**Chapter 22 CMSA Requirements for Storage Applications**

22.1 General

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

22.1.1

Quick-response CMSA sprinklers designed to meet any criteria in Chapter 20 through Chapter 25 shall be permitted to protect any of the following:

Light hazard occupancies

Ordinary hazard occupancies

22.1.2

Standard-response CMSA sprinklers designed to meet any criteria in Chapter 20 through Chapter 25 shall be permitted to protect ordinary hazard occupancies.

22.1.3

When using CMSA, the design area shall meet the requirements of 27.2.4.3.1.

22.1.4

Protection shall be provided as specified in this chapter or appropriate NFPA standards in terms of minimum operating pressure and the number of sprinklers to be included in the design area.

22.1.5 Open Wood Joist Construction

22.1.5.1

Where CMSA sprinklers are installed under open wood joist construction, one of the following shall be provided:

A minimum pressure of 50 psi (3.4 bar) for K-11.2 (160) sprinklers

A minimum pressure of 22 psi (1.5 bar) for K-16.8 (240) sprinklers

The pressure from Table 22.4 for K-19.6 (280) or larger sprinkler.

The pressure from Table 22.4 for K-11.2 (160) or K-16.8 (240) where each joist channel is fully separated with material equal to the joist material to its full depth at intervals not exceeding 20 ft (6.1 m).

22.1.5.2 Preaction Systems

22.1.5.2.1

For the purpose of using Table 22.2, preaction systems shall be classified as dry pipe systems.

22.1.5.3

Building steel shall not require special protection where Table 22.2 are applied as appropriate for the storage configuration.

22.1.5.4\* Storage Conditions

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

Pile height

Clearance to ceiling

Pile stability

Array

22.1.6\*

The ceiling design criteria for single-, double-, and multiple-row racks in Chapter 22 shall be based on open rack configurations as defined in 3.3.140.

22.1.7

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

22.1.8

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

22.2 Palletized and Solid-Piled Storage of Class I Through Class IV Commodities

Protection of palletized and solid-piled storage of Class I through Class IV commodities shall be in accordance with Table 22.2.

Table 22.2 CMSA Sprinkler Design Criteria for Palletized and Solid-Piled Storage of Class I Through Class IV Commodities (Encapsulated and Nonencapsulated)

Configuration Commodity Class Maximum Storage Height Maximum Ceiling/Roof Height K-Factor/Orientation Type of System Number of Design Sprinklers Minimum Operating Pressure

ft m ft m psi bar

Palletized Class I or II 25 7.6 30 9.1 11.2 (160) Upright Wet 15 25 1.7

Dry 25 25 1.7

16.8 (240) Upright Wet 15 10 0.7

Dry 25 15 1.0

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

35 11 11.2 (160) Upright Wet 15 25 1.7

Dry 25 25 1.7

16.8 (240) Upright Wet 15 15 1.0

Dry 25 15 1.0

40 12 25.2 (360) Pendent Wet 15 23 1.6

30 9.1 35 11 19.6 (280) Pendent Wet 15 25 1.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

35 11 40 12 19.6 (280) Pendent Wet 15 30 2.1

25.2 (360) Pendent Wet 15 23 1.6

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

Dry 25 25 1.7

16.8 (240) Upright Wet 15 15 1.0

Dry 25 15 1.0

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0,7

35 11 11.2 (160) Upright Wet 15 25 1.7

Dry 25 25 1.7

16.8 (240) Upright Wet 15 15 1.0

Dry 25 15 1.0

40 12 25.2 (360) Pendent Wet 15 23 1.6

30 9.1 35 11 19.6 (280) Pendent Wet 15 25 1.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

35 11 40 12 19.6 (280) Pendent Wet 15 30 2.1

40 12 25.2 (360) Pendent Wet 15 23 1.6

Class IV 20 6.1 30 9.1 11.2 (160) Upright Wet 20 25 1.7

15 50 3.4

16.8 (240) Upright Wet 20 15 1.0

15 22 1.5

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

25 7.6 30 9.1 16.8 (240) Upright Wet 15 22 1.5

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

30 9.1 35 11 19.6 (280) Pendent Wet 15 25 1.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

