First Revision No. 632-NFPA 13-2016 [ Global Input ]

See attached file for the reorganization of existing Chapter 4.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [ Not Specified ]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Fri Aug 05 17:14:38 EDT 2016

Committee Statement

Committee Statement: Chapter 4 has been revised to truly contain the general information needed for a fire sprinkler system. It begins with the expected level of protection, as it has in previous editions. Then it covers the owner’s certificate also similar to other editions. It now includes occupancy classification as that is the primary step necessary in layout and detail of a fire sprinkler system. The language for this subject has been overhauled to fit the manual of style and definitions were modified appropriately in Chapter 3 to reflect this. Miscellaneous and low-piled storage have been incorporated into the occupancy classifications so that the user stays in the occupancy requirements for protection, eliminating the confusion with applying design methods and other criteria. High-piled storage is only mentioned as a pointer to the storage chapters. Limitations on system size have been moved to this Chapter along with the requirements for working plans as these are both general information that is applicable to all systems.

Chapter 4  General Requirements

4.1  Level of Protection. [move text to 4.1.1]
A building, where protected by an automatic sprinkler system installation, shall be provided with
sprinklers in all areas except where specific sections of this standard permit the omission of
sprinklers.

4.2  Limited Area Systems. [move to 4.1.2]

4.2.1  [move to 4.1.2.1]
When partial sprinkler systems are installed, the requirements of this standard shall be used
insofar as they are applicable.

4.2.2  [move to 4.1.2.2]
The authority having jurisdiction shall be consulted in each case.

4.3*  Owner’s Certificate. [renumber to 4.2]
The owner(s) of a building or structure where the fire sprinkler system is going to be installed or
their authorized agent shall provide the sprinkler system installer with the following information
prior to the layout and detailing of the fire sprinkler system [see Figure A.23.1(b)]:
(1)  Intended use of the building including the materials within the building and the maximum
height of any storage
(2)  A preliminary plan of the building or structure along with the design concepts necessary to
perform the layout and detail for the fire sprinkler system
(3)  *Any special knowledge of the water supply, including known environmental conditions
that might be responsible for corrosion, including microbiologically influenced corrosion (MIC)

4.4*  Additives. [renumber to 4.8]
Additives or chemicals intended to stop leaks, such as sodium silicate or derivatives of sodium
silicate, brine, or similar acting chemicals, shall not be used in sprinkler systems.

4.5  Air, Nitrogen, or Other Approved Gas. [renumber to 4.9]
Where air is used to charge, maintain, or supervise sprinkler systems, nitrogen or other approved
gas shall also be permitted to be used.

4.6*  Support of Nonsprinkler System Components. [renumber to 4.10]
Sprinkler system components shall not be used to support nonsprinkler system components
unless expressly permitted by this standard.
See attached file for the reorganization of existing Chapter 5.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [ Not Specified ]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Fri Aug 05 17:18:42 EDT 2016

Committee Statement

Committee Statement: Chapter 5 was Chapter 24 in the 2016 edition of NFPA 13. The task group felt that this chapter belongs at the beginning of the document as usually determining the water supply is the first step in designing a sprinkler system.

Response Message: 

National Fire Protection Association Report http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...
Chapter 5  Classification of Occupancies and Commodities

5.1*  Classification of Occupancies. [move to 4.3]

5.1.1  Occupancy classifications for this standard shall relate to sprinkler design, installation, and water supply requirements only.

5.1.2  Occupancy classifications shall not be intended to be a general classification of occupancy hazards.

5.2*  Light Hazard Occupancies. [move to 4.3.2]
Light hazard occupancies shall be defined as occupancies or portions of other occupancies where the quantity and/or combustibility of contents is low and fires with relatively low rates of heat release are expected.

5.3*  Ordinary Hazard Occupancies.—being deleted with an FR

5.3.1*  Ordinary Hazard (Group 1). [move to 4.3.3]

5.3.1.1  Ordinary hazard (Group 1) occupancies shall be defined as occupancies or portions of other occupancies where combustibility is low, quantity of combustibles is moderate, stockpiles of combustibles do not exceed 8 ft (2.4 m), and fires with moderate rates of heat release are expected.

5.3.2*  Ordinary Hazard (Group 2). [move to 4.3.4]

5.3.2.1  Ordinary hazard (Group 2) occupancies shall be defined as occupancies or portions of other occupancies where the quantity and combustibility of contents are moderate to high, stockpiles of contents with moderate rates of heat release do not exceed 12 ft (3.7 m), and stockpiles of contents with high rates of heat release do not exceed 8 ft (2.4 m).

5.4  Extra Hazard Occupancies.  —being deleted with an FR

5.4.1*  Extra Hazard (Group 1). [move to 4.3.5]
Extra hazard (Group 1) occupancies shall be defined as occupancies or portions of other occupancies where the quantity and combustibility of contents are very high and dust, lint, or other materials are present, introducing the probability of rapidly developing fires with high rates of heat release but with little or no combustible or flammable liquids.

5.4.2* Extra Hazard (Group 2). [move to 4.3.6]
Extra hazard (Group 2) occupancies shall be defined as occupancies or portions of other occupancies with moderate to substantial amounts of flammable or combustible liquids or occupancies where shielding of combustibles is extensive.

5.5* Special Occupancy Hazards. [move to 4.3.8]

5.6* Commodity Classification. .—being deleted with an FR
See Section C.2.

5.6.1 General. .—being deleted with an FR

5.6.1.1* Classification of Commodities. [move to 20.3]

5.6.1.1 [move to 20.3.1]
Commodity classification and the corresponding protection requirements shall be determined based on the makeup of individual storage units (i.e., unit load, pallet load).

5.6.1.1.1 [move to 20.3.1.1]
The type and amount of materials used as part of the product and its primary packaging as well as the storage pallet shall be considered in the classification of the commodity.

5.6.1.2 [move to 20.3.1.2]
When specific test data of commodity classification by a nationally recognized testing agency are available, the data shall be permitted to be used in determining classification of commodities.

5.6.1.2 Mixed Commodities. [move to 20.4.14]

5.6.1.2.1 [move to 20.4.14.1]
Protection requirements shall not be based on the overall commodity mix in a fire area.

5.6.1.2.2 [move to 20.4.14.2]
Unless the requirements of 5.6.1.2.3 or 5.6.1.2.4 are met, mixed commodity storage shall be protected by the requirements for the highest classified commodity and storage arrangement.

5.6.1.2.3 [move to 20.4.14.3]
The protection requirements for the lower commodity class shall be permitted to be utilized where all of the following are met:
(1) Up to 10 pallet loads of a higher hazard commodity, as described in 5.6.3 and 5.6.4, shall be permitted to be present in an area not exceeding 40,000 ft² (3720 m²).
(2) The higher hazard commodity shall be randomly dispersed with no adjacent loads in any direction (including diagonally).
(3) Where the ceiling protection is based on Class I or Class II commodities, the allowable number of pallet loads for Class IV or Group A plastics shall be reduced to five.

5.6.1.2.4 Mixed Commodity Segregation. [move to 20.4.14.4]
The protection requirements for the lower commodity class shall be permitted to be utilized in the area of lower commodity class, where the higher hazard material is confined to a designated area and the area is protected to the higher hazard in accordance with the requirements of this standard.

5.6.2 Pallet Types. [move to 20.3.2]

5.6.2.1 General. [move to 20.3.2.1]
When loads are palletized, the use of wood or metal pallets, or listed pallets equivalent to wood, shall be assumed in the classification of commodities.

5.6.2.2* Unreinforced Plastic Pallets. [move to 20.3.2.2.1]
For Class I through Class IV commodities, when unreinforced polypropylene or unreinforced high-density polyethylene plastic pallets are used, the classification of the commodity unit shall be increased one class.

5.6.2.2.1 [move to 20.3.2.2.1.2]
Unreinforced polypropylene or unreinforced high-density polyethylene plastic pallets shall be marked with a permanent symbol to indicate that the pallet is unreinforced.

5.6.2.3* [move to 20.3.2.2.2.1]
For Class I through Class IV commodities, when reinforced polypropylene or reinforced high-density polyethylene plastic pallets are used, the classification of the commodity unit shall be increased two classes except for Class IV commodity, which shall be increased to a cartoned unexpanded Group A plastic commodity.

5.6.2.3.1 [move to 20.3.2.2.2.2]
Pallets shall be assumed to be reinforced if no permanent marking or manufacturer's certification of nonreinforcement is provided.

5.6.2.4 [move to 20.3.2.2.3]
No increase in the commodity classification shall be required for Group A plastic commodities stored on plastic pallets.

5.6.2.5 [move to 20.3.2.2.4]
For ceiling-only sprinkler protection, the requirements of 5.6.2.2 and 5.6.2.3 shall not apply where plastic pallets are used and where the sprinkler system uses spray sprinklers with a minimum K-factor of K-16.8 (240).
5.6.2.6 [move to 20.3.2.3]  
The requirements of 5.6.2.2 through 5.6.2.7 shall not apply to nonwood pallets that have demonstrated a fire hazard that is equal to or less than wood pallets and are listed as such.

5.6.2.7 [move to 20.3.2.4]  
For Class I through Class IV commodities stored on plastic pallets when other than wood, metal, or polypropylene or high-density polyethylene plastic pallets are used, the classification of the commodity unit shall be determined by specific testing conducted by a national testing laboratory or shall be increased two classes.

5.6.3* Commodity Classes. [move to 20.4]  

5.6.3.1* Class I. [move to 20.4.1]  
A Class I commodity shall be defined as a noncombustible product that meets one of the following criteria:
(1) Placed directly on wood pallets
(2) Placed in single-layer corrugated cartons, with or without single-thickness cardboard dividers, with or without pallets
(3) Shrink-wrapped or paper-wrapped as a unit load with or without pallets

5.6.3.2* Class II. [move to 20.4.2]  
A Class II commodity shall be defined as a noncombustible product that is in slatted wooden crates, solid wood boxes, multiple-layered corrugated cartons, or equivalent combustible packaging material, with or without pallets.

5.6.3.3* Class III. [move to 20.4.3]  

5.6.3.3.1 [move to 20.4.3.1]  
A Class III commodity shall be defined as a product fashioned from wood, paper, natural fibers, or Group C plastics with or without cartons, boxes, or crates and with or without pallets.

5.6.3.3.2* [move to 20.4.3.2]  
A Class III commodity shall be permitted to contain a limited amount (5 percent or less by weight of unexpanded plastic or 5 percent or less by volume of expanded plastic) of Group A or Group B plastics.

5.6.3.3.3 [move to 20.4.3.3]  
Class III commodities containing a mix of both Group A expanded and unexpanded plastics shall comply with Figure 5.6.3.3.3(a) where they are within cartons, boxes, or crates or with Figure 5.6.3.3.3(b) where they are exposed.

Figure 5.6.3.3.3(a) Commodities Containing a Mixture of Expanded and Unexpanded Group A Plastics.
Figure 5.6.3.3.3(b) Exposed Commodities Containing a Mixture of Expanded and Unexpanded Group A Plastics.

III - Class III Commodity. Refer to 5.6.2 if a plastic pallet is used.

IV - Class IV Commodity. Refer to 5.6.2 if a plastic pallet is used.
5.6.3.4* Class IV. [move to 20.4.4]

5.6.3.4.1 [move to 20.4.4.1]
A Class IV commodity shall be defined as a product, with or without pallets, that meets one of the following criteria:
1. Constructed partially or totally of Group B plastics
2. Consists of free-flowing Group A plastic materials
3. Cartoned, or within a wooden container, that contains greater than 5 percent and up to 15 percent by weight of Group A unexpanded plastic
4. Cartoned, or within a wooden container, that contains greater than 5 percent and up to 25 percent by volume of expanded Group A plastics
5. Cartoned, or within a wooden container, that contains a mix of Group A expanded and unexpanded plastics and complies with Figure 5.6.3.3.3(a)
6. Exposed, that contains greater than 5 percent and up to 15 percent by weight of Group A unexpanded plastic
7. Exposed, that contains a mix of Group A expanded and unexpanded plastics and complies with Figure 5.6.3.3.3(b)

5.6.3.4.2 [move to 20.4.4.2]
The remaining materials shall be permitted to be metal, wood, paper, natural or synthetic fibers, or Group B or Group C plastics.

5.6.4* Classification of Plastics, Elastomers, and Rubber. [move to 20.4.5]
Plastics, elastomers, and rubber shall be classified as Group A, Group B, or Group C.

5.6.4.1* Group A. [move to 20.4.5.1]
The following materials shall be classified as Group A:
1. ABS (acrylonitrile-butadiene-styrene copolymer)
2. Acetal (polyformaldehyde)
3. Acrylic (polymethyl methacrylate)
4. Butyl rubber
5. Cellulosics (cellulose acetate, cellulose acetate butyrate, ethyl cellulose)
6. EPDM (ethylene-propylene rubber)
7. FRP (fiberglass-reinforced polyester)
8. Natural rubber
9. Nitrile-rubber (acrylonitrile-butadiene-rubber)
10. Nylon (nylon 6, nylon 6/6)
11. PET (thermoplastic polyester)
12. Polybutadiene
13. Polycarbonate
14. Polyester elastomer
15. Polyethylene
16. Polypropylene
17. Polystyrene
18. Polyurethane
(19) PVC (polyvinyl chloride — highly plasticized, with plasticizer content greater than 20 percent) (rarely found)
(20) PVF (polyvinyl fluoride)
(21) SAN (styrene acrylonitrile)
(22) SBR (styrene-butadiene rubber)

5.6.4.1.1* [move to 20.4.5.2]
Group A plastics shall be further subdivided as either expanded or unexpanded.

5.6.4.1.1.1 [move to 20.4.5.3]
A Group A expanded plastic commodity shall be defined as a product, with or without pallets, that meets one of the following criteria:
(1) Cartoned, or within a wooden container, that contains greater than 40 percent by volume of Group A expanded plastic
(2) Exposed, that contains greater than 25 percent by volume of Group A expanded plastic

5.6.4.1.1.2 [move to 20.4.5.4]
A Group A unexpanded plastic commodity shall be defined as a product, with or without pallets, that meets one of the following criteria:
(1) Cartoned, or within a wooden container, that contains greater than 15 percent by weight of Group A unexpanded plastic
(2) Cartoned, or within a wooden container, that contains greater than 25 percent and up to 40 percent by volume of Group A expanded plastic
(3) Cartoned, or within a wooden container, that contains a mix of Group A unexpanded and expanded plastics, in compliance with Figure 5.6.3.3.3(a)
(4) Exposed, that contains greater than 15 percent by weight of Group A unexpanded plastic
(5) Exposed, that contains greater than 5 percent and up to 25 percent by volume of Group A expanded plastic
(6) Exposed, that contains a mix of Group A unexpanded and expanded plastics, in compliance with Figure 5.6.3.3.3(b)

5.6.4.1.1.3 [move to 20.4.5.4] [text for 5.6.4.1.1.2 & 5.6.4.1.1.3 combined into 1 section?]
The remaining materials shall be permitted to be noncombustible, wood, paper, natural or synthetic fibers, or Group A, Group B, or Group C plastics.

5.6.4.2 Group B. [move to 20.4.6]
The following materials shall be classified as Group B:
(1) Chloroprene rubber
(2) Fluoroplastics (ECTFE — ethylene-chlorotrifluoro-ethylene copolymer; ETFE — ethylene-tetrafluoroethylene-copolymer; FEP — fluorinated ethylene-propylene copolymer)
(3) Silicone rubber

5.6.4.3 Group C. [move to 20.4.7]
The following materials shall be classified as Group C:
(1) Fluoroplastics (PCTFE — polychlorotrifluoroethylene; PTFE — polytetrafluoroethylene)
5.6.5* Classification of Rolled Paper Storage. [move to 20.4.10]

For the purposes of this standard, the classifications of paper described in 5.6.5.1 through 5.6.5.4 shall apply and shall be used to determine the sprinkler system design criteria.

5.6.5.1 Heavyweight Class. [move to 20.4.10.1]

Heavyweight class shall be defined so as to include paperboard and paper stock having a basis weight [weight per 1000 ft² (92.9 m²)] of 20 lb (9.1 kg).

5.6.5.2 Mediumweight Class. [move to 20.4.10.2]

Mediumweight class shall be defined so as to include all the broad range of papers having a basis weight [weight per 1000 ft² (92.9 m²)] of 10 lb to 20 lb (4.5 kg to 9.1 kg).

5.6.5.3 Lightweight Class. [move to 20.4.10.3]

Lightweight class shall be defined so as to include all papers having a basis weight [weight per 1000 ft² (92.9 m²)] of 10 lb (4.5 kg).

5.6.5.4 Tissue. [move to 20.4.10.4]

5.6.5.4.1 [move to 20.4.10.4.1]

Tissue shall be defined so as to include the broad range of papers of characteristic gauzy texture, which, in some cases, are fairly transparent.

5.6.5.4.2 [move to 20.4.10.4.2]

For the purposes of this standard, tissue shall be defined as the soft, absorbent type, regardless of basis weight — specifically, crepe wadding and the sanitary class including facial tissue, paper napkins, bathroom tissue, and toweling.
First Revision No. 647-NFPA 13-2016 [ Global Input ]

See attached file for the reorganization of existing Chapter 19.

Supplemental Information

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Submitter Information Verification

- **Submitter Full Name:** AUT-SSD
- **Organization:** [ Not Specified ]
- **Street Address:**
- **City:**
- **State:**
- **Zip:**
- **Submittal Date:** Fri Aug 05 17:33:46 EDT 2016

Committee Statement

**Committee Statement:** Chapter 19 is a combination of chapters 11 and 23, part of Chapter 4, and a small section from Chapter 8 of the 2016 edition. The goal was to streamline the chapter by removing material best grouped with other sections. Plan Requirements moved to the new Chapter 4 General Chapter, Exposure Protection moved to the new Chapter 8 System Types and Requirements, and the Owner’s Certificate was incorporated to show what is to be supplied to start the design.

**Response Message:**
Chapter 19 Protection of Roll Paper

19.1* Protection of Roll Paper Storage. —being deleted with an FR

19.1.1 General. —being deleted with an FR
The requirements of Chapter 12 shall apply unless modified by this chapter.

19.1.1.1 [move to 20.5.9.13.1]
The water supply design shall include the demand of the automatic sprinkler system plus the hose stream allowance plus, where provided, the high-expansion foam system for the duration specified in Table 12.8.6.

19.1.1.2 [move to 20.5.9.13]
Wet pipe systems shall be used in tissue storage areas.

19.1.1.3 [move to 20.5.9.14]
Horizontal storage of heavyweight or mediumweight paper shall be protected as a closed array.

19.1.1.4 [move to 20.5.9.15]
Mediumweight paper shall be permitted to be protected as heavyweight paper where wrapped completely on the sides and both ends, or where wrapped on the sides only with steel bands. Wrapping material shall be either a single layer of heavyweight paper with a basis weight of 40 lb (18.1 kg) or two layers of heavyweight paper with a basis weight of less than 40 lb (18.1 kg).

19.1.1.5 [move to 20.5.9.16]
Lightweight paper or tissue paper shall be permitted to be protected as mediumweight paper where wrapped completely on the sides and both ends, or where wrapped on the sides only with steel bands. Wrapping material shall be either a single layer of heavyweight paper with a basis weight of 40 lb (18.1 kg) or two layers of heavyweight paper with a basis weight of less than 40 lb (18.1 kg).

