulic calculations are valid.

### Response Message:

[Public Input No. 96-NFPA 30-2015 \[New Section after A.16.6.1.5\]](#)

[Public Input No. 97-NFPA 30-2015 \[Section No. 16.6.2.4\]](#)