35 11 40 12 19.6 (280) Pendent Wet 15 30 2.1

25.2 (360) Pendent Wet 15 23 1.6

Solid piled Class I or II 20 6.1 30 9.1 11.2 (160) Upright Wet 15 25 1.7

Dry 25 25 1.7

16.8 (240) Upright Wet 15 10 0.7

Dry 25 15 1.0

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

25 7.6 30 9.1 16.8 (240) Upright Wet 15 10 0.7

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

30 9.1 35 11 19.6 (280) Pendent Wet 15 25 1.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

35 11 40 12 19.6 (280) Pendent Wet 15 30 2.1

25.2 (360) Pendent Wet 15 23 1.6

Class III 20 6.1 30 9.1 11.2 (160) Upright Wet 15 25 1.7

Dry 25 25 1.7

16.8 (240) Upright Wet 15 15 1.0

Dry 25 15 1.0

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

25 7.6 30 9.1 16.8 (240) Upright Wet 15 22 1.5

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

30 9.1 35 11 19.6 (280) Pendent Wet 15 25 1.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

35 11 40 12 19.6 (280) Pendent Wet 15 30 2.1

25.2 (360) Pendent Wet 15 23 1.6

Class IV 20 6.1 30 9.1 11.2 (160) Upright Wet 15 50 3.4

16.8 (240) Upright Wet 15 22 1.5

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

25 7.6 30 9.1 16.8 (240) Upright Wet 15 22 1.5

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

30 9.1 35 11 19.6 (280) Pendent Wet 15 25 1.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

35 11 40 12 19.6 (280) Pendent Wet 15 30 2.1

25.2 (360) Pendent Wet 15 23 1.6

22.3 Palletized and Solid-Piled Storage of Nonexpanded and Expanded Group A Plastic Commodities

Protection of palletized and solid-piled storage of nonexpanded and expanded Group A plastic commodities shall be in accordance with Table 22.3.

Table 22.3 CMSA Sprinkler Design Criteria for Palletized and Solid-Piled Storage of Group A 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

ft m ft m psi bar

Palletized Cartoned nonexpanded plastics 20 6.1 30 9.1 11.2 (160) Upright Wet 25 25 1.7

16.8 (240) Upright Wet 15 22 1.5

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

25 7.6 30 9.1 16.8 (240) Upright Wet 15 22 1.5

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

30 9.1 35 11 19.6 (280) Pendent Wet 15 25 1.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

35 11 40 12 19.6 (280) Pendent Wet 15 30 2.1

25.2 (360) Pendent Wet 15 23 1.6

Solid piled Cartoned nonexpanded plastics 20 6.1 30 9.1 11.2 (160) Upright Wet 15 50 3.4

16.8 (240) Upright Wet 15 22 1.5

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

25 7.6 30 9.1 16.8 (240) Upright Wet 15 22 1.5

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

30 9.1 35 11 19.6 (280) Pendent Wet 15 25 1.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

35 11 40 12 19.6 (280) Pendent Wet 15 30 2.1

25.2 (360) Pendent Wet 15 23 1.6

Palletized Exposed nonexpanded plastics 20 6.1 30 9.1 11.2 (160) Upright Wet 25 25 1.7

16.8 (240) Upright Wet 15 22 1.5

25 7.6 30 9.1 16.8 (240) Upright Wet 15 22 1.5

Cartoned or exposed expanded plastics 18 5.5 26 7.9 11.2 (160) Upright Wet 15 50 3.4

16.8 (240) Upright Wet 15 22 1.5

Solid piled Cartoned or exposed nonexpanded plastics 20 6.1 30 9.1 11.2 (160) Upright Wet 15 50 3.4

25 7.6 30 9.1 16.8 (240) Upright Wet 15 22 1.5

22.4 Single-, Double-, and Multiple-Row Rack Storage for Class I Through Class IV Commodities

Protection of single-, double-, and multiple-row rack storage for Class I through Class IV commodities shall be in accordance with Table 22.4.