19.1.1.6 [move to 20.5.9.17]
For purposes of sprinkler system design criteria, lightweight class paper shall be protected as tissue.

19.1.2* Protection Criteria for Roll Paper Storage. [move to 20.5.9.12]

19.1.2.1 Control Mode Density/Area Sprinkler Protection Criteria for Roll Paper Storage. [move to 21.7]

19.1.2.1.1 [move to 21.7.1]
Storage of heavyweight or mediumweight classes of rolled paper up to 10 ft (3.0 m) in height shall be protected by sprinklers designed for ordinary hazard Group 2 densities.

19.1.2.1.2 [move to 21.7.2]
Storage of tissue and lightweight classes of paper up to 10 ft (3.0 m) in height shall be protected by sprinklers in accordance with extra hazard Group 1 densities.

19.1.2.1.3 [move to 21.7.3]
Sprinkler design criteria for storage of roll paper 10 ft (3.0 m) high and higher in buildings or structures with roof or ceilings up to 30 ft (9.1 m) shall be in accordance with Table 19.1.2.1.3(a) and Table 19.1.2.1.3(b).

Table 19.1.2.1.3(a) Control Mode Density/Area Sprinkler Protection Criteria for Roll Paper Storage for Buildings or Structures with Roof or Ceilings Up to 30 ft (Discharge Densities are gpm/ft² over ft²)

<table>
<thead>
<tr>
<th>Storage Height (ft)</th>
<th>Ceiling (ft)</th>
<th>Heavyweight</th>
<th>Mediumweight</th>
</tr>
</thead>
<tbody>
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<td>Standard Array</td>
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<td>Banded or Unbanded</td>
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</table>

Notes:
(1) Sprinkler protection requirements for tissue stored above 20 ft have not been determined.
(2) Densities or areas, or both, shall be permitted to be interpolated between any 5 ft storage height increment.

Table 19.1.2.1.3(b) Control Mode Density/Area Sprinkler Protection Criteria for the Protection of Roll Paper Storage for Buildings or Structures with Roof or Ceilings Up to 9.1 m (Discharge Densities are mm/min over m²)
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<thead>
<tr>
<th>Storage Height (m)</th>
<th>Ceiling (m)</th>
<th>Heavyweight</th>
<th>Mediumweight</th>
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<td>24.5/232</td>
</tr>
</tbody>
</table>

Notes:
(1) Sprinkler protection requirements for tissue stored above 6.1 m have not been determined.
(2) Densities or areas, or both, shall be permitted to be interpolated between any 1.5 m storage height increment.

19.1.2.1.4* [move to 21.7.4]
High-temperature sprinklers shall be used for installations protecting roll paper stored 15 ft (4.6 m) or higher.

19.1.2.1.5 [move to 21.7.5]
The protection area per sprinkler shall not exceed 100 ft² (9.3 m²) or be less than 70 ft² (6.5 m²).

19.1.2.1.6 [move to 21.7.6]
Where high-expansion foam systems are installed in heavyweight class and mediumweight class storage areas, sprinkler discharge design densities shall be permitted to be reduced to not less than 0.24 gpm/ft² (9.8 mm/min) with a minimum operating area of 2000 ft² (186 m²).

19.1.2.1.7 [move to 21.7.7]
Where high-expansion foam systems are installed in tissue storage areas, sprinkler discharge densities and areas of application shall not be reduced below those provided in Table 19.1.2.1.3(a) and Table 19.1.2.1.3(b).

19.1.2.2 CMSA Sprinklers for Protection of Roll Paper Storage. [move to 22.7]
Where automatic sprinkler system protection utilizes CMSA sprinklers, hydraulic design criteria shall be as specified in Table 19.1.2.2.

Table 19.1.2.2 CMSA Sprinklers for Protection of Roll Paper Storage [Number of Sprinklers at Operating Pressure, psi (bar)]

<table>
<thead>
<tr>
<th>Storage Height</th>
<th>Nominal K-Factor</th>
<th>Type of System</th>
<th>Heavyweight</th>
<th>Mediumweight</th>
<th>Tissue All Storage Arrays</th>
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<td>Max Building Height</td>
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<td>Standard Array</td>
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<td>ft  m</td>
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<td>Band</td>
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<td>Band</td>
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<tr>
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<td>30 9.1</td>
<td>Wet</td>
<td>15 at 50(3.4)</td>
<td>15 at 50(3.4)</td>
<td>15 at 50(3.4)</td>
</tr>
<tr>
<td>2 0 6</td>
<td>30 9.1</td>
<td>Dry</td>
<td>15 at 22(1.5)</td>
<td>25 at 22(1.5)</td>
<td>25 at 22(1.5)</td>
</tr>
<tr>
<td>2 7 6.9</td>
<td>60 18</td>
<td>Wet</td>
<td>15 at 22(1.5)</td>
<td>25 at 22(1.5)</td>
<td>25 at 22(1.5)</td>
</tr>
<tr>
<td>2 7 6.9</td>
<td>60 18</td>
<td>Dry</td>
<td>15 at 22(1.5)</td>
<td>25 at 22(1.5)</td>
<td>25 at 22(1.5)</td>
</tr>
</tbody>
</table>

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

19.1.2.3 Early Suppression Fast-Response (ESFR) Sprinklers for Protection of Roll Paper Storage. [move to 23.9]

Where automatic sprinkler system protection utilizes ESFR sprinklers, hydraulic design criteria shall be as specified in Table 19.1.2.3. Design discharge pressure shall be applied to 12 operating sprinklers.

Table 19.1.2.3 ESFR Sprinklers for Protection of Roll Paper Storage (Maximum Height of Storage Permitted)
<table>
<thead>
<tr>
<th>ESFR K-Factor</th>
<th>Orientatio n</th>
<th>System Type</th>
<th>Pressure</th>
<th>Buildin g Height</th>
<th>Heavyweight</th>
<th>Mediumweight</th>
<th>Tissue All Arrays</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>psi</td>
<td>bar ft m ft m ft m ft m ft m ft m ft m ft m ft m ft m ft m</td>
<td>Close d</td>
<td>Standard d</td>
<td>Open</td>
</tr>
<tr>
<td>14.0 (201)</td>
<td>Upright/ pendent</td>
<td>Wet</td>
<td>50</td>
<td>3.4</td>
<td>30 9.1 25 7.6 25 7.6 2 5 7.6 25 7.6 25 7.6 2 5 7.6</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>16.8 (242)</td>
<td>Upright/ pendent</td>
<td>Wet</td>
<td>35</td>
<td>2.4</td>
<td>30 9.1 25 7.6 25 7.6 2 5 7.6 25 7.6 25 7.6 2 5 7.6</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>22.4 (322)</td>
<td>Pendent</td>
<td>Wet</td>
<td>25</td>
<td>1.7</td>
<td>30 9.1 25 7.6 25 7.6 2 5 7.6 25 7.6 25 7.6 2 5 7.6</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>25.2 (363)</td>
<td>Pendent</td>
<td>Wet</td>
<td>15</td>
<td>1.0</td>
<td>30 9.1 25 7.6 25 7.6 2 5 7.6 25 7.6 25 7.6 2 5 7.6</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>14.0 (201)</td>
<td>Upright/ pendent</td>
<td>Wet</td>
<td>75</td>
<td>5.2</td>
<td>35 11 30 9.1 30 9.1 3 0 9.1 NA NA NA NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>16.8 (242)</td>
<td>Upright/ pendent</td>
<td>Wet</td>
<td>52</td>
<td>3.6</td>
<td>35 11 30 9.1 30 9.1 3 0 9.1 NA NA NA NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>16.8 (242)</td>
<td>Pendent</td>
<td>Wet</td>
<td>52</td>
<td>3.6</td>
<td>35 11 30 9.1 30 9.1 3 0 9.1 NA NA NA NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>22.4 (322)</td>
<td>Pendent</td>
<td>Wet</td>
<td>40</td>
<td>2.7</td>
<td>40 12 30 9.1 30 9.1 3 0 9.1 NA NA NA NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>25.2 (363)</td>
<td>Pendent</td>
<td>Wet</td>
<td>25</td>
<td>1.7</td>
<td>40 12 30 9.1 30 9.1 3 0 9.1 NA NA NA NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>22.4 (322)</td>
<td>Pendent</td>
<td>Wet</td>
<td>50</td>
<td>3.4</td>
<td>45 14 30 9.1 30 9.1 3 0 9.1 NA NA NA NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>25.2 (363)</td>
<td>Pendent</td>
<td>Wet</td>
<td>50</td>
<td>3.4</td>
<td>45 14 30 9.1 30 9.1 3 0 9.1 NA NA NA NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

NA: Not applicable.
See attached file for the reorganization of existing Chapter 20.

Committee Statement

Chapter 20 replaces the old Chapter 12 with more storage information – such as the steps of protection, commodity class and many of the definitions that had criteria in them for compliance. The format of the chapter reads:

20.1 – scope
20.2 – steps of protection
20.3 – Commodity Class General
20.4 – Commodity Classification
20.5 – Storage Arrangements
20.6 – Building construction/feature, heights and clearances
20.7 – Unsprinklered comb concealed penalty
20.8 – Room Design Method
20.9 – High Ex foam
20.10 – Adjacent Hazards
20.11 – Hose Connection
20.12 – Hose stream allowance and water supply duration
20.13 – Discharge Considerations General
20.14 – Idle Pallets
20.15 – Column Protection

20.16 – Alternative Protection (Scheme A)

Response

Message:
Chapter 20  Special Designs of Storage Protection

20.1  General. —being deleted with an FR
The requirements of Chapter 12 shall apply unless modified by this chapter.

20.2*  Plastic Motor Vehicle Components. [move to 20.4.11]
Group A plastic automotive components and associated packaging material shall be permitted to be protected in accordance with Table 20.2.

Table 20.2 ESFR Sprinkler Design Criteria K-25.2 (360) for Portable Racks (Closed Array\(^a\)) Without Solid Shelves Containing Automotive Components

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Maximum Storage Height</th>
<th>Maximum Ceiling/Roof Height</th>
<th>Type of System</th>
<th>Maximum Sprinkler Spacing(^b)</th>
<th>Number of Design Sprinklers by Minimum Operating Pressure(^c)</th>
<th>Maximum Deflector Distance Below Ceiling(^d)</th>
<th>Hose Stream Allowance</th>
<th>Water Supply Duration (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ft m ft m</td>
<td></td>
<td></td>
<td>ft(^2) m(^2) psi bar</td>
<td>16 ft(^2) at 37 psi 16 ft(^2) at 2.5 bar</td>
<td>18 in. 450 mm 500 L/min 1900 L/min</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Automotive components and associated packaging material</td>
<td>25 7.6 35 11</td>
<td>Wet</td>
<td>100 9.3</td>
<td>16 at 37 psi</td>
<td>16 at 2.5 bar</td>
<td>18</td>
<td>450</td>
<td>500</td>
</tr>
</tbody>
</table>

\(^a\)Portable rack array shall be tightly nested without any flue spaces.

\(^b\)Sprinkler spacing can exceed 100 ft\(^2\) (9.3 m\(^2\)) where sprinklers are listed for larger spacing.

\(^c\)System hydraulic design shall also be capable of delivering a discharge density of 0.60 gpm/ft\(^2\) (24.4 mm/min) over the most hydraulically remote 4000 ft\(^2\) (370 m\(^2\)) area.

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

20.3*  Sprinkler Design Criteria for Storage and Display of Class I Through Class IV Commodities, Cartoned Nonexpanded Group A Plastics and Nonexpanded Exposed Group A Plastics in Retail Stores.  [move to 21.10]

20.3.1  [move to 21.10.1]
A wet pipe system designed to meet two separate design points — 0.6 gpm/ft\(^2\) (24.4 mm/min) density over 2000 ft\(^2\) (186 m\(^2\)) and 0.7 gpm/ft\(^2\) (28.5 mm/min) density for the four hydraulically most demanding sprinklers with 500 gpm (1900 L/min) hose stream allowance for a 2-hour duration — shall be permitted to protect single- and double-row slatted shelf racks when the following conditions are met:

1. An extended coverage sprinkler with a nominal K-factor of K-25.2 (360) listed for storage occupancies shall be provided.
2. Shelves shall be either open shelving or slatted using a 2 in. (50 mm) thick by maximum 6 in. (150 mm) wide slat held in place by spacers that maintain a minimum 2 in. (50 mm) opening between each slat.
3. There shall be no slatted shelf levels in the rack above nominal 12 ft (3.7 m) level. Wire mesh (greater than 50 percent opening) shall be permitted for shelf levels above 12 ft (3.7 m).
4. A single level of solid shelving (31/2 ft × 8 ft 3 in.) (1.1 m × 2.5 m) shall be permissible at an elevation of not more than 5 ft (1.5 m).
5. Perforated metal (open area of 40 percent or more) shall be permitted over either the open shelving or the slatted shelves up to the 60 in. (1.5 m) level.
6. Other than what is allowed in this section, solid plywood or similar materials shall not be placed on the slatted shelves.
7. Solid displays shall be permissible, provided that all flues are maintained and only one display is installed per bay.
8. Maximum roof height shall be 30 ft (9.1 m) in the protected area.
9. Maximum storage height shall be 22 ft (6.7 m).
10. Aisle widths shall be a minimum of 8 ft (2.4 m).
11. Minimum transverse flue spaces of 3 in. every 10 ft (75 mm every 3.0 m) horizontally shall be provided.
12. Minimum longitudinal flue spaces of 6 in. (150 mm) shall be provided for double-row racks.
13. Storage in the aisle shall be permissible, provided the aisle storage is no more than 4 ft (1.2 m) high and a minimum clear aisle of 4 ft (1.2 m) is maintained.

20.3.2 [move to 21.10.2]
A wet pipe system designed to meet two separate design points — 0.425 gpm/ft² (17.3 mm/min) density over 2000 ft² (186 m²) and 0.50 gpm/ft² (20.4 mm/min) density for the four hydraulically most demanding sprinklers with 500 gpm (1900 L/min) hose stream allowance for a 2-hour duration — shall be permitted in solid steel cantilever-style retail shelving racks (gondola racks) when the following conditions are met:
1. An extended coverage sprinkler with a nominal K-factor of K-25.2 (360) listed for storage occupancies shall be provided.
2. The storage height shall not exceed 12 ft (3.7 m).
3. The ceiling height shall not exceed 22 ft (6.7 m) in the protected area.
4. Gondola rack structure shall not exceed 48 in. (1.2 m) in aggregate depth or 78 in. (2 m) in height.
5. A minimum aisle of 5 ft (1.5 m) between storage shall be maintained.
6. Rack lengths shall be no more than 70 ft (21 m).

20.3.3 [move to 21.10.3]
A wet system designed to meet two separate design points — 0.425 gpm/ft² (17.3 mm/min) density over 2000 ft² (186 m²) and 0.50 gpm/ft² (20.4 mm/min) density for the four hydraulically most demanding sprinklers with 500 gpm (1900 L/min) hose stream allowance for a 2-hour duration — shall be permitted in solid steel cantilever-style retail shelving racks (gondola racks) when the following conditions are met:
1. An extended coverage sprinkler with a nominal K-factor of K-25.2 (360) listed for storage occupancies shall be provided.
(2) Storage height shall not exceed 15 ft (4.6 m).
(3) Ceiling height shall not exceed 25 ft (7.6 m) in the protected area.
(4) Gondola rack structure shall not exceed 60 in. (1.5 m) in aggregate depth or 8 ft (2.4 m) in height.
(5) A perforated metal deck at the 8 ft (2.4 m) level shall be permissible with storage placed on top with or without flue spaces to a maximum height from floor of 15 ft (4.6 m).
(6) Rack lengths shall not exceed 70 ft (21 m).
(7) A minimum aisle space of 6 ft (1.8 m) shall be provided.

20.3.4 [move to 21.10.4]
A wet pipe system designed to meet two separate design points — 0.45 gpm/ft² (18.3 mm/min) density over 2000 ft² (186 m²) and 0.55 gpm/ft² (22.4 mm/min) density for the four hydraulically most demanding sprinklers with 500 gpm (1900 L/min) hose stream allowance for a 2-hour duration — shall be permitted without the use of in-rack sprinklers when the following conditions are met:
(1) An extended coverage sprinkler with a nominal K-factor of K-25.2 (360) listed for storage occupancies shall be provided.
(2) Storage height shall not exceed 15 ft (4.6 m).
(3) Ceiling height shall not exceed 25 ft (7.6 m).
(4) Shelving structure shall not exceed 48 in. (1.2 mm) aggregate depth or 12 ft (3.7 m) in height.
(5) Shelving shall be permitted to be made of solid particleboard.
(6) A minimum aisle space of 3 ft (900 mm) shall be maintained.
(7) Shelving length shall be a maximum of 70 ft (21 m).

20.3.5 [move to 21.10.5]
A wet pipe system designed to meet two separate design points — 0.38 gpm/ft² (15.5 mm/min) density over 2000 ft² (186 m²) and 0.45 gpm/ft² (18.3 mm/min) density for the four hydraulically most demanding sprinklers with 500 gpm (1900 L/min) hose stream allowance for a 2-hour duration — shall be permitted without the use of in-rack sprinklers in steel retail sales floor shelving racks where the following conditions are met:
(1) An extended coverage sprinkler with a nominal K-factor of K-25.2 (360) listed for storage occupancies shall be provided.
(2) Storage height shall not exceed 14 ft (4.3 m).
(3) Ceiling height shall not exceed 20 ft (6.1 m).
(4) Solid metal shelving shall be permissible up to the 72 in. (1.8 mm) level and wire shelving shall be permissible up to the 10 ft (3.0 m) level.
(5) The solid metal shelving shall not exceed 66 in. (1.7 m) in aggregate depth with a 6 in. (150 mm) longitudinal flue between two 30 in. (750 mm) deep shelves.
(6) A minimum aisle space of 5 ft (1.5 m) shall be maintained.
(7) A minimum longitudinal flue of 6 in. (150 mm) shall be maintained.
(8) Rack length shall be a maximum of 70 ft (21 m).

20.3.6 [move to 21.10.6]
A wet pipe system designed to meet two separate design points — 0.49 gpm/ft² (20 mm/min) density over 2000 ft² (186 m²) and 0.55 gpm/ft² (22.4 mm/min) density for the four hydraulically
most demanding sprinklers with 500 gpm (1900 L/min) hose stream allowance for a 2-hour duration — shall be permitted without the use of in-rack sprinklers in retail solid shelved steel rack structure when the following conditions are met:
(1) An extended coverage sprinkler with a nominal K-factor of K-25.2 (360) listed for storage occupancies shall be provided.
(2) Storage height shall not exceed 16.5 ft (5 m).
(3) Ceiling height shall not exceed 22 ft (6.7 m).
(4) Shelving structure shall not exceed 51 in. (1.3 m) aggregate depth or 148 in. (3.7 m) in height.
(5) The intersection of perpendicular steel racks shall be permissible as long as no storage is placed within the void space at the junction of the racks.
(6) The top shelf shall be wire mesh.
(7) A minimum aisle width of 4 ft (1.2 m) shall be maintained between shelf units and other displays.

