24.1 * General.

24.1.1

Sprinklers intended to protect storage fire risks shall be permitted to be installed using water supply design criteria that are different from the design criteria specified for the sprinklers described in Chapters 20 through 23 and 25 when specifically listed for such use within the limitations described in this chapter.

24.1.2

The requirements of Chapters 20 through 23 and 25 shall apply unless modified by this chapter.

24.1.2.1

Sprinklers having standard coverage areas that require up to 20 sprinklers to be included in the hydraulic calculation shall be installed in accordance with 14.2.3, 14.2.4, 14.2.4.1, and 20.9.5.

24.1.2.1.1

Quick-response sprinklers shall also be installed in accordance with 14.2.4.1 and 14.2.4.2.

24.1.2.2

Sprinklers having extended coverage areas that require up to 10 sprinklers to be included in the hydraulic calculation shall be installed in accordance with 14.2.3, 14.2.4, 14.2.4.1, and 20.9.5.

24.1.2.2.1

Quick-response sprinklers shall also be installed in accordance with 14.2.4.1 and 14.2.4.2.

24.1.3

The in-rack protection requirements of Chapter 25 shall apply when storage racks are equipped with solid shelves, and in-rack sprinklers are required per the applicable chapter.

24.1.4

The requirements of the applicable chapter shall apply when ceiling-only protection options are not available per this chapter.

24.1.5

The design criteria in this chapter shall not be used to permit a reduction in the water supply requirements for in-rack sprinkler protection.

24.1.6

A series of large-scale fire tests involving challenging test scenarios that address the range of variables associated with the intended application of the sprinkler shall be conducted to evaluate the ability of the sprinkler to protect storage fire risks that are representative of those described in the manufacturer's installation and design parameter instructions and referenced in the listing.

24.1.7

The manufacturer's installation and design parameter instructions for these sprinklers shall specify in a standardized manner the end-use limitations and sprinkler system design criteria including at least the following:

(1) Commodity or commodities to be protected
(2) Storage arrangements allowed
(3) Installation guidelines including obstruction and ceiling construction limitations
(4) Maximum ceiling and storage heights with associated minimum operating pressures and number of sprinklers required to be included in the hydraulic calculation
(5) Hose stream allowance and duration

24.1.8

The number of sprinklers to be used in the sprinkler system design shall be based on the worst-case result obtained from the full-scale fire test series increased by a minimum 50 percent.

24.1.8.1

Regardless of the number of sprinklers that operated during the worst-case full-scale fire test, the number in the sprinkler system demand shall be no less than one of the following:

(1) Twelve sprinklers for standard coverage sprinklers
(2) Eight sprinklers for extended-coverage sprinklers based on a spacing of 12 ft × 12 ft (3.7 × 3.7 m)
(3) Six sprinklers for extended-coverage sprinklers based on a spacing of 14 ft × 14 ft (4.3 m × 4.3 m)

24.1.8.2

Once the number of sprinklers for a demand area has been established, the minimum operating area, based on the proposed sprinkler spacing, shall not be less than 768 ft^2 (71 m^2).

24.1.8.3

The design area and number of sprinklers calculated on a branch line shall be in accordance with 28.2.4.2 using an area of sprinkler operation equal to the required number of operating sprinklers and the maximum allowable coverage for the specific design criteria being utilized.

24.1.9

Listed storage sprinklers that are not specifically referenced in Sections 24.2 and 24.3 but are tested in accordance with Chapter 24 with system design criteria based upon Sections 24.1, 24.4, and 24.5 shall be permitted to be used in accordance with their listing limitations, where approved.

24.2 * Sprinkler Design Criteria for Palletized and Solid-Piled, Storage of Class I Through Class IV and Plastic Commodities.

24.2.1

Protection of palletized and solid-piled storage of Class I through Class IV and cartoned nonexpanded plastic commodities shall be permitted to be protected in accordance with Table 24.2.1.