Table 22.4 CMSA Sprinkler Design Criteria for Rack Storage of Class I Through Class IV Commodities (Encapsulated and Nonencapsulated)

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

ft m ft m psi bar

Single-, double-, and multiple-row racks (no open-top containers) Class I or II 20 6.1 30 9.1 11.2 (160) Upright Wet 15 25 1.7

Dry 25 25 1.7

16.8 (240) Upright Wet 15 10 0.7

Dry 25 15 1.0

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

25 7.6 30 9.1 11.2 (160) Upright Wet 20 25 1.7

Dry 30 25 1.7

16.8 (240) Upright Wet 15 10 0.7

Dry 30 15 1.0

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

Class III 20 6.1 30 9.1 11.2 (160) Upright Wet 15 25 1.7

Dry 25 25 1.7

16.8 (240) Upright Wet 15 15 1.0

Dry 25 15 1.0

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

25 7.6 30 9.1 11.2 (160) Upright Wet \* NA NA

Dry \* NA NA

16.8 (240) Upright Wet 15 22 1.5

Dry \* NA NA

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

35 11 11.2 (160) Upright Wet \* NA NA

Dry \* NA NA

16.8 (240) Upright Wet \* NA NA

Dry \* NA NA

19.6 (280) Pendent Wet 15 25 1.7

40 12 19.6 (280) Pendent Wet 15 30 2.1

25.2 (360) Pendent Wet 15 23 1.6

Class IV 20 6.1 25 7.6 11.2 (160) Upright Wet 15 50 3.4

16.8 (240) Upright Wet 15 22 1.5

19.6 (280) Pendent Wet 15 16 1.1

30 9.1 11.2 (160) Upright Wet 20 50 3.4

15 75 5.2

16.8 (240) Upright Wet 15 22 1.5

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

40 12 25.2 (360) Pendent Wet 15 23 1.6

25 7.6 30 9.1 11.2 (160) Upright Wet \* NA NA

16.8 (240) Upright Wet 15 22 1.5

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

35 11 11.2 (160) Upright Wet \* NA NA

\* NA NA

16.8 (240) Upright Wet \* NA NA

\* NA NA

19.6 (280) Pendent Wet 15 25 1.7

40 12 19.6 (280) Pendent Wet 15 30 2.1

25.2 (360) Pendent Wet 15 23 1.6

NA: Not applicable

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

22.5 Single-, Double-, and Multiple-Row Racks of Group A Plastic Commodities

Protection of single-, double-, and multiple-row rack storage for nonexpanded Group A plastic commodities shall be in accordance with Table 22.5.

Table 22.5 CMSA Sprinkler Design Criteria for Single-, Double-, and Multiple-Row Racks of Group A Plastic Commodities Stored Up and Including 25 ft (7.6 m) in Height

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

ft m ft m psi bar

Single-, double-, and multiple-row racks (no open-top containers) Cartoned nonexpanded plastics 20 6.1 25 7.6 11.2 (160) Upright Wet 15 50 3.4