20.3.7 [move to 23.11.1]
A sprinkler system with K-25.2 (360) ESFR sprinklers operating at a minimum pressure of 15 psi (1 bar) shall be permitted to protect single- and double-row racks with solid displays without the use of in-rack sprinklers in retail sales floor where the following conditions are met:
(1) Storage height shall not exceed 20 ft (6.1 m).
(2) Solid veneered particleboard/plywood displays shall be permissible, provided that all flues are maintained and only one display is installed per bay.
(3) A single display shall be permitted to have one or two solid horizontal or slanted members, and a solid back.
(4) Maximum roof height shall be 30 ft (9.1 m) in the protected area.
(5) Aisle widths shall be a minimum of 6 ft (1.8 m).
(6) Minimum transverse flue spaces of 3 in. every 10 ft (75 mm every 3 m) horizontally shall be provided.
(7) Minimum longitudinal flue spaces of 6 in. (150 mm) shall be provided for double-row racks.

20.4 Protection of Baled Cotton Storage. —being deleted with an FR

20.4.1 General. —being deleted with an FR
The requirements of Chapter 12 shall apply unless modified by this chapter.

20.4.1.1 [move to 20.12.2.7]
The total water supply available shall be sufficient to provide the recommended sprinkler discharge density over the area to be protected, plus a minimum of 500 gpm (1900 L/min) for hose streams.

20.4.1.2 [move to 20.12.2.7.1]
Water supplies shall be capable of supplying the total demand for sprinklers and hose streams for not less than 2 hours.
20.4.2 Control Mode Density/Area Sprinkler Protection Criteria for Baled Cotton Storage. [move to 21.11]

20.4.2.1 [move to 21.11.1]
For tiered or rack storage up to a nominal 15 ft (4.6 m) in height, sprinkler discharge densities and areas of application shall be in accordance with Table 20.4.2.1.

Table 20.4.2.1 Baled Cotton Storage Up to and Including 15 ft (4.6 m)

<table>
<thead>
<tr>
<th>System Type</th>
<th>Discharge Density per Area [gpm/ft² over (ft²) (mm/min over m²)]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tiered Storage</td>
</tr>
<tr>
<td>Wet</td>
<td>0.25/3000 (0.95/280)</td>
</tr>
<tr>
<td>Dry</td>
<td>0.25/3900 (0.95/360)</td>
</tr>
</tbody>
</table>

20.4.2.2 [move to 21.11.2]
Where roof or ceiling heights would prohibit storage above a nominal 10 ft (3 m), the sprinkler discharge density shall be permitted to be reduced by 20 percent of that indicated in Table 20.4.2.1 but shall not be reduced to less than 0.15 gpm/ft² (6.1 mm/min).

20.5 Sprinkler Protection of Carton Records Storage with Catwalk Access. [move to 21.12]

20.5.1 [move to 21.12.1]
Carton records storage shall be permitted to be protected in accordance with the succeeding subsections of Section 20.5.

20.5.2 [move to 21.12.2]
Carton records storage shall be permitted to be supported on shelving that is a minimum of 50 percent open from approved flue space to approved flue space.

20.5.2.1 [move to 21.12.2.1]
Transverse flue spaces of a nominal 6 in. (150 mm) width shall be located at each rack upright.

20.5.2.2 [move to 21.12.2.2]
Rack uprights shall be installed on a maximum of 10 ft 6 in. (3.2 m) centers.

20.5.2.3 [move to 21.12.2.3]
Longitudinal flues shall not be required.

20.5.3 [move to 21.12.3]
The storage rack structure for carton records storage shall consist of either of the following:
(1) A single-row rack not greater than 72 in. (1.8 m) deep
(2) Double-row racks having a total depth of not greater than 102 in. (2.6 m) aisle to aisle
20.5.3.1 [move to 21.12.3.1]
Each storage rack shall be separated from other storage racks by aisles that are not less than 30 in. (750 mm) and not more than 36 in. (900 mm) in width.

20.5.3.2 [move to 21.12.3.2]
Aisles used for ingress and egress shall be permitted to be up to 44 in. (1.1 m) wide when solid decking is used.

20.5.4 [move to 21.12.4]
Catwalk aisles between racks shall be constructed of open metal grating that is at least 50 percent open.

20.5.4.1 [move to 21.12.4.1]
Catwalk aisles at the ends of racks shall be permitted to be constructed of solid materials.

20.5.5 [move to 21.12.5]
Catwalks shall be installed at a maximum of 12 ft (3.7 m) apart vertically.

20.5.6 Sprinkler Criteria. [move to 21.12.6]

20.5.6.1 [move to 21.12.6.1]
Cartoned record storage in racks with access utilizing catwalks shall be protected in accordance with this subsection.

20.5.6.2 [move to 21.12.6.2]
The design criteria for the ceiling sprinkler system shall be in accordance with Table 20.5.6.2.

Table 20.5.6.2 Ceiling Sprinkler Design Criteria for Carton Record Storage

<table>
<thead>
<tr>
<th>Density</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>gpm/ft²</td>
<td>0.33</td>
<td>0.29</td>
<td>0.3</td>
</tr>
<tr>
<td>mm/min</td>
<td>13.4</td>
<td>11.8</td>
<td>12.2</td>
</tr>
<tr>
<td>Area ft²</td>
<td>2000</td>
<td>2000</td>
<td>2000</td>
</tr>
<tr>
<td>m²</td>
<td>186</td>
<td>186</td>
<td>186</td>
</tr>
<tr>
<td>Hose Allowance (gpm)</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>L/m</td>
<td>1900</td>
<td>1900</td>
<td>1900</td>
</tr>
<tr>
<td>Duration (hours)</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

20.5.6.2.1 [move to 21.12.6.2.1]
Ceiling sprinklers spaced to cover a maximum of 100 ft² (9.3 m²) shall be standard-response spray sprinklers with K-factors per Section 12.6.

20.5.6.3 [move to 21.12.6.3]
Intermediate-level sprinklers shall be installed at each catwalk level in accordance with 20.5.6.3.1 through 20.5.6.3.4 and shall be quick-response, ordinary temperature, nominal K-5.6 (80), K-8.0 (115), or K-11.2 (160).

20.5.6.3.1 [move to 21.12.6.3.1]
Intermediate-level sprinklers shall be installed in the center ±4 in. (100 mm) of each aisle below each catwalk level.

20.5.6.3.2 [move to 21.12.6.3.2]
Intermediate-level sprinklers shall be installed a minimum 6 in. (150 mm) above the top of storage.

20.5.6.3.3 [move to 21.12.6.3.3]
Sprinklers shall be supplied from the in-rack sprinkler system.

20.5.6.3.4 [move to 21.12.6.3.4]
Spacing of sprinklers within the aisles shall be located so as to align with the transverse flues and the center of the storage unit when staggered and shall not exceed 10 ft 6 in. (3.2 m) on center.

20.5.6.3.5* [move to 21.12.6.3.5]
Sprinklers installed below each catwalk level shall be staggered vertically and horizontally. [See Figure A.20.5.6.3.5(a) and Figure A.20.5.6.3.5(b).]

20.5.6.4 [move to 21.12.6.4]
Sprinklers shall be provided in transverse flue spaces in accordance with 20.5.6.4.1 through 20.5.6.4.3.1 and Figure 20.5.6.4.

Figure 20.5.6.4 Sprinkler Location and Spacing in Transverse Flues.
20.5.6.4.1 [move to 21.12.6.4.1]
For double- and multiple-row racks, in-rack sprinklers shall be installed in the transverse flues at each catwalk level and shall be staggered vertically. For single-row racks, in-rack sprinklers shall be installed in the transverse flue at each catwalk level.

20.5.6.4.2 [move to 21.12.6.4.2]
For double- and multiple-row racks sprinklers installed in the transverse flues shall be located not less than 18 in. (450 mm) but not greater than 24 in. (600 mm) from the face of the rack on the catwalk side.

20.5.6.4.3 [move to 21.12.6.4.3]
For single-row racks, sprinklers installed in the transverse flues shall be staggered horizontally such that the sprinkler at first level is not less than 18 in. (450 mm) but not greater than 24 in. (600 mm m) from the face of the rack on the catwalk side.

20.5.6.4.3.1 [move to 21.12.6.4.3.1]
At the next level the sprinkler in the transverse flue shall be located not less than 6 in. (150 mm) but not greater than 12 in. (300 mm) from the back face of the rack. This staggering shall be repeated throughout all catwalk levels.

20.5.6.4.4 [move to 21.12.6.4.4]
In-rack sprinklers shall be installed a minimum 6 in. (150 mm) above the top of storage.

20.5.6.4.5 [move to 21.12.6.4.5]
Transverse flue sprinklers shall be quick-response, ordinary temperature, nominal K-5.6 (80), K-8.0 (115), or K-11.2 (160) and installed in accordance with Figure A.20.5.6.3.5(a) and Figure A.20.5.6.3.5(b).

20.5.6.5 [move to 21.12.6.5]
For multiple-level catwalk systems, a minimum of 10 sprinklers, five on each of the top two levels, shall be calculated with a minimum flow rate of 30 gpm (115 L/min) per sprinkler. Calculated sprinklers shall be the hydraulically most demanding on each level.

20.5.6.5.1 [move to 21.12.6.5.1]
For single-level catwalks, a minimum of six sprinklers shall be calculated with a minimum flow rate at 30 gpm (115 L/min) per sprinkler. Calculated sprinklers shall be the hydraulically most demanding.

20.5.6.5.2 [move to 21.12.6.5.2]
The in-rack sprinkler system shall be balanced in with the ceiling system.

20.6 Compact Storage of Commodities Consisting of Paper Files, Magazines, Books, and Similar Documents in Folders and Miscellaneous Supplies with No More Than 5 Percent Plastics Up to 8 ft (2.4 m) High. [move to 21.13]

20.6.1* [move to 21.13.1]
Compact storage modules up to 8 ft (2.4 m) high storing commodities consisting of paper files, magazines, books, and similar documents in folders and miscellaneous supplies with no more than 5 percent plastics shall be permitted to be classified as light hazard.

20.6.2 [move to 21.13.2]
The top of the compact storage module shall be at least 18 in. (450 mm) below the sprinkler deflector.

20.6.3 [move to 21.13.3]
Sprinklers shall be ordinary temperature, quick-response, standard spray upright or pendent.
20.6.4  [move to 21.13.4]
The compact storage module shall be provided with minimum solid steel 24 gauge (0.63 mm) metal longitudinal barriers installed every third carriage.

20.6.5*  [move to 21.13.5]
Solid 24 (0.63 mm) gauge metal transverse barriers shall be spaced not more than 4 ft (1.2 m) apart.

20.6.6  [move to 21.13.6]
Compact storage module sizes shall not exceed 250 ft² (23.2 m²).

20.6.6.1  [move to 21.13.6.1]
The size of a module shall be defined as the area of compact storage bound by the length of the carriages times the distance between longitudinal barriers or to the outward edge of a fixed storage unit in the module, including the width of the aisle in the module.

20.6.6.2  [move to 21.13.6.2]
The lengths of the carriages shall be measured to the end of the carriages enclosed by solid metal transverse panels and separated by a minimum 28 in. (700 mm) aisle to a storage unit perpendicular to the carriage.

20.7  Protection of High Bay Records Storage. [move to 23.12]

20.7.1*  Mobile High Bay Records Storage.  [move to 23.12.1]
The requirements in this section shall be permitted to apply to ceiling-only sprinkler protection of paper products, including paper files, magazines, books, and similar paper documents in corrugated containers either closed or open top, to include corrugated totes, with no more than 5 percent plastics stored in mobile shelving units greater than 12 ft (3.7 m) and up to 34 ft (10 m) high and up to 30 shelving units (storage tiers) high, when the shelving unit structure meets all of the requirements in 20.7.3.

20.7.2  Fixed High Bay Records Storage.  [move to 23.12.2]
High bay record storage shall be permitted to be fixed in place when meeting the limitations of 20.7.1 and 20.7.3.

20.7.3  [move to 23.12.3]
A wet pipe sprinkler system with nominal K-25.2 (360) ESFR sprinklers operating at a minimum of 40 psi (2.7 bar) shall be provided. The shelving units shall be subject to the following limitations:
(1) Back-to-back storage shelving units each no greater than 36 in. (900 mm) deep separated by longitudinal flue space not less than 6 in. (150 mm) wide.
(2) Solid steel shelving units not exceeding 54 in. (1.4 m) wide separated by steel barriers mechanically fastened to upright steel framing that forms a transverse flue space not less than 3 in. (75 mm) wide.
(3) Upright steel framing not completely blocking transverse flue space between adjacent shelving units.
(4) Noncombustible shelving backstops and side shelf supports, also referred to as side box guides, projecting not less than 3 in. (75 mm) above the shelves and that prevent stored commodities from encroaching into transverse and longitudinal flue spaces.
(5) Solid steel shelving not greater than 18 in. (450 mm) on centers vertically.
(6) Solid steel tops over top shelving units except at tops of transverse and longitudinal flue spaces.
(7) Open-ended, hollow tubular steel vertical (upright) shelving columns at top of shelving system.
(8) Shelving system framing and power tracks not exceeding 3 in. (75 mm) in width and not less than 1 ft (300 mm) on centers and not less than 6 in. (150 mm) below sprinkler deflectors.
(9) Minimum clearance of 36 in. (900 mm) above top solid steel cover over top storage shelf to the sprinkler deflector.
(10) Mobile shelving systems arranged to shift automatically to a uniform nominal 6 in. (150 mm) clearance clear space between mobile carriages supporting back-to-back shelving units. Systems shall be arranged to initiate the shifting 60 seconds after activation of ceiling-mounted smoke detectors or upon sprinkler flow, whichever is first. Shelving system carriage electrical motors shall be listed and integral to the mobile carriage systems for normal functions and shall not be required to have emergency power back-up.
See the attached file for the reorganization of existing Chapter 21.

Supplemental Information

<table>
<thead>
<tr>
<th>File Name</th>
<th>Description</th>
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</tbody>
</table>

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [ Not Specified ]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Fri Aug 05 17:35:32 EDT 2016

Committee Statement

Committee Statement: Chapter 21 consolidates all of the Control Mode Density Area (CMDA) sprinkler criteria into one Chapter. A benefit of this is to have all of the charts, curves and tables relative to CMDA in one spot and not intermixed with other sprinkler technologies.

Response Message:
Chapter 21  Alternative Sprinkler System Designs for Chapters 12 Through 20

21.1*  General. [move to 24.1]

21.1.1  [move to 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 12 through 20 when specifically listed for such use within the limitations described in this chapter.

21.1.2  [move to 24.1.2]
The requirements of Chapters 12 through 20 shall apply unless modified by this chapter.

21.1.2.1  [move to 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 8.4.6.2, 8.4.6.3, 8.4.6.3.1 and 12.1.1.

21.1.2.1.1  [move to 24.1.2.1.1]
Quick-response sprinklers shall also be installed in accordance with 8.4.6.4.1 and 8.4.6.4.2.

21.1.2.2  [move to 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 8.4.6.2, 8.4.6.3, 8.4.6.3.1 and 12.1.1.

21.1.2.2.1  [move to 24.1.2.2.1]
Quick-response sprinklers shall also be installed in accordance with 8.4.6.4.1 and 8.4.6.4.2.

21.1.3  [move to 24.1.3]
The in-rack protection requirements of Chapters 12 through 20 shall apply when storage racks are equipped with solid shelves and in-rack sprinklers are required per the applicable chapter.

21.1.4  [move to 24.1.4]
The requirements of the applicable chapter shall apply when ceiling-only protection options are not available per this chapter.

21.1.5  [move to 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.

21.1.6  [move to 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.

21.1.7  [move to 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

21.1.8 [move to 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.

21.1.8.1 [move to 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)

21.1.8.2 [move to 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 ft² (71 m²).

21.1.8.3 [move to 24.1.8.3]
The design area and number of sprinklers calculated on a branch line shall be in accordance with 23.4.4.2 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.

21.1.9 [move to 24.1.9]
Listed storage sprinklers that are not specifically referenced in Sections 21.2 and 21.3 but are tested in accordance with Chapter 21 with system design criteria based upon Sections 21.1, 21.4, and 21.5 shall be permitted to be used in accordance with their listing limitations, where approved.

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

21.2.1 [move to 24.2.1]
Protection of palletized and solid-piled storage of Class I through Class IV and cartoned unexpanded plastic commodities shall be permitted to be protected in accordance with Table 21.2.1.
Table 21.2.1 Extended Coverage, CMSA [K-factor 25.2 (360)] Sprinkler Design Criteria for Palletized and Solid-Piled Storage of Class I Through Class IV and Cartoned Unexpanded Plastic Commodities

<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Commodity Class</th>
<th>Maximum Storage Height</th>
<th>Maximum Ceiling/Ro of Height</th>
<th>K-Factor/Orientation</th>
<th>Type of System</th>
<th>Number of Design Sprinklers</th>
<th>Minimum Operating Pressure</th>
<th>Maximum Coverage Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palletized and solid-piled</td>
<td>Class I through Class IV, encapsulated and nonencapsulated, and cartoned nonexpanded plastics</td>
<td>20 6.1</td>
<td>30 9.1</td>
<td>25.2 (360) Upright/pendent</td>
<td>Wet</td>
<td>6</td>
<td>30 psi (2.1 bar)</td>
<td>12 ft × 12 ft (3.7 m × 3.7 m) 144 ft² (13.4 m²)</td>
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<td>20 6.1</td>
<td>30 9.1</td>
<td>25.2 (360) Upright/pendent</td>
<td>Wet</td>
<td>6</td>
<td>30 psi (2.1 bar)</td>
<td>14 ft × 14 ft (4.3 m × 4.3 m) 196 ft² (18.2 m²)</td>
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<td>25 7.6</td>
<td>30 9.1</td>
<td>25.2 (360) Upright/pendent</td>
<td>Wet</td>
<td>6</td>
<td>30 psi (2.1 bar)</td>
<td>12 ft × 12 ft (3.7 m × 3.7 m) 144 ft² (13.4 m²)</td>
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<td>25 7.6</td>
<td>30 9.1</td>
<td>25.2 (360) Upright/pendent</td>
<td>Wet</td>
<td>6</td>
<td>30 psi (2.1 bar)</td>
<td>14 ft × 14 ft (4.3 m × 4.3 m) 196 ft² (18.2 m²)</td>
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<td>25 7.6</td>
<td>35 11</td>
<td>25.2 (360) Upright/pendent</td>
<td>Wet</td>
<td>8</td>
<td>40 psi (2.7 bar)</td>
<td>12 ft × 12 ft (3.7 m × 3.7 m) 144 ft² (13.4 m²)</td>
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<td>25 7.6</td>
<td>35 11</td>
<td>25.2 (360) Upright</td>
<td>Wet</td>
<td>8</td>
<td>40 psi (2.8 bar)</td>
<td>14 ft × 14 ft (4.3 m × 4.3 m) 196 ft² (18.2 m²)</td>
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</tbody>
</table>
21.3* Sprinkler Protection Criteria for Open-Frame Rack Storage of Class I Through Class IV and Plastic Commodities. [move to 24.3]

21.3.1 [move to 24.3.1]
Protection of single-, double-, and multiple-row racks without solid shelves of Class I through Class IV and cartoned unexpanded plastic commodities shall be permitted to be protected in accordance with Table 21.3.1.