Table 24.2.1 Extended Coverage, CMSA [K-factor 25.2 (360)] Sprinkler Design Criteria for Palletized and S Piled Storage of Class I Through Class IV and Cartoned Nonexpanded Plastic Commodities

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

Storage Arrangement	Commodity Class	Maximum Storage Height*		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	Maxi Cove Ar
		ft	m	ft	m					
Palletized and solid-piled	Class I through Class IV, encapsulated and nonencapsulated, and cartoned nonexpanded plastics	20	6.1	30	9.1	25.2 (360) Upright/ pendent	Wet	6	30 psi (2.1 bar)	12 ft × (3.7 3.7 144 (13
		20	6.1	30	9.1	25.2 (360) Upright/ pendent	Wet	6	30 psi (2.1 bar)	14 ft × (4.3 4.3 196 (18
		25	7.6	30	9.1	25.2 (360) Upright/ pendent	Wet	6	30 psi (2.1 bar)	12 ft × (3.7 3.7 144 (13
		25	7.6	30	9.1	25.2 (360) Upright/ pendent	Wet	6	30 psi (2.1 bar)	14 ft × (4.3 4.3 196 (18
		25	7.6	35	10.7	25.2 (360) Upright/ pendent	Wet	8	40 psi (2.8 bar)	12 ft × (3.7 3.7 144 (13
		25	7.6	35	10.7	25.2 (360) Upright	Wet	8	40 psi (2.8 bar)	14 ft × (4.3 4.3 196 (18
		30	9.1	35	10.7	25.2 (360) Upright/ pendent	Wet	8	40 psi (2.8 bar)	12 ft × (3.7 3.7 144 (13
		30	9.1	35	10.7	25.2 (360) Upright	Wet	8	40 psi (2.8 bar)	14 ft × (4.3 4.3 196 (18

*A minimum clearance of 5 ft (1.5 m) shall be provided from sprinkler deflector to the top of storage.

24.3 * Sprinkler Protection Criteria for Open-Frame Rack Storage of Class I Through Class IV and Plastic Commodities.

24.3.1

Protection of single-, double-, and multiple-row racks without solid shelves of Class I through Class IV and cartoned nonexpanded plastic commodities shall be permitted to be protected in accordance with Table 24.3.1.

Table 24.3.1 Extended Coverage, CMSA [K-Factor 25.2 (360)] Sprinkler Design Criteria for Single-, Double and Multiple-Row Racks Without Solid Shelves of Class I Through Class IV and Cartoned Nonexpanded

Plastic Commodities

Storage Arrangement	Commodity Class	Maximum Storage Height*		Maximum Ceiling/Roof Height		K-Factor/ Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	Maxi Cove Ar
		ft	m	ft	m					
Single-, double-, and multiple-row racks without solid shelves (no open-top containers)	Class I through Class IV, encapsulated and nonencapsulated, and cartoned nonexpanded plastics	20	6.1	30	9.1	25.2 (360) Upright/ pendent	Wet	6	30 psi (2.1 bar)	12 ft × (3.7 3.7 144 (13
		20	6.1	30	9.1	25.2 (360) Upright/ pendent	Wet	6	30 psi (2.1 bar)	14 ft × (4.3 4.3 196 (18
		25	7.6	30	9.1	25.2 (360) Upright/ pendent	Wet	6	30 psi (2.1 bar)	12 ft × (3.7 3.7 144 (13
		25	7.6	30	9.1	25.2 (360) Upright/ pendent	Wet	6	30 psi (2.1 bar)	14 ft × (4.3 4.3 196 (18
		25	7.6	35	10.7	25.2 (360) Upright/ pendent	Wet	8	40 psi (2.8 bar)	12 ft × (3.7 3.7 144 (13
		25	7.6	35	10.7	25.2 (360) Upright	Wet	8	40 psi (2.8 bar)	14 ft × (4.3 4.3 196 (18
		30	9.1	35	10.7	25.2 (360) Upright/ pendent	Wet	8	40 psi (2.8 bar)	12 ft × (3.7 3.7 144 (13
		30	9.1	35	10.7	25.2 (360) Upright	Wet	8	40 psi (2.8 bar)	14 ft × (4.3 4.3 196 (18

*A minimum clearance of 5 ft (1.5 m) shall be provided from sprinkler deflector to the top of storage.

24.3.2

Protection of Class I through Class IV and cartoned nonexpanded plastic commodities stored on single-, double-, or multiple-row racks without solid shelves or solid-piled, palletized, storage arrangements shall be permitted to be protected in accordance with Table 24.3.2.