16.8 (240) Upright Wet 15 22 1.5

19.6 (280) Pendent Wet 15 16 1.1

30 9.1 11.2 (160) Upright Wet 30 50 3.4

Wet 20 75 5.2

16.8 (240) Upright Wet 15† 22 1.5

19.6 (280) Pendent Wet 15 16 1.1

25 7.6 30 9.1 11.2 (160) Upright Wet \* NA NA

16.8 (240) Upright Wet 15† 22 1.5

19.6 (280) Pendent Wet 15 16 1.1

25.2 (360) Pendent Wet 15 10 0.7

25 7.6 35 11 11.2 (160) Upright Wet \* NA NA

Wet \* NA NA

16.8 (240) Upright Wet \* NA NA

Wet \* NA NA

19.6 (280) Pendent Wet 15 25 1.7

35

10.6

40

12

25.2 (360) Pendent

Wet

15

23

0.7

Exposed nonexpanded plastics 20 6.1 25 7.6 11.2 (160) Upright Wet 15 50 3.4

16.8 (240) Upright Wet 15 22 1.5

20 6.1 30 9.1 11.2 (160) Upright Wet 30 50 3.4

Wet 20 75 5.2

16.8 (240) Upright Wet 15† 22 1.5

25 7.6 30 9.1 11.2 (160) Upright Wet \* NA NA

16.8 (240) Upright Wet 15† 22 1.5

25 7.6 35 11 11.2 (160) Upright Wet \* NA NA

Wet \* NA NA

16.8 (240) Upright Wet \* NA NA

Wet \* NA NA

NA: Not applicable

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

†Limited to single- and double-row racks with minimum 8 ft (2.4 m) aisles.

22.6 Rubber Tires

Protection of rubber tires with CMSA sprinklers shall be in accordance with Table 22.6.

Table 22.6 Control Mode Specific Application (CMSA) Protection for Rubber Tires

Piling Method Maximum Storage Height Maximum Ceiling/Roof Height K-Factor Type of System Number of Sprinklers Operating Pressure

ft m ft m

Rubber tire storage, on-side or on-tread, in palletized portable racks, or open portable racks, or fixed racks without solid shelves 25 7.6 32 10 11.2 (160) Wet 15 75 psi (5.2 bar)

25 7.6 32 10 16.8 (240) Wet 15 35 psi (2.4 bar)

22.7 Roll Paper Storage

Protection of roll paper storage with CMSA sprinklers shall be in accordance with Table 22.7.

Table 22.7 Control Mode Specific Application (CMSA) Protection of Roll Paper Storage [Number of Sprinklers at Operating Pressure, psi (bar)]

Storage Height Maximum Building Height Nominal K-Factor Type of System Heavyweight Mediumweight Tissue All Storage Arrays

Closed Array Standard Array Open Array Closed Array Standard Array Open Array

ft m ft m Banded or Unbanded Banded Unbanded Banded Unbanded Banded or Unbanded Banded Unbanded Banded Unbanded

15 at 50(3.4) 15 at 50(3.4) 15 at 50(3.4) 15 at 50(3.4) NA 15 at 50(3.4) 15 at 50(3.4) 15 at 50(3.4) NA NA See Note

20 6.1 30 9.1 11.2 (160) Dry 25 at 50(3.4) 25 at 50(3.4) 25 at 50(3.4) NA NA 25 at 50(3.4) 25 at 50(3.4) 25 at 50(3.4) NA NA NA

26 7.9 60 18 11.2 (160) Wet 15 at 50(3.4) 15 at 50(3.4) 15 at 50(3.4) 15 at 50(3.4) NA NA NA NA NA NA NA

20 6.1 30 9.1 16.8 (240) Wet 15 at 22(1.5) 15 at 22(1.5) 15 at 22(1.5) 15 at 22(1.5) NA 15 at 22(1.5) 15 at 22(1.5) 15 at 22(1.5) NA NA See Note

20 6.1 30 9.1 16.8 (240) Dry 25 at 22(1.5) 25 at 22(1.5) 25 at 22(1.5) NA NA 25 at 22(1.5) 25 at 22(1.5) 25 at 22(1.5) NA NA NA

26 7.9 60 18 16.8 (240) Wet 15 at 22(1.5) 15 at 22(1.5) 15 at 22(1.5) 15 at 22(1.5) NA NA NA NA NA NA NA

Note: Base design on 25 sprinklers at 75 psi (5.2 bar) for K-11.2 (160) sprinklers or 25 sprinklers at 35 psi (240) for K-16.8 (240) sprinklers when storage is in closed or standard array; other arrays not applicable (NA).