Table 21.3.1 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 Unexpanded Plastic Commodities

<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Commodity Class</th>
<th>Maximum Storage Height</th>
<th>Maximum Ceiling/© of Height</th>
<th>K-Factor/Orientation</th>
<th>Type of System</th>
<th>Number of Design Sprinklers</th>
<th>Minimum Operating Pressure</th>
<th>Maximum Coverage Area</th>
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</thead>
<tbody>
<tr>
<td>Single-, double-, and multiple-row racks without solid shelves (no open-top containers)</td>
<td>Class I through Class IV, encapsulated and nonencapsulated, and cartoned nonexpanded plastics</td>
<td>20 6.1</td>
<td>30 9.1</td>
<td>25.2 (360) Upright/pendent</td>
<td>Wet</td>
<td>6</td>
<td>30 psi (2.1 bar)</td>
<td>12 ft × 12 ft (3.7 m × 3.7 m) 144 ft² (13.4 m²)</td>
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<tr>
<td>Storage Arrangement</td>
<td>Commodity Class</td>
<td>Maximum Storage Height ft</td>
<td>Maximum Ceiling/Root of Height ft</td>
<td>K-Factor/Orientation</td>
<td>Type of System</td>
<td>Number of Design Sprinklers</td>
<td>Minimum Operating Pressure psi</td>
<td>Maximum Coverage Area ft² (m²)</td>
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<td>25.2 (360) Upright/Pendent</td>
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<td>25.2 (360) Upright/Pendent</td>
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</table>
21.3.2 [move to 24.3.2]
Protection of Class I through Class IV and cartoned unexpanded plastic commodities stored on single-, double-, or multiple-row racks without solid shelves or solid-piled, palletized, shelf, or bin-box storage arrangements shall be permitted to be protected in accordance with Table 21.3.2.

Table 21.3.2 CMSA K-25.2 Upright Standard Coverage Sprinkler Design Criteria for Single-, Double-, and Multiple-Row Racks Without Solid Shelves and Solid-Piled, Palletized Storage Arrangement of Class I Through IV and Cartoned Unexpanded Plastic Commodities

<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Commodity Class</th>
<th>Maximum Storage Height/Room Height ft/m</th>
<th>K-Factor Orientation</th>
<th>System Type</th>
<th>Number of Design Sprinklers</th>
<th>Minimum Operating Pressure psi/bar</th>
<th>Sprinkler Linear Spacing ft/m</th>
<th>Sprinkler Area Spacing ft²/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid-piled, palletized, and single-, double- and multiple-row racks without solid shelves (no open top containers)</td>
<td>Class I–IV encapsulated and nonencapsulated, and cartoned nonexpanded plastics</td>
<td>25/7.6</td>
<td>30/9.1</td>
<td>25.2 (360) Upright</td>
<td>Wet</td>
<td>12</td>
<td>20 psi (1.4 bar)</td>
<td>8 ft (2.4 m)</td>
</tr>
</tbody>
</table>

21.3.3 [move to 24.3.3]
Protection of Class I through Class IV and cartoned unexpanded plastic commodities stored on single-, double-, or multiple-row racks without solid shelves or solid-piled, palletized, shelf, or bin-box storage arrangements shall be permitted to be protected in accordance with Table 21.3.3.

Table 21.3.3 CMSA K-25.2 Upright Standard Coverage Sprinkler Design Criteria for Single-, Double-, and Multiple-Row Racks Without Solid Shelves and Solid-Piled, Palletized Storage Arrangement of Class I Through IV and Cartoned Unexpanded Plastic Commodities
### Storage Arrangement

<table>
<thead>
<tr>
<th>Commodity Class</th>
<th>Maximum Storage Height</th>
<th>K-Factor Orientation</th>
<th>System Type</th>
<th>Number of Design Sprinklers</th>
<th>Minimum Operating Pressure</th>
<th>Sprinkler Linear Spacing</th>
<th>Sprinkler Area Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid-piled, palletized, and single-, double-, and multiple-row racks without solid shelves (no open top containers)</td>
<td>Class I–IV encapsulated and nonencapsulated, and cartoned nonexpanded plastics</td>
<td>25.2 (360) Upright</td>
<td>Wet</td>
<td>12</td>
<td>15 psi (1.0 bar)</td>
<td>8 ft (2.4 m)</td>
<td>8 ft (2.4 m)</td>
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</table>

**21.4 Hose Stream Allowance and Water Supply Duration.** [move to 24.4]

**21.4.1** [move to 24.4.1]

The minimum water supply requirements for a hydraulically designed occupancy hazard fire control sprinkler system shall be determined by adding the hose stream allowance from Table 21.4.1 to the water supply for sprinklers obtained from this chapter.

### Table 21.4.1 Hose Stream Allowance and Water Supply Duration

<table>
<thead>
<tr>
<th>Sprinkler Type</th>
<th>Sprinkler Spacing Type</th>
<th>Number of Sprinklers in Design Area</th>
<th>Hose Stream Allowance</th>
<th>Water Supply Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control mode density/area and CMSA</td>
<td>Standard</td>
<td>Up to 12</td>
<td>250 gpm 950 L/min</td>
<td>60 minutes</td>
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<td></td>
<td></td>
<td>Over 12 to 15</td>
<td>500 gpm 1900 L/min</td>
<td>90 minutes</td>
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<td>Over 15 to 25</td>
<td>500 gpm 1900 L/min</td>
<td>120 minutes</td>
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<td>Over 25</td>
<td>500 gpm 1900 L/min</td>
<td>150 minutes</td>
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<td></td>
<td>Extended coverage</td>
<td>Up to 6</td>
<td>250 gpm 950 L/min</td>
<td>60 minutes</td>
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<td>Up to 8 (144 ft²)</td>
<td>250 gpm 950 L/min</td>
<td>60 minutes</td>
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<td></td>
<td>Over 6 to 8</td>
<td>500 gpm 1900 L/min</td>
<td>90 minutes</td>
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<td></td>
<td>Over 8 to 12</td>
<td>500 gpm 1900 L/min</td>
<td>120 minutes</td>
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<tr>
<td>Sprinkler Type</td>
<td>Sprinkler Spacing Type</td>
<td>Number of Sprinklers in Design Area</td>
<td>Hose Stream Allowance (gpm)</td>
<td>Water Supply Duration (minutes)</td>
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<tr>
<td>ESFR</td>
<td>Standard</td>
<td>Over 12</td>
<td>500</td>
<td>1900</td>
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<td>Up to 12</td>
<td>250</td>
<td>950</td>
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<td>Over 12 to 15</td>
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<td>1900</td>
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<td></td>
<td>Over 25</td>
<td>500</td>
<td>1900</td>
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</table>

21.4.1.1 [move to 24.4.1.1]

The water supply requirements for a hydraulically designed occupancy hazard fire control sprinkler system shall be available for the minimum duration specified in Table 21.4.1.

21.5 Minimum Obstruction Criteria. [move to 24.5]

21.5.1 General. [move to 24.5.1]

The installation guidelines for obstructions to ceiling-level sprinklers shall be in accordance with the requirements of Section 21.5 for sprinkler system designs obtained from this chapter.

21.5.2 Standard Coverage Spacing Sprinklers. [move to 24.5.2]

21.5.2.1 [move to 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 8.12.5, unless large-scale fire testing is conducted with a representative obstruction below the sprinkler that demonstrates equivalent performance.

21.5.2.2 [move to 24.5.2.2]

Control mode density/area (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 8.11.5.

21.5.2.2.1 [move to 24.5.2.2.1]

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 8.12.5.

21.5.2.2.2 [move to 24.5.2.2.2]

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

21.5.3 Extended Coverage Spacing Sprinklers. [move to 24.5.3]

21.5.3.1 [move to 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 8.8.5.1, 8.12.5.2, and 8.12.5.3, unless large-scale fire testing is conducted with a representative obstruction below the sprinkler that demonstrates equivalent performance.

**21.5.3.2 [move to 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 8.11.5 and 8.8.5.1.

**21.5.3.2.1 [move to 24.5.3.2.1]**
ESFR 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 8.12.5.2 and 8.12.5.3.

**21.5.3.2.2 [move to 24.5.3.2.2]**
Other obstruction criteria shall be acceptable if large-scale fire testing is conducted with a representative obstruction below the sprinkler that demonstrates equivalent performance.

**21.5.3.2.3 [move to 24.5.3.2.3]**
When utilizing upright CMSA, CMDA, or ESFR sprinklers, any continuous obstruction 4 in. (100 mm) or less shall be permitted to be ignored.
See attached file for the reorganization of existing Chapter 22.

## Supplemental Information

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## Submitter Information Verification

- **Submitter Full Name:** AUT-SSD
- **Organization:** [ Not Specified ]
- **Street Address:**
- **City:**
- **State:**
- **Zip:**
- **Submittal Date:** Fri Aug 05 17:36:27 EDT 2016

## Committee Statement

- **Committee Statement:** Chapter 22 consolidates all of the Control Mode Specific Application (CMSA) sprinkler criteria into one Chapter. A benefit of this is to have all of the charts, curves and tables relative to CMSA in one spot and not intermixed with other sprinkler technologies.

- **Response Message:**

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National Fire Protection Association Report

http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...
Chapter 22 Special Occupancy Requirements

22.1 General. [move to 26.26.1]

22.1.1 Application. [move to 26.26.1.1]

22.1.1.1 [move to 26.26.1.1.1]
In addition to the requirements of Chapter 8, Chapters 11 through 22, and Chapter 23, the following special occupancy requirements shall apply.

22.1.1.1.1 [move to 26.26.1.1.1.1]
All provisions of design criteria in this standard, including design area increases and reductions, shall also apply to these special occupancy requirements.

22.1.1.2 [move to 26.26.1.1.2]
Where the requirements of the reference standard differ from the requirements of this standard, the reference standard shall take precedence.

22.1.2 Definitions. [move to 26.26.1.2]
For terms not defined in Chapter 3, the definitions of the reference standard shall apply.

22.2 Flammable and Combustible Liquids. [move to 26.26.2]

22.2.1 Design Requirements. [move to 26.26.2.1]
Sprinkler system discharge criteria for the protection of flammable and combustible liquids shall comply with NFPA 30.

22.2.2 Installation Requirements. (Reserved) [move to 26.26.2.2]

22.3 Aerosol Products. [move to 26.26.3]

22.3.1 Design Requirements. [move to 26.26.3.1]
Sprinkler system discharge criteria for the protection of aerosol products shall comply with NFPA 30B.

22.3.2 Installation Requirements. [move to 26.26.3.2]
(Reserved)

22.4 Spray Application Using Flammable or Combustible Materials. [move to 26.26.4]

22.4.1 Design Requirements. [move to 26.26.4.1]

22.4.1.1* [move to 26.26.4.1.1]
The automatic sprinkler system shall be a wet pipe system, a dry pipe system, a preaction system, or an open-head deluge system, whichever is most appropriate for the portion of the spray operation being protected. [33:9.4.1]
22.4.1.2 [move to 26.26.4.1.2]  
The automatic sprinkler system shall be designed for Extra Hazard (Group 2) occupancies as defined in NFPA 13.  
Exception No. 1: For spray application of styrene cross-link thermoset resins, Section 17.3 of NFPA 33 shall apply.  
Exception No. 2: Automatic sprinkler systems for powder coating operations shall be designed for Ordinary Hazard (Group 2), as defined in NFPA 13. [33:9.4.2]

22.4.1.3 [move to 26.26.4.1.3]  
The water supply shall be sufficient to supply all sprinklers likely to open in any one fire incident without depleting the available water for use in hose streams. [33:9.4.3]

22.4.1.4 [move to 26.26.4.1.4]  
Where sprinklers are installed to protect spray areas and mixing rooms only, water shall be permitted to be supplied from domestic water systems, provided the domestic supply can meet the design criteria of 22.4.1.2. [33:9.4.4]

22.4.1.5 [move to 26.26.4.1.5]  
The sprinkler system shall be controlled by a separate, listed indicating valve(s), operable from floor level. [33:9.4.5]

22.4.1.6 [move to 26.26.4.1.6]  
Automated liquid electrostatic spray application equipment that is unlisted shall be protected further by the following:  
(1) In addition to meeting the requirements in 9.8.1 of NFPA 33, the optical flame detection system shall also activate one of the following over each zone in which fire has been detected:  
   (a) An open head deluge system designed to discharge a minimum density of 24.4 mm/min (0.6 gpm/ft²)  
   (b) A carbon dioxide extinguishing system  
   (c) A dry chemical extinguishing system  
   (d) A gaseous agent extinguishing system [33:9.8.2(1)]  
(2) A wet pipe sprinkler system shall also be provided throughout the spray booth. This system shall meet all the applicable requirements of this standard for Extra Hazard (Group 2) occupancies. [33:9.8.2(3)]

22.4.2 Installation Requirements. [move to 26.26.4.2]

22.4.2.1* [move to 26.26.4.2.1]  
Sprinkler systems protecting stacks or ducts shall meet all of the following requirements:  
(1) Sprinklers shall be spaced no more than 3.7 m (12 ft) apart.  
(2) If exhaust ducts are manifolded, a sprinkler shall be located in the manifold at the junction of each exhaust duct with the manifold.
(3) Sprinklers shall provide a minimum flow of 114 L/min (30 gpm) per head at a minimum of 1 bar (15 psi) pressure.
(4) Sprinklers shall be ordinary temperature rated, unless required to be higher due to operating temperatures measured in the ducts, in which case the operating temperature shall be at least 28°C (50°F) above the inside temperature of the duct. [33:9.4.6]

22.4.2.1.1 [move to 26.26.4.2.1.1] Stacks and exhaust ducts shall be provided with access openings for inspection and cleaning of sprinklers. [33:9.4.6.1]

22.4.2.1.2 [move to 26.26.4.2.1.2] Sprinkler systems protecting stacks and ducts that are subject to freezing shall be of a nonfreezing type or be a manually controlled open-head system. [33:9.4.6.2]

22.4.2.2 [move to 26.26.4.2.2] Sprinklers shall be protected against overspray residue, either by location or covering, so that they will operate quickly in event of fire. [33:9.4.7]

22.4.2.2.1 [move to 26.26.4.2.2.1] Sprinklers shall be permitted to be covered only by cellophane bags having a thickness of 0.08 mm (0.003 in.) or less or by thin paper bags. These coverings shall be replaced frequently so that heavy deposits of residue do not accumulate. [33:9.4.7.1]

22.4.2.2.2 [move to 26.26.4.2.2.2] Sprinklers that have been painted or coated by overspray or residues shall be replaced with new sprinklers. [33:9.4.7.2]

22.5 Solvent Extraction Plants. [NFPA 36] [move to 26.5]

22.5.1* Design Requirements. [move to 26.5.1]

22.5.2 Installation Requirements. (Reserved) [move to 26.5.2]

22.6 Installation and Use of Stationary Combustion Engines and Gas Turbines. [move to 26.6]

22.6.1* Design Requirements. [move to 26.6.1] Automatic sprinkler systems shall be designed to provide for a density of 0.3 gpm/ft² (12.2 mm/min) over the most remote 2500 ft² (230 m²). [37:11.4.5.1]

22.6.2 Installation Requirements. [move to 26.6.2]

22.6.2.1 [move to 26.6.2.1] Sprinklers and spray nozzles shall be spaced at a 100 ft² (9 m²) maximum area of coverage per sprinkler or spray nozzle. [37:11.4.5.1.1]
22.6.2.2 [move to 26.6.2.2]
Sprinkler and water spray system coverage shall be provided to all areas within the enclosure located within 20 ft (6 m) of the following:
(1) The engine
(2) The lubricating oil system
(3) The fuel system
[37:11.4.5.1.2]

22.6.2.3 [move to 26.6.2.3]
Sprinklers and water spray nozzles shall not be directed at engine components that are susceptible to thermal shock or deformation. [37:11.4.5.2]

22.7 Nitrate Film. [move to 26.7]

22.7.1 Design Requirements. [move to 26.7.1]

22.7.1.1 [move to 26.7.1.1]
Every room, except projection booths and rewinding rooms, where nitrate film is stored or handled in quantities greater than 51 lb (23 kg), or 10 standard rolls, shall be protected by an automatic sprinkler system that is installed in accordance with the requirements for Group II extra hazard occupancies. [40:5.1.2]

22.7.1.2 [move to 26.7.1.2]
Water supplies for automatic sprinklers shall be based on 20 gpm (1.26 L/sec) per sprinkler for 20 minutes for the total number of sprinklers in one vault plus 25 percent of the sprinklers in the communicating fire area. [40:5.2.2]

22.7.1.3* Vaults Other Than Extended Term Storage Vaults. [move to 26.7.1.3]
[40:6.3] (See Figure A.22.7.1.3.) Fire protection in vaults shall be provided by a deluge system with directional nozzles meeting the criteria in 22.7.1.4. [40:6.3.7]

22.7.1.4 [move to 26.7.1.4]
For extended term storage vaults in accordance with Section 6.5.5 of NFPA 40, fire protection shall be provided by a deluge system with directional nozzles installed in accordance with NFPA 15 and meeting the criteria in 22.7.1.4.1 through 22.7.1.4.9. [40:6.5.6]

22.7.1.4.1 [move to 26.7.1.4.1]
Sprinkler systems in existing extended term storage vaults that were in compliance with the provisions of this standard at the time of installation shall be permitted to be continued in use. [40:6.5.6.1]

22.7.1.4.2 [move to 26.7.1.4.2]
High-velocity open head nozzles each capable of providing a discharge rate of 1.26 L/sec (20 gpm) at a gauge pressure of 345 kPa (50 psi) shall be installed. [40:6.5.6.2]
22.7.1.4.3  [move to 26.7.1.4.3]
The design shall be based on a discharge density of 28 mm/min (0.68 gpm/ft²) over each face of storage racks. [40:6.5.6.3]

22.7.1.4.4*  [move to 26.7.1.4.4]
The nozzles shall have a combined spray pattern capable of covering the face of the film storage racks. [40:6.5.6.4]

22.7.1.4.5  [move to 26.7.1.4.5]
The nozzles shall be installed at the top of the storage shelf array, aimed at the opposite shelf array. [40:6.5.6.5]

22.7.1.4.6*  [move to 26.7.1.4.6]
Nozzles shall be installed on opposite faces of the storage shelf array in a staggered pattern such that no nozzles are directly opposite one another. [40:6.5.6.6]

22.7.1.4.7  [move to 26.7.1.4.7]
The water supply duration shall be a minimum of 20 minutes. [40:6.5.6.7]

22.7.1.4.8  [move to 26.7.1.4.8]
The deluge system shall be activated by a signal from one of the following: [40:6.5.6.8]
(1) An air sampling–type smoke detection system
(2) A fixed temperature heat sensitive cable

22.7.1.4.9  [move to 26.7.1.4.9]
Full water flow shall be discharged from the water spray nozzles within 10 seconds of reaching the set point actuation of the detection system [40:6.5.6.9.6]

22.7.2  Installation Requirements. [move to 26.7.2]

22.7.2.1  [move to 26.7.2.1]
In areas or rooms where nitrate film is handled, the area that is protected per sprinkler head shall not exceed 64 ft² (6 m²) with sprinklers not being more than 8 ft (2.4 m) apart. [40:5.1.4]

22.7.2.2  Cabinet Protection. [move to 26.7.2.2]
[40:6.2.5.2]

22.7.2.2.1  [move to 26.7.2.2.1]
Cabinets having a capacity of more than 34 kg (75 lb), or 15 standard rolls, of film shall be provided with at least one automatic sprinkler head. [40:6.2.5.1]

22.7.2.2.2  [move to 26.7.2.2.2]
Where cans are stored on more than one shelf, as shown in Figure 22.7.2.2.2 and as described in 6.2.6.2 or 6.2.6.3 of NFPA 40, one sprinkler shall be provided for each shelf. [40:6.2.5.2]
Figure 22.7.2.2 Standard Film Cabinet for Other Than Extended Term Storage Film.