Table 24.3.2 CMSA K-25.2 (K-360) Standard Coverage Sprinkler Design Criteria for Single-, Double-, and I Solid Shelves and Solid-Piled, Palletized Storage Arrangement of Class I Through IV and Cartoned None

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor/Orientation	System Type	Number of Design Sprinklers	Minimum Operating Pressure
		ft	m	ft	m				
Solid-piled, palletized, and single-, double-, and multiple-row racks without solid shelves (no open-top containers)	Class I–IV encapsulated and nonencapsulated, and cartoned nonexpanded plastics	25	7.6	30	9.1	25.2 (360) Upright	Wet	12	20 psi (1.4 bar)
						25.2 (360) Pendent			15 psi (1.0 bar)

24.3.3

Protection of open rack storage of Class I through Class III commodities with dry pipe systems using standard response upright sprinkler design criteria and high-temperature-rated sprinklers shall be in accordance with Table 24.3.3.

Table 24.3.3 Standard Response Upright Sprinkler Design Criteria for Open Rack Storage of Class I Through Class III Commodities (Using High-Temperature-Rated Sprinklers)

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
Rack storage without solid shelves (no open-top containers)	Class I, Class II, or Class III	35	10.7	40	12.2	25.2 (360)	Dry	24	15*	1.0*
		40	12.2	45	13.7	25.2 (360)	Dry	12	50†	3.4†
		45	13.7	50	15.2	33.6 (480)	Dry	15	50†	3.4†
		50	15.2	55	16.7	33.6 (480)	Dry	16	50†	3.4†

*25-second water delivery time maximum.

†20-second water delivery time maximum. For the 12-sprinkler design incorporate a 500 gpm (1900 L/min) hose stream allowance and a 90-minute duration.

24.3.3.1

For protection criteria using a minimum operating pressure of 15 psi (1 bar), a maximum water delivery time of 25 seconds shall be used.

24.3.3.2

For protection criteria using a minimum operating pressure of 50 psi (3.4 bar), a maximum water delivery time of 20 seconds shall be used.

24.4 Hose Stream Allowance and Water Supply Duration.

24.4.1

The minimum water supply requirements for a hydraulically designed sprinkler system shall be determined by adding the hose stream allowance from 20.15.2.6 to the water supply for sprinklers obtained from this chapter.

24.4.1.1

The water supply requirements for a hydraulically designed sprinkler system shall be available for the minimum duration specified in 20.15.2.6.

24.5 Minimum Obstruction Criteria.

24.5.1 General.

The installation guidelines for obstructions to ceiling-level sprinklers shall be in accordance with the requirements of Section 24.5 for sprinkler system designs obtained from this chapter.

24.5.2 Standard Coverage Sprinklers.

24.5.2.1

Sprinklers having standard coverage areas requiring up to 20 sprinklers to be included in the hydraulic calculation shall be installed in accordance with the obstruction criteria described in 14.2.10, unless large-scale fire testing is conducted with a representative obstruction below the sprinkler that demonstrates equivalent performance.

24.5.2.2

CMDA and CMSA sprinklers having standard coverage areas requiring more than 20 sprinklers in the design area shall be installed in accordance with the obstructions to sprinkler discharge criteria described in 13.2.7.

24.5.2.3

ESFR sprinklers having standard-coverage areas requiring more than 20 sprinklers in the design area shall be installed in accordance with the obstructions to sprinkler discharge criteria described in 14.2.10.

24.5.2.4

Other obstruction criteria shall be acceptable if large-scale fire testing is conducted with a representative obstruction below the sprinkler that demonstrates equivalent performance.

24.5.3 Extended Coverage Sprinklers.

24.5.3.1

Sprinklers having extended coverage areas requiring up to 10 sprinklers to be included in the hydraulic calculation shall be installed in accordance with the obstruction criteria described in 11.2.5.1, 14.2.10.2, and 14.2.10.3, unless large-scale fire testing is conducted with a representative obstruction below the sprinkler that demonstrates equivalent performance.

24.5.3.2

CMDA and CMSA sprinklers having extended coverage areas requiring more than 10 sprinklers in the design area shall be installed in accordance with the obstructions to sprinkler discharge criteria described in 13.2.7 and 11.2.5.1.

24.5.3.3

Other obstruction criteria shall be acceptable if large-scale fire testing is conducted with a representative obstruction below the sprinkler that demonstrates equivalent performance.

24.5.3.4

When utilizing upright CMSA, CMDA, or ESFR sprinklers, any continuous obstruction 4 in. (100 mm) or less shall be permitted to be ignored.