[40:Figure 6.2.1]

22.7.2.3 Motion Picture Film Laboratories. [move to 26.7.2.3]
In all cases, sprinklers shall be arranged so that not more than two machines are protected by any one sprinkler head. [40:9.2.5.2]

22.8 Laboratories Using Chemicals. [move to 26.8]

22.8.1 Design Requirements. [move to 26.8.1]
Automatic sprinkler system protection shall be required for all new laboratories in accordance with the following:
(1) Automatic sprinkler system protection for Class A and Class B laboratories shall be in accordance with NFPA 13 for ordinary hazard (Group 2) occupancies.
(2) Automatic sprinkler system protection for Class C and Class D laboratories shall be in accordance with NFPA 13 for ordinary hazard (Group 1) occupancies. [45:6.1.1.1]

22.8.2 Installation Requirements. [move to 26.8.2]
Fire sprinklers in laboratory units shall be the quick response (QR) sprinkler type installed in accordance with NFPA 13. [45:6.1.1.2]

22.9 Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes. [move to 26.9]

22.9.1 Design Requirements. [move to 26.9.1]

22.9.1.1 [move to 26.9.1.1]
Oxygen cylinders connected to one manifold shall be limited to a total gas capacity of 6500 ft³ (184 m³). [51:5.2.5]

22.9.1.1.1 [move to 26.9.1.1.1]
Two such manifolds with connected cylinders shall be permitted to be located in the same room, provided the building is protected throughout with an approved automatic sprinkler system designed in accordance with this standard, furnishing a sprinkler discharge density of at least 0.25 gpm/ft² (10.2 mm/min) over a minimum operating area of at least 3000 ft² (279 m²) with sprinklers located not more than 20 ft (6.1 m) above the floor where the manifolds are located. [51:5.2.5.1]

22.9.1.2 [move to 26.9.1.2]
For mobile acetylene trailer systems, a deluge sprinkler system shall be provided for MATS fire areas used as indoor and outdoor discharging stations. [51:10.5.8.1.1]

22.9.1.3 [move to 26.9.1.3]
Deluge sprinkler systems shall provide a minimum density of 0.3 gpm/ft² (12.2 mm/min) over the MATS fire area being protected. [51:10.5.8.1.2]

22.9.1.4 [move to 26.9.1.4]
The deluge system shall be identified and marked with a sign and shall be activated automatically by a fast-acting fire detection system and also by a manual actuator. [51:10.5.8.1.3]

22.9.1.5 [move to 26.9.1.5]
The requirements of 22.9.1.2 shall not apply to existing indoor or outdoor facilities, equipment, structures, or installations where MATS are discharged that existed or were approved for construction or installation prior to the effective date of this standard, provided the MATS are protected with an automatic sprinkler system with a minimum design density of not less than 0.25 gm/ft² (10.2 mm/min). [51:10.5.8.1.4.1]

22.9.2 Installation Requirements. [move to 26.9.2]

22.9.2.1 [move to 26.9.2.1]
In buildings protected by an automatic sprinkler system and water supply designed in accordance with this standard for an Ordinary Hazard Group 2 or more hazardous occupancy, where the occupancy other than the cylinder storage is not more hazardous than ordinary hazard as defined
in this standard, the distance between designated storage areas shall be permitted to be reduced to 15.2 m (50 ft) (15.2 m). [51:4.3.4.1].

22.10  Acetylene Cylinder Charging Plants. [move to 26.10]

22.10.1  Design Requirements. [move to 26.10.1]

22.10.1.1  [move to 26.10.1.1]
When sprinkler protection is provided, the area in which flammable compressed gases are stored or used shall be protected with a sprinkler system designed to be not less than that required by NFPA 13 for Extra Hazard Group 1 with a minimum design area of 2500 ft² (232.26 m²). [51A:11.2.1.2]

22.10.1.2  [move to 26.10.1.2]
At mobile acetylene trailer systems (MATS) at mobile acetylene charging plants, a fire sprinkler system in accordance with this standard, Extra Hazard Group I shall be installed in the areas occupied by trailers in charging or discharging stations. [51A:11.2.1.3]

22.10.2  Installation Requirements. (Reserved) [move to 26.10.2]

22.11  Compressed Gases and Cryogenic Fluids Code. [move to 26.11]

22.11.1  Design Criteria. [move to 26.11.1]

22.11.1.1  [move to 26.11.1.1]
When sprinkler protection is required, the area in which compressed gases or cryogenic fluids are stored or used shall be protected with a sprinkler system designed to be not less than that required by NFPA 13 for Ordinary Hazard Group 2. [55:6.10.2.1]

22.11.1.2  [move to 26.11.1.2]
When sprinkler protection is required, the area in which the flammable or pyrophoric compressed gases or cryogenic fluids are stored or used shall be protected with a sprinkler system designed to be not less than that required by NFPA 13 for Extra Hazard Group 1. [55:6.10.2.2]

22.11.2  Installation Requirements. (Reserved) [move to 26.11.2]

22.12  Utility LP-Gas Plants. [move to 26.12]

22.12.1  Design Requirements. [move to 26.12.1]

22.12.1.1  [move to 26.12.1.1]
The design of fire water supply and distribution systems, where used, shall provide for the simultaneous supply of those fixed fire protection systems involved in the maximum single incident expected in the plant, including monitor nozzles, at their design flow and pressure. [59:13.4.2]

22.12.1.2 [move to 26.12.1.2]
An additional supply of 1000 gal/min (63 L/sec) shall be available for hand hose streams for a period of not less than 2 hours. [59:13.4.2.1]

22.12.1.3 [move to 26.12.1.3]
Manually actuated monitors shall be permitted to be used to augment hand hose streams. [59:13.4.2.2]

22.12.2 Installation Requirements. (Reserved) [move to 26.12.2]

22.13 Production, Storage, and Handling of Liquefied Natural Gas (LNG). [move to 26.13]

22.13.1 Design Requirements. [move to 26.13.1]
The fire water supply and distribution systems, if provided, shall simultaneously supply water to fixed fire protection systems, including monitor nozzles, at their design flow and pressure, involved in the maximum single incident expected in the plant plus an allowance of 1000 gpm (63 L/sec) for hand hose streams for not less than 2 hours. [59A:12.5.2]

22.13.2 Installation Requirements. (Reserved) [move to 26.13.2]

22.14 Protection of Information Technology Equipment. [move to 26.14]

22.14.1 Design Requirements. (Reserved) [move to 26.14.1]

22.14.2 Installation Requirements. [move to 26.14.2]

22.14.2.1* [move to 26.14.2.1]
Information technology equipment rooms and information technology equipment areas located in a sprinklered building shall be provided with an automatic sprinkler system. [75:9.1.1]

22.14.2.2 [move to 26.14.2.2]
Sprinkler systems protecting information technology equipment areas shall be valved separately from other sprinkler systems. [75:9.1.3]

22.14.2.3* [move to 26.14.2.3]
An automatic sprinkler system or a gaseous fire extinguishing system shall be provided for the protection of the area below a raised floor in an information technology equipment room or information technology equipment area when one or more of the following exist:
(1) There is a critical need to protect data in the process, reduce equipment damage, and facilitate return to service.
(2) The area below the raised floor contains combustible material.
22.15 Standard on Incinerators, and Waste and Linen Handling Systems and Equipment. [move to 26.15]

22.15.1 Design Requirements. (Reserved) [move to 26.15.1]

22.15.2 Installation Requirements. [move to 26.15.2]

22.15.2.1 Automatic sprinklers shall be provided in incinerator rooms in accordance with this standard. [82:5.2.7.3]

22.15.2.2 Waste and Linen Chutes and Transport Systems. [move to 26.15.2.2]

22.15.2.2.1 Lined metal chutes shall be protected internally by automatic sprinklers unless they are lined in accordance with 6.2.2.6.1 in NFPA 82. [82:6.2.2.6.2]

22.15.2.2.1.1 This protection requires that a sprinkler be installed at or above the top service opening of the chute. [82:6.2.6.1.2]

22.15.2.2.1.2 Chute Sprinkler Protection. [move to 26.15.2.2.1.3]

22.15.2.2.1.3 Automatic sprinklers installed in gravity chute service openings shall be recessed out of the chute area through which the material travels. [82:6.2.6.1.3]

22.15.2.2.1.4 In addition, a sprinkler shall be installed within the chute at alternate floor levels in buildings over two stories in height, with a mandatory sprinkler located at the lowest service level. [82:6.2.6.1.4]

22.15.2.2.1.5 Gravity chutes shall be protected internally by automatic sprinklers unless they are lined in accordance with 6.2.2.6.1 in NFPA 82. [82:6.2.6.1.1]

22.15.2.2.1.6 Chute Room Automatic Sprinklers. [move to 26.15.2.2.1.6]

22.15.2.2 Full Pneumatic Waste and Linen Conveying Systems. [move to 26.15.2.2.2] [82:6.3]
22.15.2.2.2.1  [move to 26.15.2.2.2.1]
Full pneumatic-type risers shall be protected internally by automatic sprinklers. [82:6.3.4.1]

22.15.2.2.2  [move to 26.15.2.2.2.2]
A sprinkler shall be required at or above the top loading station and at alternate floor levels in buildings over two stories in height, with a mandatory sprinkler located at the lowest loading station. [82:6.3.4.2]

22.15.2.2.2.3  [move to 26.15.2.2.2.3]
Sprinklers shall be recessed out of the station area through which the material travels. [82:6.3.4.3]

22.15.2.2.3  Gravity Pneumatic Trash or Linen Conveying Systems. [move to 26.15.2.2.3] [82:6.4]

22.15.2.2.3.1  Chute Automatic Sprinklers. [move to 26.15.2.2.3.1]
Where material is to be stored at the bottom of the chute and above the riser discharge damper (above the transport tee), automatic sprinklers shall be installed below the last service door on the chute. [82:6.4.2.3]

22.15.2.2.3.2  [move to 26.15.2.2.3.2]
Automatic sprinklers shall be installed in chute discharge rooms. [82:6.4.2.4.3]

22.15.2.3  Other Waste Handling Systems. [82:7.4] [move to 26.15.2.3]

22.15.2.3.1  [move to 26.15.2.3.1]
Automatic sprinklers shall be installed in rooms where waste handling systems and equipment are used to transport waste from interim storage areas to waste processing equipment, such as incinerators. [82:7.4.1]

22.15.2.3.2  [move to 26.15.2.3.2]
In locations or rooms where waste handling systems and equipment are used for interim storage of waste only, the rooms shall be sprinklered in accordance with requirements specified in 22.15.2.4. [82:7.4.2]

22.15.2.4  Waste Compactors. [82:8] [move to 26.15.2.4]

22.15.2.4.1  [move to 26.15.2.4.1]
All chute-fed compactors shall have an automatic sprinkler with a minimum 13 mm (1/2 in.) orifice installed in the hopper of the compactor. [82:8.2.1]

22.15.2.4.2  [move to 26.15.2.4.2]
Sprinklers shall be ordinary temperature-rated sprinklers. [82:8.2.1.1]

22.15.2.4.3  [move to 26.15.2.4.3]
Sprinklers shall be supplied by a minimum of 1 in. (25.4 mm) ferrous piping or 3/4 in. (19 mm) copper tubing line from the domestic cold water supply or by the building fire sprinkler system. [82:8.2.1.2]

**22.15.2.4.4 [move to 26.15.2.4.4]**
Sprinkler water pipe shall be protected from freezing in outdoor installations. [82:8.2.1.3]

**22.15.2.4.5 [move to 26.15.2.4.5]**
Hand-fed compactors located within a building and not operated in conjunction with a chute shall not require installation of an automatic sprinkler in the hopper. [82:8.2.2]

**22.15.2.5 [move to 26.15.2.5]**
Waste and recyclables storage rooms shall be provided with automatic sprinklers in accordance with this standard. [82:9.3]

**22.15.2.6 [move to 26.15.2.6]**
Rooms in which waste processing equipment is located shall be installed with automatic sprinklers. [82:10.4.1]

22.16 Standard for Ovens and Furnaces. [move to 26.16]

**22.16.1 Design Requirements. (Reserved) [move to 26.16.1]**

**22.16.2 Installation Requirements. [move to 26.16.2]**

**22.16.2.1* [move to 26.16.2.1]**
Where automatic sprinklers are provided, they shall be installed in accordance with NFPA 13, unless otherwise permitted by 22.16.2.2. [86:9.2.1]

**22.16.2.2 [move to 26.16.2.2]**
Where sprinklers that protect only ovens are installed and connection to a reliable fire protection water supply is not feasible, a domestic water supply connection shall be permitted to supply these sprinklers subject to the approval of the authority having jurisdiction. [86:9.2.2]

**22.16.2.3 [move to 26.16.2.3]**
Where sprinklers are selected for the protection of ovens, furnaces, or related equipment, the use of closed-head sprinkler systems shall be prohibited and only deluge sprinkler systems shall be used where the following conditions exist:
(1) In equipment where temperatures can exceed 625°F (329°C)
(2) Where flash fire conditions can occur
[86:9.3.3]

**22.16.2.4 [move to 26.16.2.4]**
Furnaces shall be located so as to minimize exposure to power equipment, process equipment, and sprinkler risers. [86:5.1.3.1]
22.16.2.5  [move to 26.16.2.5]
Where water from a fixed protection system could come in contact with molten materials, such as molten salt or molten metal, shielding shall be provided to prevent water from contacting the molten material. [86:9.3.1]

22.16.2.6*  [move to 26.16.2.6]
Galvanized pipe shall not be used in sprinkler or water spray systems in ovens, furnaces, or related equipment. [86:9.3.2]

22.17  Health Care Facilities Code, Class A Hyperbaric Chambers. [move to 26.17]

22.17.1  Design Requirements. [move to 26.17.1]

22.17.1.1  [move to 26.17.1.1]
A fixed water deluge extinguishing system shall be installed in all chamber compartments that are designed for manned operations. [99:14.2.5.2]

22.17.1.2  [move to 26.17.1.2]
In chambers that consist of more than one chamber compartment (lock), the design of the deluge system shall meet the requirements of 22.17.1.1 when the chamber compartments are at different depths (pressures). [99:14.2.5.2.1]

22.17.1.3  [move to 26.17.1.3]
The deluge system in different compartments (locks) shall operate independently or simultaneously. [99:14.2.5.2.2]

22.17.1.4  [move to 26.17.1.4]
Fixed deluge systems shall not be required in chamber compartments that are used strictly as personnel transfer compartments (locks) and for no other purposes. [99:14.2.5.2.3]

22.17.1.5*  [move to 26.17.1.5]
Manual activation and deactivation deluge controls shall be located at the operator's console and in each chamber compartment (lock) containing a deluge system. [99:14.2.5.2.4]

22.17.1.6  [move to 26.17.1.6]
Controls shall be designed to prevent unintended activation. [99:14.2.5.2.4.1]

22.17.1.7  [move to 26.17.1.7]
Water shall be delivered from the fixed discharge nozzles as specified in 22.17.1.9 within 3 seconds of activation of any affiliated deluge control. [99:14.2.5.2.5]

22.17.1.8*  [move to 26.17.1.8]
Average spray density at floor level shall be not less than 2 gpm/ft² (81.5 L/min/m²), with no floor area larger than 10.76 ft² (1 m²) receiving less than 1 gpm/ft² (40.75 L/min/m²). [99:14.2.5.2.6]
22.17.1.9 [move to 26.17.1.9]
Water shall be available in the deluge system to maintain the flow specified in 22.17.1.8 simultaneously in each chamber compartment (lock) containing the deluge system for 1 minute. [99:14.2.5.2.7]

22.17.1.10 [move to 26.17.1.10]
The limit on maximum extinguishment duration shall be governed by the chamber capacity (bilge capacity also, if so equipped) or its drainage system, or both. [99:14.2.5.2.7.1]

22.17.1.11 [move to 26.17.1.11]
The deluge system shall have stored pressure to operate for at least 15 seconds without electrical branch power. [99:14.2.5.2.8]

22.17.2 Installation Requirements. (Reserved) [move to 26.17.2]

22.18 Fixed Guideway Transit and Passenger Rail Systems. [move to 26.18]

22.18.1 Design Requirements. [move to 26.18.1]

22.18.1.1 [move to 26.18.1.1]
Other fire suppression systems, if approved, shall be permitted to be substituted for automatic sprinkler systems in the areas listed in 22.18.2.1. [130:5.7.3.4]

22.18.2 Installation Requirements. [move to 26.18.2]

22.18.2.1 [move to 26.18.2.1]
An automatic sprinkler protection system shall be provided in areas of stations used for concessions, in storage areas, in trash rooms, and in the steel truss area of all escalators and other similar areas with combustible loadings, except trainways. [130:5.7.3.1]

22.18.2.2 [move to 26.18.2.2]
Sprinkler protection shall be permitted to be omitted in areas of open stations remotely located from public spaces. [130:5.7.3.1.1]

22.18.2.3 [move to 26.18.2.3]
Installation of sprinkler systems shall comply with NFPA 13 or applicable local codes as required. [130:5.7.3.2]

22.18.2.4 [move to 26.18.2.4]
A sprinkler system waterflow alarm and supervisory signal service shall be installed. [130:5.7.3.3]

22.19 Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations. [move to 26.19]

22.19.1 Design Requirements. (Reserved) [move to 26.19.1]
22.19.2 Installation Requirements. [move to 26.19.2]

22.19.2.1 [move to 26.19.2.1]
The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if approved mitigation is employed. [140:4.11.1.3.1]

22.19.2.2 [move to 26.19.2.2]
The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if the building sprinkler system meets the design criteria for Extra Hazard, Group 2. [140:4.11.1.3.2]

22.19.2.3 [move to 26.19.2.3]
In any production location building protected by an existing automatic sprinkler system, where solid- or hard-ceiling sets or platforms are introduced and create an obstruction to sprinkler discharge, the provisions of 22.19.2.4 or 22.19.2.5 shall be met. [140:5.11.3]

22.19.2.4* [move to 26.19.2.4]
The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if approved mitigation is employed. [140:5.11.4]

22.19.2.5* [move to 26.19.2.5]
The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if the building sprinkler system meets the design criteria for Extra Hazard, Group 2. [140:5.11.5]

22.20 Animal Housing Facilities. [move to 26.20]

22.20.1 Design Requirements. (Reserved) [move to 26.20.1]

22.20.1.1 (Reserved) [move to 26.20.1.1]

22.20.2 Installation Requirements. (Reserved) [move to 26.20.2]

22.20.2.1 [move to 26.20.2.1]
Quick-response sprinklers shall be utilized in animal housing facilities. [150:9.2.3]

22.21 Water Cooling Towers. [move to 26.21]

22.21.1 Design Requirements. [move to 26.21.1]

22.21.1.1 Types of Systems. [move to 26.21.1.1]

22.21.1.1* [move to 26.21.1.1.1]
Because the counterflow tower design lends itself to either closed- or open-head systems, the following systems shall be permitted to be used:
The open-head deluge system shall be used in crossflow towers to maximize the water distribution and heat detection activation. [214:5.2.2.2]

Minimum Rate of Application. [move to 26.21.1.2] [214:5.2.3]

Under the fan decks of counterflow towers, the rate of application of water shall be 0.5 gpm/ft² (20.4 mm/min), including fan opening. [214:5.2.3.1]

Under the fan decks of crossflow towers, the rate of application of water shall be 0.33 gpm/ft² (13.45 mm/min), including fan opening. [214:5.2.3.2]

Over the fill areas of crossflow towers, the rate of application of water shall be 0.5 gpm/ft² (20.4 mm/min). [214:5.2.3.3]

Extended Fan Decks. [move to 26.21.1.3]

On towers having extended fan decks that completely enclose the distribution basin, the discharge outlets protecting the fill area shall be located over the basin, under the extension of the fan deck. [214:5.2.4.3]

These discharge outlets shall be open directional spray nozzles or other approved spray devices arranged to discharge 0.35 gpm/ft² (14.26 mm/min) directly on the distribution basin and 0.15 gpm/ft² (6.11 mm/min) on the underside of the fan deck extension. [214:5.2.4.3.1]

On towers having extended fan decks that do not completely enclose the hot-water basin, outlets protecting the fill shall be located under the distribution basin in accordance with 5.2.4.2.2 of NFPA 214. [214:5.2.4.3.2]

For deluge systems using directional spray nozzles in the pendant position, provisions shall be made to protect the underside of a combustible fan deck at a minimum of 0.15 gpm/ft² (6.11 mm/min), which shall be included as part of the application rate specified in 5.2.3 of NFPA 214. [214:5.2.4.4]
22.21.1.5* Water Basin Covers. [move to 26.21.1.5]
On film-filled towers that have solid, hot-water basin covers over the complete basin, the discharge outlets protecting the fill area shall be permitted to be located under the basin covers. [214:5.2.4.5]

22.21.1.5.1 [move to 26.21.1.5.1]
These discharge outlets shall be open directional spray nozzles or other approved devices arranged to discharge 0.50 gpm/ft² (20.4 mm/min) into the distribution basin horizontally, with some of the spray splashing up and on the underside of the water basin covers. [214:5.2.4.5.1]

22.21.1.6 Exterior Protection. [move to 26.21.1.6] [214:5.2.10]

22.21.1.6.1 [move to 26.21.1.6.1]
Where any combustible exterior surfaces of a tower, including the fan deck and distribution basins, are less than 100 ft (30.5 m) from significant concentrations of combustibles such as structures or piled material, the combustible exposed surfaces of the tower shall be protected by an automatic water spray system. [214:5.2.10.1]

22.21.1.6.2 [move to 26.21.1.6.2]
Systems for exterior protection shall be designed with the same attention and care as interior systems. [214:5.2.10.2]

22.21.1.6.2.1 [move to 26.21.1.6.2.1]
Pipe sizing shall be based on hydraulic calculations. [214:5.2.10.2.1]

22.21.1.6.2.2 [move to 26.21.1.6.2.2]
Water supply and discharge rate shall be based on a minimum 0.15 gpm/ft² (6.11 mm/min) for all protected surfaces. [214:5.2.10.2.2]

22.21.1.7 Sprinkler System Water Supply. [move to 26.21.1.7]

22.21.1.7.1 Deluge Systems. [move to 26.21.1.7.1]

22.21.1.7.1.1* [move to 26.21.1.7.1.1]
Where all cells of a cooling tower are protected by a single deluge system, the water supply shall be adequate to supply all discharge outlets on that system. [214:5.6.1.1]

22.21.1.7.1.2 [move to 26.21.1.7.1.2]
Where two or more deluge systems are used to protect a cooling tower and fire-resistant partitions are not provided between the deluge systems, the water supply shall be adequate to supply all discharge outlets in the two most hydraulically demanding adjacent systems. [214:5.6.1.2]

22.21.1.7.1.3* [move to 26.21.1.7.1.3]
Where two or more deluge systems are separated by fire-resistant partitions, the water supply shall be adequate to supply all discharge outlets in the single most hydraulically demanding system. [214:5.6.1.3]

22.21.1.7.2 Wet, Dry, and Preaction Systems. [move to 26.21.1.7.2]

22.21.1.7.2.1* [move to 26.21.1.7.2.1]
Where each cell of the cooling tower is separated by a fire-resistant partition, the water supply shall be adequate to supply all discharge outlets in the hydraulically most demanding single cell. [214:5.6.2.1]

22.21.1.7.2.2* [move to 26.21.1.7.2.2]
Where fire-resistant partitions are not provided between each cell of a cooling tower, the water supply shall be adequate to supply all discharge outlets in the two most hydraulically demanding adjoining cells. [214:5.6.2.2]

22.21.1.7.3 Hose Streams. [move to 26.21.1.7.3]
Water supplies shall be sufficient to include a minimum of 500 gpm (1892.5 L/min) for hose streams in addition to the sprinkler requirements. [214:5.6.3]

22.21.1.7.4 Duration. [move to 26.21.1.7.4]
A water supply adequate for at least a 2-hour duration shall be provided for the combination of the water supply specified in 5.6.1 or 5.6.2 of NFPA 214, plus the hose stream demand specified in 22.21.1.7.3. [214:5.6.4]

22.21.2 Installation Requirements. [move to 26.21.2]

22.21.2.1* Counterflow Towers. [move to 26.21.2.1] [214:5.2.4.1]

22.21.2.1.1 [move to 26.21.2.1.1]
The discharge outlets shall be located under the fan deck and fan opening. [214:5.2.4.1.1]

22.21.2.1.2 [move to 26.21.2.1.2]
Except under the fan opening, all discharge outlets shall have deflector distances installed in accordance with Section 8.5 of NFPA 13. [214:5.2.4.1.2]

22.21.2.1.3 [move to 26.21.2.1.3]
Closed-head discharge outlets for dry-pipe and preaction systems shall be installed in the upright position only. [214:5.2.4.1.3]

22.21.2.2* Crossflow Towers. [move to 26.21.2.2] [214:5.2.4.2]

22.21.2.2.1 [move to 26.21.2.2.1]
The discharge outlets protecting the plenum area shall be located under the fan deck and in the fan opening. [214:5.2.4.2.1]

22.21.2.2.2 [move to 26.21.2.2.2]
Discharge outlets protecting the fill shall be located under the distribution basin on either the louver or drift eliminator side, discharging horizontally through the joist channels. [214:5.2.4.2.2]

22.21.2.2.3 [move to 26.21.2.2.3]
Towers with an air travel dimension longer than the maximum allowable for the discharge device being used shall have discharge devices placed on both sides of the fill area in each joist channel. [214:5.2.4.2.3.1]

22.21.2.2.4 [move to 26.21.2.2.4]
The pressure at each discharge device shall be adequate to provide protection for half of the length of the fill measured along the air travel. [214:5.2.4.2.3.2]

22.21.2.2.5 [move to 26.21.2.2.5]
Where joist channels are wider than 2 ft (0.6 m), more than one discharge device shall be required per joist channel. [214:5.2.4.2.4.1]

22.21.2.2.6 [move to 26.21.2.2.6]
If the discharge device being used is listed for the width of the joist channel being protected, one discharge device per joist channel shall be permitted to be used. [214:5.2.4.2.4.2]

22.21.2.3* Extended Fan Decks. [move to 26.21.2.3]
On towers having extended fan decks that completely enclose the distribution basin, the discharge outlets protecting the fill area shall be located over the basin, under the extension of the fan deck. [214:5.2.4.3]

22.21.2.4* Water Basin Covers. [move to 26.21.2.4]
On film-filled towers that have solid, hot-water basin covers over the complete basin, the discharge outlets protecting the fill area shall be permitted to be located under the basin covers. [214:5.2.4.5]

22.21.2.5 Valves. [move to 26.21.2.5]
[214:5.2.6]

22.21.2.5.1 [move to 26.21.2.5.1]
Shutoff valves and automatically operated water control valves, if provided, shall be located as follows:
(1) Outside the fire-exposed area
(2) As close to the cooling tower as possible to minimize the amount of pipe to the discharge device
(3) Where they will be accessible during a fire emergency
[214:5.2.6.1.2]
22.21.2.5.2 Manual Release Valve. [move to 26.21.2.5.2] [214:5.2.6.2]

22.21.2.5.2.1 [move to 26.21.2.5.2.1]
Remote manual release valves, where required, shall be conspicuously located and accessible during a fire emergency. [214:5.2.6.2.1]

22.21.2.5.2.2 [move to 26.21.2.5.2.2]
Where remote manual release valves are not required, an inspector's test valve shall be provided for each pilot-head-operated system. [214:5.2.6.2.2]

22.21.2.6 Strainers. [move to 26.21.2.6]
Strainers shall be required for systems utilizing discharge devices with waterways of less than 3/8 in. (9.5 mm) diameter. [214:5.2.7]

22.21.2.7 Heat Detectors. [move to 26.21.2.7]
Where deluge or preaction systems are used, heat detectors shall be installed and shall be selected from either of the types in 5.2.8.1 or 5.2.8.2 of NFPA 214. [214:5.2.8]

22.21.2.7.1 [move to 26.21.2.7.1]
In mechanical-draft towers, pilot line detectors shall be located under the fan deck at the circumference of the fan opening and under the fan opening where necessary to comply with the spacing requirements in 22.21.2.7.1.1. (For extended fan decks, see 5.2.8.2.3 in NFPA 214.) [214:5.2.8.1.2.1(A)]

22.21.2.7.1.1 [move to 26.21.2.7.1.1]
Pilot line detectors shall be spaced not more than 8 ft (2.4 m) apart in any direction including the fan opening. Temperature ratings shall be selected in accordance with operating conditions, but shall be no less than intermediate. [214:5.2.8.1.2.1(B)]

22.21.2.7.2 [move to 26.21.2.7.2]
On towers having extended fan decks that completely enclose the distribution basin, electrical heat detectors shall be located under the fan deck extension in accordance with standard, indoor-spacing rules for the type detectors used in accordance with NFPA 72. [214:5.2.8.2.3]

22.21.2.7.2.1 [move to 26.21.2.7.2.1]
Where the fan deck extension is 16 ft (4.9 m) or less and this dimension is the length of the joist channel, then only one row of detectors centered on and at right angles to the joist channels shall be required. Spacing between detectors shall be in accordance with NFPA 72. [214:5.2.8.2.3.1]

22.21.2.7.2.2 [move to 26.21.2.7.2.2]
On towers having extended fan decks that do not completely enclose the hot-water basin, electrical heat detectors shall not be required under the fan deck extension. [214:5.2.8.2.3.2]

22.21.2.7.3 [move to 26.21.2.7.3]
Where electrical heat detectors are inaccessible during tower operation, an accessible test detector shall be provided for each detection zone. [214:5.2.8.3]

22.21.2.7.4 [move to 26.21.2.7.4]
Electrical heat detector components exposed to corrosive vapors or liquids shall be protected by materials of construction or by protective coatings applied by the equipment manufacturer. [214:5.2.8.4]

22.21.2.8 Protection for Fan Drive Motor. [move to 26.21.2.8]
[214:5.2.9]

22.21.2.8.1 [move to 26.21.2.8.1]
A sprinkler or spray nozzle shall be provided over each fan drive motor where the motor is located so that it is not within the protected area of the tower. [214:5.2.9.1]

22.21.2.8.2 [move to 26.21.2.8.2]
Where a preaction or deluge system is used, the detection system shall be extended to cover the motor. [214:5.2.9.2]

22.21.2.8.3 [move to 26.21.2.8.3]
Provision shall be made to interlock the fan motors with the fire protection system so that the cooling tower fan motors are stopped in the cell(s) for which the system is actuated. [214:5.2.9.3]

22.21.2.8.4 [move to 26.21.2.8.4]
Where the continued operation of the fans is vital to the process, a manual override switch shall be permitted to be provided to reactivate the fan when it is determined that there is no fire. [214:5.2.9.4]

22.21.2.9 Corrosion Protection. [move to 26.21.2.9]
[214:5.3]

22.21.2.9.1 [move to 26.21.2.9.1]
Piping, fittings, hangers, braces, and attachment hardware including fasteners shall be hot-dipped galvanized steel in accordance with ASTM A153A/153M, Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware, or other materials having a superior corrosion resistance. [214:5.3.1]

22.21.2.9.1.1 [move to 26.21.2.9.1.1]
Exposed pipe threads and bolts on fittings shall be protected against corrosion. [214:5.3.1.1]

22.21.2.9.1.2 [move to 26.21.2.9.1.2]
All other components shall be corrosion resistant or protected against corrosion by a coating. [214:5.3.1.2]

22.21.2.9.2* [move to 26.21.2.9.2]
Wax-type coatings shall not be used on devices without fusible elements. [214:5.3.2]

22.21.2.9.3* [move to 26.21.2.9.3]
Special care shall be taken in the handling and installation of wax-coated or similar sprinklers to avoid damaging the coating. [214:5.3.3]

22.21.2.9.3.1 [move to 26.21.2.9.3.1]
Corrosion-resistant coatings shall not be applied to the sprinklers by anyone other than the manufacturer of the sprinklers. [214:5.3.3.1]

22.21.2.9.3.2 [move to 26.21.2.9.3.2]
In all cases, any damage to the protective coating occurring at the time of installation shall be repaired at once using only the coating of the manufacturer of the sprinkler in an approved manner, so that no part of the sprinkler will be exposed after the installation has been completed. [214:5.3.3.2]

22.22 Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves. [move to 26.22]

22.22.1 Design Requirements. [move to 26.22.1]

22.22.1.1* [move to 26.22.1.1]
Unless the requirements of 22.22.1.2 apply, automatic sprinkler systems shall be designed based upon the design criteria for the protection of Group A plastics. [307:5.4.2.1]

22.22.1.2 [move to 26.22.1.2]
With the approval of the authority having jurisdiction, the requirements of 22.22.1.1 shall not apply to buildings used exclusively for the handling or storage of specific cargoes and commodities that are defined as commodity classes less than Group A plastics by this standard. [307:5.4.2.2]

22.22.1.3 [move to 26.22.1.3]
Buildings consistent with 22.22.1.2 shall be protected in accordance with the design criteria for the applicable commodity as required by this standard. [307:5.4.2.3]

22.22.1.4 [move to 26.22.1.4]
Buildings used for the storage of hazardous materials shall be protected in accordance with this standard and the applicable codes and standards for the type of hazardous material being stored. [307:5.4.2.4]

22.22.2 Installation Requirements. [move to 26.22.2]

22.22.2.1 Piers and Wharves with Combustible Substructure. [move to 26.22.2.1]
Where there is danger of damage to sprinkler equipment by floating objects, physical barriers shall be provided to exclude such objects. [307:4.3.3.1.2.2]

22.22.2.1.2  [move to 26.22.2.1.2]
The installation requirements in 22.22.2.1.2.1, 22.22.2.1.2.1(A), and 22.22.2.1.2.1(B) are also required.

22.22.2.1.2.1*  Upward Projecting Sprinklers. [move to 26.22.2.1.2.1]
Where narrow horizontal channels or spaces are caused by caps, stringers, ties, and other structural members and where the standard upright sprinkler does not project sufficient water upward to extinguish or control fires on the underside of the pier or wharf deck, a sprinkler that projects water upward to wet the overhead shall be used. [307:4.3.3.1.3.1]

(A)
Location, spacing, and deflector position shall be governed by the discharge pattern of the sprinkler and the structure being protected. [307:4.3.3.1.3.1(A)]

(B)
The following design and installation guides shall apply where pendent sprinklers in the upright position or old-style sprinklers are to be utilized:
(1) The maximum coverage per sprinkler head shall be limited to 80 ft² (7.5 m²).
(2) Where spacing or arrangement of stringers constitutes typical open-joist construction directly supporting the deck, sprinkler branch lines shall be installed between the bents at right angles to the stringers and shall meet the following requirements:
   (a) Spacing between branch lines shall not exceed 10 ft (3 m).
   (b) Sprinklers on branch lines shall be staggered and spaced not to exceed 8 ft (2.5 m) on center.
(3) *Where crisscross construction is involved, closer spacing of sprinklers shall be permitted as necessary to provide wetting of the entire structure.
(4) The deflectors of sprinklers on lines under stringers shall be located not less than 4 in. (100 mm) nor more than 10 in. (250 mm) below the bottom plane of the stringer, and not more than 18 in. (450 mm) below the underside of the pier or wharf deck.
(5) *The sprinkler system shall be hydraulically designed in accordance with the requirements of this standard and shall meet the following requirements:
   (a) Sprinkler orifice shall be 1/2 in. (12.7 mm) and shall discharge at a minimum pressure of 12.5 psi (85 kPa).
   (b) Design area shall be based upon the largest area between firestops plus an additional area embracing at least two branch lines on opposite sides of the firestop.
   (c) Minimum design area shall be not less than 5000 ft² (465 m²).
(6) The temperature rating of the sprinkler shall not exceed 165°F (74°C).
(7) The maximum area to be protected by any one system shall be limited to 25,000 ft² (2325 m²).

22.23  Semiconductor Fabrication Facilities.  [move to 26.23]
22.23.1 Design Requirements. [move to 26.23.1]

22.23.1.1* [move to 26.23.1.1]
Automatic sprinklers for cleanrooms or clean zones shall be installed in accordance with this standard and shall be hydraulically designed for a density of 0.20 gpm/ft² (8.15 L/min·m²) over a design area of 3000 ft² (278.8 m²). [318:4.1.2.1]

22.23.1.2 [move to 26.23.1.2]
Automatic sprinkler protection shall be designed and installed in the plenum and interstitial space above cleanrooms in accordance with this standard, for a density of 0.20 gpm/ft² (8.15 L/min·m²) over a design area of 3000 ft² (278.8 m²). [318:4.1.2.5]

22.23.1.2.1* [move to 26.23.1.2.1]
Automatic sprinklers shall be permitted to be omitted if the construction and occupancy of these spaces are noncombustible. [318:4.1.2.5.1]

22.23.1.3* [move to 26.23.1.3]
Sprinklers installed in duct systems shall be hydraulically designed to provide 0.5 gpm (1.9 L/min) over an area derived by multiplying the distance between the sprinklers in a horizontal duct by the width of the duct. [318:4.1.2.6.2]

22.23.1.3.1* [move to 26.23.1.3.1]
Minimum discharge shall be 20 gpm (76 L/min) per sprinkler from the five hydraulically most remote sprinklers. [318:4.1.2.6.2.1]

22.23.2 Installation Requirements. [move to 26.23.2]

22.23.2.1* [move to 26.23.2.1]
Wet pipe automatic sprinkler protection shall be provided throughout facilities containing cleanrooms and clean zones. [318:4.1.1]

22.23.2.2* [move to 26.23.2.2]
Approved quick-response sprinklers shall be utilized for sprinkler installations within down-flow airstreams in cleanrooms and clean zones. [318:4.1.2.2]

22.23.2.3* [move to 26.23.2.3]
Sprinklers shall be spaced a maximum of 20 ft (6.1 m) apart horizontally and 12 ft (3.7 m) apart vertically. [318:4.1.2.6.2.2]

22.23.2.4 [move to 26.23.2.4]
A separate indicating control valve shall be provided for sprinklers installed in ductwork. [318:4.1.2.6.3]

22.23.2.5 [move to 26.23.2.5]
The sprinklers shall be accessible for periodic inspection and maintenance. [318:4.1.2.6.6]
22.24 Aircraft Hangars. [move to 26.24]

22.24.1 Design Requirements. [move to 26.24.1]
Sprinkler systems installed in aircraft hangars shall comply with NFPA 409.

22.24.2 Installation Requirements. [move to 26.24.2]
Sprinkler systems installed in aircraft hangars shall comply with NFPA 409.

22.25 Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways. [move to 26.25]

22.25.1 Design Requirements. [move to 26.25.1]

22.25.1.1 [move to 26.25.1.1]
Passenger-handling areas shall be classified as Ordinary Hazard Group 1 Occupancy for the purpose of sprinkler system design. [415:4.5.1.3]

22.25.1.2* [move to 26.25.1.2]
Baggage, package, and mail-handling areas shall be classified as Ordinary Hazard Group 2 Occupancy for the purpose of sprinkler system design. [415:4.5.1.4]

22.25.1.3 [move to 26.25.1.3]
Other areas of the airport terminal building shall be classified in accordance with Chapter 5 of this standard. [415:4.5.1.5]

22.25.1.4 Water Supply. [move to 26.25.1.4]
Water supply from public and private sources shall be adequate to supply maximum calculated sprinkler demand plus a minimum of 500 gpm (1893 L/min) for hose streams. The supply shall be available at the rate specified for a period of at least 1 hour. [415:4.5.5]

22.25.1.4.1 [move to 26.25.1.4.1]
Main sizes shall be hydraulically calculated based on the total domestic and fire protection requirements. Mains shall not be less than 8 in. (203 mm) in diameter except that laterals shall be permitted to be 6 in. (152 mm) in diameter if not over 200 ft (61 m) long. [415:4.5.5.1]

22.25.2 Installation Requirements. (Reserved) [move to 26.25.2]

22.26 Aircraft Engine Test Facilities. [move to 26.26]

22.26.1 Design Requirements. [move to 26.26.1]

22.26.1.1* [move to 26.26.1.1]
In engine test cells, the minimum design discharge density shall be 0.50 gpm/ft² (0.34 L/sec/m²) of protected area. [423:7.6.3]

22.26.1.2 [move to 26.26.1.2]
In engine test cells, water supplies shall be capable of meeting the largest demand at the design rate plus hose stream demand for a period of 30 minutes. [423:7.6.4]

22.26.1.2.1 [move to 26.261.2.1]
Hose stream demand shall be a minimum of 250 gpm (16 L/sec). [423:7.6.4.1]

22.26.1.2.2 [move to 26.261.2.2]
The hydraulic calculation and the water supply shall be based on the assumption that all sprinklers in the test cell are operating simultaneously. [423:7.6.4.2]

22.26.2 Installation Requirements. (Reserved) [move to 26.26]

22.27 Advanced Light Water Reactor Electric Generating Plants. [move to 26.27]

22.27.1 Design Requirements. [move to 26.27.1]

22.27.1.1* Sprinkler System Water Supply. [move to 26.27.1.1]
The fire water supply shall be calculated on the basis of the largest expected flow rate for a period of 2 hours but shall not be less than 300,000 gal (1,135,500 L), and the following criteria also shall apply:
(1) The flow rate shall be based on 500 gpm (1892.5 L/min) for manual hose streams plus the largest design demand of any sprinkler or fixed water spray system as determined in accordance with this standard, with NFPA 15, or with NFPA 804.
(2) The fire water supply shall be capable of delivering the design demand specified in 22.27.1.1(1) with the hydraulically least demanding portion of fire main loop out of service. [804:9.2.1]

22.27.1.2 Yard Mains. [move to 26.27.1.2]
The underground yard fire main loop shall be installed to furnish anticipated water requirements, and the following criteria also shall be met:
(1) The type of pipe and water treatment shall be design considerations, with tuberculation as one of the parameters.
(2) Means for inspecting and flushing the systems shall be provided. [804:9.4.1]

22.27.1.3 Cable Spreading Room. [move to 26.27.1.3]
The cable spreading room shall have an automatic fixed water-based suppression system, and the following criteria also shall be met:
(1) The location of sprinklers or spray nozzles shall protect cable tray arrangements to ensure water coverage for areas that could present exposure fire hazards to the cable raceways.
(2) Automatic sprinkler systems shall be designed for a density of 0.30 gpm/ft² (12.2 L/min•m²) over the most remote 2500 ft² (232.2 m²). [804:10.4.1.1]

22.27.1.4 Cable Tunnels. [move to 26.27.1.4]
[804:10.4.2]
22.27.1.4.1 [move to 26.27.1.4.1]  
Automatic sprinkler systems shall be designed for a density of 0.30 gpm/ft² (12.2 L/min·m²) for the most remote 100 linear ft (30.5 m) of cable tunnel up to the most remote 2500 ft² (232.2 m²). [804:10.4.2.2.2]

22.27.1.4.2 [move to 26.27.1.4.2]  
Deluge sprinkler systems or deluge spray systems shall meet the following criteria:
(1) They shall be zoned to limit the area of protection to that which the drainage system can handle with any two adjacent systems actuated.
(2) They shall be hydraulically designed with each zone calculated with the largest adjacent zone flowing. [804:10.4.2.2.4]

22.27.1.5* Beneath Turbine Generator Operating Floor. [move to 26.27.1.5]  
All areas beneath the turbine generator operating floor shall be protected by an automatic sprinkler or foam-water sprinkler system meeting the following criteria:
(1) The sprinkler system beneath the turbine generator shall be designed around obstructions from structural members and piping.
(2) The sprinkler system shall be designed to a minimum density of 0.30 gpm/ft² (12.2 L/min·m²) over a minimum application of 5000 ft² (464.5 m²). [804:10.8.2.1]

22.27.1.6* Turbine Generator Bearings. [move to 26.27.1.6]  
[804:10.8.3]

22.27.1.6.1 [move to 26.27.1.6.1]  
Lubricating oil lines above the turbine operating floor shall be protected with an automatic sprinkler system to a minimum density of 0.30 gpm/ft² (12.2 L/min·m²) that covers those areas subject to oil accumulation, including the area within the turbine lagging (skirt). [804:10.8.4]

22.27.1.6.2 [move to 26.27.1.6.2]  
Where shaft-driven ventilation systems are used, an automatic preaction sprinkler system providing a density of 0.30 gpm/ft² (12.2 L/min·m²) over the entire area shall be provided. [804:10.8.7(2)]

22.27.1.7 Standby Emergency Diesel Generators and Combustion Turbines. [move to 26.27.1.7]  
The sprinkler and water spray protection systems shall be designed for a 0.25 gpm/ft² (10.19 L/min·m²) density over the entire area. [804:10.9.3(2)]

22.27.1.8 Fire Pump Room/House. [move to 26.27.1.8]  
If sprinkler and water spray systems are provided for fire pump houses, they shall be designed for a minimum density of 0.25 gpm/ft² (10.19 L/min·m²) over the entire fire area. [804:10.22.2]

22.27.1.9 Auxiliary Boilers. [move to 26.27.1.9]
Sprinkler and water spray systems shall be designed for a minimum density of 0.25 gpm/ft² (10.19 L/min·m²) over the entire area. [804:10.24.3]

22.27.2 Installation Requirements. [move to 26.27.2]

22.27.2.1 Yard Mains, Hydrants, and Building Standpipes. [move to 26.27.2.1] [804:9.4]

22.27.2.1.1 Approved visually indicating sectional control valves such as postindicator valves shall be provided to isolate portions of the main for maintenance or repair without simultaneously shutting off the supply to both primary and backup fire suppression systems. [804:9.4.2]

22.27.2.1.2* Sectional control valves shall allow maintaining independence of the individual loop around each unit, and the following also shall apply:

   (1) For such installations, common water supplies shall also be permitted to be utilized.
   (2) For multiple-reactor sites with widely separated plants [approaching 1 mi (1.6 km) or more], separate yard fire main loops shall be used. [804:9.4.4]

22.27.2.1.3 Sprinkler systems and manual hose station standpipes shall have connections to the plant underground water main so that a single active failure or a crack in a moderate-energy line can be isolated so as not to impair both the primary and the backup fire suppression systems unless otherwise permitted by the following:

   (1) Alternatively, headers fed from each end shall be permitted inside buildings to supply both sprinkler and standpipe systems, provided steel piping and fittings meeting the requirements of ASME B31.1, *Code for Power Piping*, are used for the headers (up to and including the first valve) supplying the sprinkler systems where such headers are part of the seismically analyzed hose standpipe system.
   (2) Where provided, such headers shall be considered an extension of the yard main system.
   (3) Each sprinkler and standpipe system shall be equipped with an outside screw and yoke (OS&Y) gate valve or other approved shutoff valve. [804:9.4.7]

22.27.2.2 Cable Tunnels. [move to 26.27.2.2]
The location of sprinklers or spray nozzles shall protect cable tray arrangements and possible transient combustibles to ensure water coverage for areas that could present exposure fire hazards to the cable raceways. [804:10.4.2.2.3]

22.27.2.3 Deluge. [move to 26.27.2.3]
Deluge sprinkler systems or deluge spray systems shall meet the following criteria:

   (1) They shall be zoned to limit the area of protection to that which the drainage system can handle with any two adjacent systems actuated.
(2) They shall be hydraulically designed with each zone calculated with the largest adjacent zone flowing. \[804:10.4.2.2.4\]

**22.27.2.4 [move to 26.27.2.4]**
Cable tunnels over 50 ft (15.2 m) long shall be provided with hose stations and portable fire extinguishers installed outside the tunnel. \[804:10.4.2.4(3)\]

**22.28 Light Water Nuclear Power Plants. [move to 26.28]**

**22.28.1 Design Requirements. [move to 26.28.1]**
A fire protection water supply of reliability, quantity, and duration shall be provided by one of the two following methods:
(1) A fire protection water supply of not less than two separate 300,000 gal (1,135,500 L) supplies shall be provided.
(2) The 2-hour fire flow rate for 2 hours shall be calculated, and the following criteria shall be met:
   (a) The flow rate shall be based on 500 gpm (1892.5 L/min) for manual hose streams plus the largest design demand of any sprinkler or fixed water spray system(s) in the power block as determined in accordance with NFPA 13 or NFPA 15.
   (b) The fire water supply shall be capable of delivering this design demand with the hydraulically least demanding portion of fire main loop out of service. \[805:5.5.1\]

**22.28.2 Installation Requirements. [move to 26.28.2]**

**22.28.2.1 [move to 26.28.2.1]**
Sprinkler systems and manual hose station standpipes shall be connected to the plant fire protection water main so that a single active failure or a crack to the water supply piping to these systems can be isolated so as not to impair both the primary and backup fire suppression systems. \[805:5.5.12\]

**22.28.2.2 [move to 26.28.2.2]**
Each sprinkler and standpipe system shall be equipped with an outside screw and yoke (OS&Y) gate valve or other approved shutoff valve. \[805:5.5.17\]

**22.29 Hydroelectric Generating Plants. [NFPA 851] [move to 26.29]**

**22.29.1 Design Requirements. [move to 26.29.1]**

**22.29.1.1 Hydraulic Control Systems. [move to 26.29.1.1]**
Fixed fire protection for this equipment, where provided, should be as follows:
(1) Automatic wet pipe sprinkler systems utilizing a design density of 0.25 gpm/ft\(^2\) (10.2 mm/min) for the entire hazard area.
(2) Automatic foam-water sprinkler systems providing a density of 0.16 gpm/ft\(^2\) (6.5 mm/min). \[851:7.2.4\]
22.29.1.2 Cable Concentrations. [move to 26.29.1.2]
Sprinkler or water spray systems should be designed for a density of 0.30 gpm/ft² (12.2 mm/min) over 2500 ft² (232 m²). This coverage is for area protection. Individual cable tray tier coverage could be required based on the fire risk evaluation. [851:7.5.3]

22.29.1.3 Cable Tunnels. [move to 26.29.1.3]
Where protection is required by the fire risk evaluation, cable tunnels should be protected by automatic water spray, automatic wet pipe sprinkler, or foam-water spray systems. Automatic sprinkler systems should be designed for a density of 0.30 gpm/ft² (12.2 mm/min) over 2500 ft² (232 m²) or the most remote 100 linear ft (30.5 m) of cable tunnel up to 2500 ft² (232 m²). [851:7.6.1]

22.29.1.4 Emergency Generators. [move to 26.29.1.4]
Emergency generators located within main plant structures should be protected by automatic sprinkler, water spray, foam-water sprinkler, compressed air foam, or gaseous-type extinguishing systems. Sprinkler and water spray protection systems should be designed for a 0.25 gpm/ft² (10.2 mm/min) density over the fire area. [851:7.11.2]

22.29.1.5 Air Compressors. [move to 26.29.1.5]
Automatic sprinkler protection designed for a density of 0.25 gpm/ft² (10.2 mm/min) over the postulated oil spill or compressed air foam should be considered for air compressors containing a large quantity of oil. [851:7.12]

22.29.1.6 Hydraulic Systems for Gate and Valve Operators. [move to 26.29.1.6]
Hydraulic control systems should use a listed fire-resistant fluid. Automatic sprinkler protection designed for a density of 0.25 gpm/ft² (10.2 mm/min) over the fire area or compressed air foam systems should be considered for hydraulic systems not using a listed fire-resistant fluid. [851:7.13]

22.29.1.7 Fire Pumps. [move to 26.29.1.7]
Rooms housing diesel-driven fire pumps should be protected by automatic sprinkler, water spray, foam-water sprinkler, or compressed air foam systems. If sprinkler and water spray protection systems are provided, they should be designed for a density of 0.25 gpm/ft² (10.2 mm/min) over the fire area. For automatic foam-water sprinkler systems, a density of 0.16 gpm/ft² (6.5 mm/min) should be provided. [851:7.14]

22.29.2 Installation Requirements. [move to 26.29.2]

22.29.2.1 Hydraulic Control Systems. [move to 26.29.2.1]
Fire extinguishing systems, where installed for lube oil systems employing combustible-type oil, should include protection for the reservoirs, pumps, and all oil lines, especially where unions exist on piping and beneath any shielded area where flowing oil can collect. Facilities not provided with curbs or drains should extend coverage for a distance of 20 ft (6 m) from the oil lines, when measured from the outermost oil line. [851:7.2.7]

22.30.1 Design Requirements. [move to 26.30.1]

22.30.1.1* [move to 26.30.1.1]

22.30.1.2* [move to 26.30.1.2]
Preaction and dry pipe systems shall be designed to minimize the risk of corrosion in accordance with the requirements of 22.30.2.1 through 22.30.2.5. [909:9.12.13.5]

22.30.1.3 System Design for Museums, Libraries, and Their Collections in Compact Storage. [move to 26.30.1.3]

22.30.1.3.1* [move to 26.30.1.3.1]
The design shall recognize the nature of the potential threat of a fire that originates in a compact mobile storage unit, where fuel loads are invariably large and fire growth is significantly different from that in other kinds of storage. [909:9.12.23.4.1.3]

22.30.1.3.2* [move to 26.30.1.3.2]
The automatic fire suppression system, the compact storage system, and the storage compartmentalization features shall be designed to limit fire damage in accordance with the facility’s fire safety objectives. [909:9.12.23.4.1.4(A)]

22.30.1.3.3 [move to 26.30.1.3.3]
Design calculations shall include the number and size of the storage modules, the separation provided between the modules end-to-end and back-to-back, and the type of material being stored. [909:9.12.23.4.1.4(B)]

22.30.1.3.4 [move to 26.30.1.3.4]
Where the automatic fire suppression is provided by automatic fire sprinkler systems, the systems shall be wet pipe, single interlock pre-action, or single non-interlock pre-action systems. [909:9.12.23.4.1.4(C)]

22.30.1.3.5 [move to 26.30.1.3.5]
Dry pipe or double-interlock pre-action systems shall not be installed in compact storage areas. [909:9.12.23.4.1.4(D)]

22.30.1.3.6 [move to 26.30.1.3.6]
Where compact storage is installed in an existing storage area, the existing automatic fire detection and fire suppression systems shall be modified as required to accommodate the increased fire loading. [909:9.12.23.4.1.4(E)]

22.30.2 Installation Requirements. [move to 26.30.2]
22.30.2.1* [move to 26.30.2.1]  
Branch lines shall be pitched at least 1/2 in. per 10 ft (4 mm/m), and mains shall be pitched at least 1/4 in. per 10 ft (2 mm/m). [909:9.12.3.1]

22.30.2.2* [move to 26.30.2.2]  
Auxiliary drains shall be provided at all low points in accordance with NFPA 13 requirements for dry pipe systems and preaction systems subject to freezing. [909:9.12.3.2.1]

22.30.2.3* [move to 26.30.2.3]  
Where steel pipe is used in dry pipe and preaction systems, the provisions of this standard shall be applied assuming water supplies and environmental conditions that contribute to unusual corrosive properties, and a plan shall be developed to address piping corrosion. [909:9.12.3.3]

22.31 National Electrical Code. [move to 26.31]

22.31.1 Design Requirements. (Reserved) [move to 26.31.1]

22.31.2 Installation Requirements. [move to 26.31.1.2]

22.31.2.1 Dedicated Electrical Space. [move to 26.31.1.2.1]  
The space equal to the width and depth of the equipment and extending from the floor to a height of 6 ft (1.8 m) above the equipment or to the structural ceiling, whichever is lower, shall be dedicated to the electrical installation. No piping, ducts, leak protection apparatus, or other equipment foreign to the electrical installation shall be located in this zone.  
Exception: Suspended ceilings with removable panels shall be permitted within the 1.8-m (6-ft) zone.  
[70:110.26(E)(1)(a)]

22.31.2.2 [move to 26.31.2.2]  
The area above the dedicated space required by 22.31.2.1 shall be permitted to contain foreign systems, provided protection is installed to avoid damage to the electrical equipment from condensation, leaks, or breaks in such foreign systems. [70:110.26(E)(1)(b)]

22.31.2.3* [move to 26.31.2.3]  
Sprinkler protection shall be permitted for the dedicated space where the piping complies with this section. [70:110.26(E)(1)(c)]

22.32 Fire Protection of Telecommunication Facilities. [move to 26.32]

22.32.1 Design Requirements. (Reserved) [move to 26.32.1]

22.32.2 Installation Requirements. [move to 26.32.2]

22.32.2.1 [move to 26.32.2.1]
All piping for dry pipe and pre-action sprinkler systems shall be installed with a pitch in accordance with NFPA 13 whether or not the piping is subjected to freezing conditions.

22.33 Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids. [move to 26.33]

22.33.1 Design Requirements. [move to 26.33.1]

22.33.1.1 Any portion of an exhaust system utilizing combustible components or having the potential for combustible residue buildup on the inside, where the duct cross-sectional area is greater than or equal to 75 in.² (480 cm²), shall be provided with an automatic extinguishing system within the duct and at the duct intake, hood, enclosure, or canopy, or shall be constructed of material listed for use without sprinkler protection. [91:9.1]

22.33.1.2 When a sprinkler system is installed, means shall be provided to prevent water accumulation in the duct or flow of water back to a process subject that could be damaged by water. [91:9.2]

22.33.2 Installation Requirements. (Reserved) [move to 26.33.2]

22.34 Hypobaric Facilities. [move to 26.34]

22.34.1 Design Requirements. [move to 26.34.1]

22.34.1.1 A fire suppression system consisting of independently supplied and operating handline and fixed deluge-type water spray systems shall be installed. [99B:4.5.1.5]

22.34.1.2 Design of the fire suppression system shall be such that failure of components in either the handline or deluge system will not render the other system inoperative. [99B:4.5.1.6]

22.34.1.3 System design shall be such that activation of either the handline or the deluge system shall automatically cause the following:
(1) Visual and audio alarm indicators shall be activated at the chamber operator's console.
(2) All ungrounded electrical leads for power and lighting circuits contained inside the chamber shall be disconnected.
(3) Emergency lighting and communication, where used, shall be activated.
[99B:4.5.1.7]

22.34.1.4 Intrinsically safe circuits, including sound-powered communications, shall be permitted to remain connected when either the handline or deluge system is activated. [99B:4.5.1.8]
22.34.1.5 [move to 26.34.1.5]
Control circuitry and other electrical equipment involved in the fire detection and suppression system shall be powered from the critical branch of the emergency electrical system and connected to the uninterruptible power supply (UPS). [99B:4.5.1.11]

22.34.1.6 [move to 26.34.1.6]
In chambers that consist of more than one compartment, the deluge system shall operate independently or simultaneously even if the compartments are at different pressures (altitudes). [99B:4.5.2.2]

22.34.1.7 [move to 26.34.1.7]
Fixed deluge systems shall not be required in chamber compartments that are used strictly as personnel transfer compartments and for no other purpose. [99B:4.5.2.3]

22.34.1.8 [move to 26.34.1.8]
Manual activation and deactivation deluge controls shall be located at the operator's console and in each chamber compartment containing a deluge system. [99B:4.5.2.4]

22.34.1.9 [move to 26.34.1.9]
Controls shall be designed to prevent unintended activation. [99B:4.5.2.4.1]

22.34.1.10 [move to 26.34.1.10]
Water shall be delivered from the fixed discharge nozzles of the deluge system within 3 seconds of activation of any affiliated deluge control. [99B:4.5.2.5]

22.34.1.11* [move to 26.34.1.11]
Total water demand shall be determined by multiplying the total chamber floor area by 7.5 gpm/ft² (305.6 L/min/m²). [99B:4.5.2.5.1]

22.34.1.12 [move to 26.34.1.12]
The minimum operating pressure at the nozzle shall be 30 psi (206 kPa). [99B:4.5.2.5.2]

22.34.1.13 [move to 26.34.1.13]
The water supply shall be constantly and fully charged. [99B:4.5.2.6]

22.34.1.14 [move to 26.34.1.14]
The water supply pressure shall be constantly monitored and an interlock shall prevent chamber operation if water supply pressure has fallen 10 percent below normal operating charge pressure. [99B:4.5.2.7]

22.34.1.15 [move to 26.34.1.15]
There shall be water in the deluge system to maintain the flow specified in 22.34.1.11 simultaneously in each chamber containing the deluge system for 1 minute. [99B:4.5.2.8]

22.34.1.16 [move to 26.34.1.16]
The limit on maximum extinguishment duration shall be governed by the chamber capacity (bilge capacity also, if so equipped) and/or its drainage system. [99B:4.5.2.9]

22.34.1.17 [move to 26.34.1.17]
The deluge system shall have stored pressure to operate for at least 15 seconds without electrical branch power. [99B:4.5.2.10]

22.34.2 Installation Requirements. (Reserved) [move to 26.34.2]

22.35 Coal Mines. [move to 26.35]

22.35.1 Design Requirements. [move to 26.35.1]

22.35.1.1 Underground Mining Operations. [move to 26.35.1.1]

22.35.1.1.1* [move to 26.35.1.1.1]
Fire sprinkler systems for underground mining operations shall be designed and installed in accordance with NFPA 120.

22.35.1.2 Coal Preparation Plants and Crusher Buildings. [move to 26.35.1.2]

22.35.1.2.1 [move to 26.35.1.2.1]
When automatic sprinkler systems are to be supplied through the standpipe system, hydraulic calculations shall be used to ensure that the piping and the water supply meet the hose and automatic sprinkler demands simultaneously. [120:6.3.2.3.2]

22.35.1.3 Underground Conveyors. [move to 26.35.1.3]

22.35.1.3.1 [move to 26.35.1.3.1]
The application rate shall not be less than 10.2 L/min/m² (0.25 gpm/ft²) of the top surface of the top belt. [120:9.4.6.4]

22.35.1.3.2 [move to 26.35.1.3.2]
The water supply shall be free of excessive sediment and corrosives and provide the required flow for not less than 10 minutes. A strainer with a flush-out connection and manual shutoff valve shall be provided. [120:9.4.6.6]

22.35.1.3.3 [move to 26.35.1.3.3]
The system shall be interlocked to shut down the conveyor and provide an audible and a visual alarm. [120:9.4.6.8]

22.35.1.3.4 [move to 26.35.1.3.4]
Fire suppression systems shall also comply with 22.35.1.1.1. [120:9.4.6.10]

22.35.1.3.5 [move to 26.35.1.3.5]
Sprinkler systems shall meet the following requirements:
(1) The sprinklers shall be installed in accordance with NFPA 13 as far as practical, and shall have components that have been listed.
(2) The water supply shall be capable of supplying a constant flow of water with all heads functioning for a period of 10 minutes.
(3) The sprinkler head activation temperature shall not be less than 65.6°C (150°F) or greater than 148.9°C (300°F).

22.35.2 Installation Requirements. [move to 26.35.2]

22.35.2.1 Underground Conveyors. [move to 26.35.2.1]

22.35.2.1.1 [move to 26.35.2.1.1]
Deluge water spray systems, foam systems, closed-head sprinkler systems, or dry-chemical systems automatically actuated by rise in temperature shall be installed at main and secondary belt conveyor drives. [120:9.4.6.1]

22.35.2.1.2 [move to 26.35.2.1.2]
Fire suppression systems shall extend to the drive areas of belt conveyors, including drive motor(s), reducer, head pulley, and belt storage unit (takeup), including any hydraulic power unit; its electrical controls; and the top and bottom of the first 15.2 m (50 ft) of belt from the drive on the downwind side. [120:9.4.6.2]

22.35.2.1.3 [move to 26.35.2.1.3]
Piping for the deluge, foam, or closed-head sprinkler system shall be metal and listed for sprinkler applications. [120:9.4.6.3]

22.35.2.1.4 [move to 26.35.2.1.4]
The discharge shall be directed at both the upper and the bottom surface of the top belt and the upper surface of the bottom belt. [120:9.4.6.5]

22.35.2.1.5 [move to 26.35.2.1.5]
Maximum distance between nozzles on a branch line shall not exceed 2.4 m (8 ft). [120:9.4.6.7]

22.35.2.1.6 [move to 26.35.2.1.6]
The components of the system shall be located so as to minimize the possibility of damage by roof fall or by the moving belt and its load. [120:9.4.6.9]

22.35.2.1.7 [move to 26.35.2.1.7]
Deluge water spray systems shall meet the requirements of 22.35.2.1.7.1 through 22.35.2.1.7.5. [120:9.4.6.11]

22.35.2.1.7.1 [move to 26.35.1.7.1]
The system shall be activated by heat detectors. [120:9.4.6.11.1]

22.35.2.1.7.2 [move to 26.35.1.7.2]
Heat detectors shall be located at the belt drive, hydraulic takeup unit (unless fire-resistive fluid is used), discharge roller, and the roof above the conveyor. [120:9.4.6.11.1.1]

22.35.2.1.7.3 [move to 26.35.1.7.3]  
Heat detectors at the roof line should be spaced 2.4 m to 3.0 m (8 ft to 10 ft) apart along the entire length of the protected area of the belt. [120:9.4.6.11.1.2]

22.35.2.1.7.4 [move to 26.35.1.7.4]  
The nozzles shall be full cone, corrosion resistant, and provided with blow-off dust covers. [120:9.4.6.11.2]

22.35.2.1.7.5 [move to 26.35.1.7.5]  
A closed sprinkler head shall be used over the electrical controls. [120:9.4.6.11.3]

22.35.2.2 Mine Surface Buildings. [move to 26.35.2.2]

22.35.2.2.1 [move to 26.35.2.2.1]  
If sprinklers are installed, waterflow, valve tamper, and low building temperature alarms shall be provided. [120:8.6.1.2]

22.36 Metal/Nonmetal Mining and Metal Mineral Processing Facilities. [move to 26.36]

22.36.1 Design Requirements. [move to 26.36.1]

22.36.1.1 Water Supplies. [move to 26.36.1.1]

22.36.1.1.1 [move to 26.36.1.1.1]  
When automatic sprinkler systems are supplied through the hand hose line standpipe system, hydraulic calculations shall be used to ensure that the piping and water supply will supply the hose and automatic sprinkler demands simultaneously. [122:6.2.3]

22.36.1.1.2 [move to 26.36.1.1.2]  
Where a fire water supply [for a surface mineral processing plant] is required by the risk assessment, capacity and availability shall provide the water demand for fire-fighting purposes, including hose and sprinkler systems, for a minimum duration of 2 hours. [122:13.7.2]

22.36.1.2* [move to 26.36.1.2]  
Where provided, automatic sprinkler systems installed for the protection of flammable liquid or diesel fuel storage areas shall be of the foam-water type. [122:11.3.1]

22.36.1.3 New Solvent Extraction (SX) Facilities. [move to 26.36.1.3]

22.36.1.3.1 [move to 26.36.1.3.1]  
Fixed fire suppression shall be provided for the following SX facility areas and equipment:  
(1) Buildings housing SX processes  
(2) Interior of all mixer-settler vessels/cells
(3) Crud tanks that include treatment filters and centrifuges
(4) Coalescers
(5) Along launders and weirs outside of mixer-settler vessels
(6) Inside pipe trenches carrying solvents
(7) Inside organic solvent and diluent tanks
(8) Inside dikes enclosing organic solvent storage tanks
(9) Over organic solvent pumps
(10) Over elevated pipe racks carrying organic solvents in plastic pipes
(11) Other areas handling, processing, or exposed to flammable or combustible liquids

22.36.1.3.2* [move to 26.36.1.3.2]
Fire suppression for applications in 22.36.1.3.1 shall be water, foam, dry chemical, or water mist.

22.36.1.3.3* [move to 26.36.1.3.3]
Design of fire suppression systems in 22.36.1.3.1 shall be based on criteria set forth in NFPA 11, NFPA 15, NFPA 16, and NFPA 17.

22.36.1.3.4* [move to 26.36.1.3.4]
Actuation of fire suppression systems in 22.36.1.3.1 shall be automatic.

22.36.1.3.5 [move to 26.36.1.3.5]
As exposure protection, automatic water-only deluge (open-head) sprinkler systems shall be provided between mixer-settler trains if spaced closer than 15.24 m (50 ft) from each other.

22.36.1.3.6 [move to 26.36.1.3.6]
As exposure protection, automatic water-only deluge sprinkler systems shall be provided around the exterior perimeter of organic solvent tanks if spaced closer than 15.24 m (50 ft) from each other.

22.36.1.3.7 [move to 26.36.1.3.7]
As exposure protection, automatic fire suppression shall be provided over other critical equipment (i.e., transformers) or outside along important building walls [i.e., motor control center (MCC) rooms] that are within 15.24 m (50 ft) of a solvent fire area.

22.36.1.3.8 [move to 26.36.1.3.8]
Hydraulic design of automatic fire suppression systems in 22.36.1.3.1 shall include the simultaneous operation of all fire protection systems associated with a single (multi-cell) train.

22.36.1.3.9 [move to 26.36.1.3.9]
The total flow rate of foam application and water associated with the discharge of automatic fire extinguishing systems, fixed monitors, and hydrants shall determine the total volume of fire water required.
22.36.2 Installation Requirements. (Reserved) [move to 26.36.2]


22.37.1 [move to 26.37.1]
Sprinkler system discharge criteria for the protection of hazardous materials shall comply with NFPA 400.

22.37.1.1 Requirements for Occupancies Storing Quantities of Hazardous Materials Exceeding the Maximum Allowable Quantities per Control Area for High Hazard Contents. [move to 26.37.1.1]
The design of the sprinkler system shall be not less than ordinary hazard Group 2 in accordance with NFPA 13, except as follows:
(1) Where different requirements are specified in Chapters 11 through 21 of NFPA 400
(2) Where the materials or storage arrangement requires a higher level of sprinkler system protection in accordance with nationally recognized standards
(3) Where approved alternative automatic fire extinguishing systems are permitted

22.37.1.2 General Requirements for Storage of Ammonium Nitrate Solids and Liquids. [move to 26.37.1.2]
Sprinkler systems shall be of the approved type and designed and installed in accordance with NFPA 13, and the following:
(1) Ammonium nitrate in noncombustible or combustible containers (paper bags or noncombustible containers with removable combustible liners) shall be designated as a Class I commodity.
(2) Where contained in plastic containers, ammonium nitrate shall be designated as a Class II commodity.
(3) Where contained in fiber packs or noncombustible containers in combustible packaging, ammonium nitrate shall be designated as a Class III commodity.

22.37.1.3 General Requirements for Storage of Organic Peroxide Formulations. [move to 26.37.1.3]

22.37.1.3.1 [move to 26.37.1.3.1]
Where required by other provisions of this code, automatic sprinklers and water spray systems shall be designed and installed according to the requirements of NFPA 13 and NFPA 15 and shall provide the following discharge densities:
(1) Class I — 0.50 gpm/ft² (20.4 L/min/m²)
(2) Class II — 0.40 gpm/ft² (16.3 L/min/m²)
(3) Class III — 0.30 gpm/ft² (12.2 L/min/m²)
(4) Class IV — 0.25 gpm/ft² (10.2 L/min/m²)
22.37.1.3.2 [move to 26.37.1.3.2]
The system shall be designed as follows:
(1) It shall provide the required density over a 3000 ft² (280 m²) area for areas protected by a wet pipe sprinkler system or 3900 ft² (360 m²) for areas protected by a dry pipe sprinkler system.
(2) The entire area of any building of less than 3000 ft² (280 m²) shall be used as the area of application.
[400:14.2.6.2]

22.37.1.3.3 [move to 26.37.1.3.3]
Where required for detached storage buildings containing Class I organic peroxide formulations in quantities exceeding 2000 lb (907 kg), automatic sprinkler protection shall be open-head deluge-type, designed and installed in accordance with NFPA 13. [400:14.2.6.3]


22.37.1.4.1 [move to 26.37.1.4.1]
Sprinkler protection for Class 2 oxidizers shall be designed in accordance with Table 22.37.1.4.1. [400:15.3.2.3.4.1]

Table 22.37.1.4.1 Ceiling Sprinkler Protection for Class 2 Oxidizers in Palletized or Bulk and Rack Storage Areas

<table>
<thead>
<tr>
<th>Type of Storage</th>
<th>Ceiling Sprinklers</th>
<th>Area of Application</th>
<th>In-Rack Sprinklers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Height</td>
<td>Density</td>
<td>ft²</td>
<td>m²</td>
</tr>
<tr>
<td>ft</td>
<td>m</td>
<td>gpm/ft²</td>
<td>L/min/m²</td>
</tr>
<tr>
<td>Palletized or bulk</td>
<td>8</td>
<td>2.4</td>
<td>0.20</td>
</tr>
<tr>
<td>Palletized or bulk</td>
<td>12</td>
<td>3.7</td>
<td>0.35</td>
</tr>
<tr>
<td>Rack</td>
<td>12</td>
<td>3.7</td>
<td>0.20</td>
</tr>
<tr>
<td>Rack</td>
<td>16</td>
<td>4.9</td>
<td>0.30</td>
</tr>
</tbody>
</table>

[400: Table 15.3.2.3.2.10(B)]

22.37.1.4.2 [move to 26.37.1.4.2]
Ceiling sprinklers shall be high-temperature sprinklers. [400:15.3.2.3.4.2]

22.37.1.4.3 Storage Protection for Class 2 Oxidizers with In-Rack Sprinklers. [move to 26.37.1.4.3]

(A)
In-rack sprinklers shall be quick-response sprinklers with an ordinary-temperature rating and have a K-factor of not less than K = 8.0. [400:15.3.2.3.4.3(A)]
(B) In-rack sprinklers shall be designed to provide 25 psi (172 kPa) for the six most hydraulically remote sprinklers on each level. [400:15.3.2.3.4.3(B)]

(C) The in-rack sprinklers shall be 8 ft to 10 ft (2.4 m to 3.0 m) spacings in the longitudinal flue space at the intersection of the transverse flue spaces. [400:15.3.2.3.4.3(C)]

22.37.1.4.4 Sprinkler Criteria for Class 3 Oxidizers. [move to 26.37.1.4.4]

22.37.1.4.4.1 Class 3 Oxidizers Less than 2300 lb (1043 kg). [move to 26.37.1.4.4.1]

(A) Sprinkler design criteria for buildings that require sprinkler protection and contain total quantities of Class 3 oxidizers less than 2300 lb (1043 kg) shall be in accordance with the requirements of 22.37.1.4.4.1(B). [400:15.3.2.4.13.1(A)]

(B) Facilities that require sprinkler protection and contain total quantities of Class 3 oxidizers greater than 200 lb (91 kg), but less than 2300 lb (1043 kg), shall follow the sprinkler design criteria in Table 22.37.1.4.4.1(B). [400:15.3.2.4.13.1(B)]

Table 22.37.1.4.4.1(B) Sprinkler Protection of Class 3 Oxidizers Stored in Total Quantities Greater than 200 lb (91 kg) but Less than 2300 lb (1043 kg)

<table>
<thead>
<tr>
<th>Storage Parameters</th>
<th>Shelf</th>
<th>Bulk or Pile</th>
<th>Bulk or Pile</th>
<th>Rack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum storage height</td>
<td>6 ft (1.8 m)</td>
<td>5 ft (1.5 m)</td>
<td>10 ft (3 m)</td>
<td>10 ft (3 m)</td>
</tr>
<tr>
<td>Maximum ceiling height</td>
<td>25 ft (7.6 m)</td>
<td>25 ft (7.6 m)</td>
<td>25 ft (7.6 m)</td>
<td>NA</td>
</tr>
<tr>
<td>Aisles — pile separation</td>
<td>4 ft (1.2 m) min. clear aisles</td>
<td>4 ft (1.2 m) min. clear aisles</td>
<td>8 ft (2.4 m) min. clear aisles</td>
<td>8 ft (2.4 m) min. clear aisles</td>
</tr>
<tr>
<td>Ceiling design criteria</td>
<td>0.45 gpm/ft²/2000 ft²</td>
<td>0.35 gpm/ft² or 5000 ft² or 0.6 gpm/2000 ft²</td>
<td>0.65 gpm/ft²/5000 ft² or 0.6 gpm/ft²/2000 ft²</td>
<td>NA</td>
</tr>
<tr>
<td>In-rack sprinklers</td>
<td>NP</td>
<td>NP</td>
<td>NA</td>
<td>See 15.3.2.4.12.2.</td>
</tr>
<tr>
<td>Hose stream demand</td>
<td>500 gpm</td>
<td>500 gpm</td>
<td>500 gpm</td>
<td>500 gpm</td>
</tr>
<tr>
<td>Duration</td>
<td>120 minutes</td>
<td>120 minutes</td>
<td>120 minutes</td>
<td>120 minutes</td>
</tr>
</tbody>
</table>

For SI units, 1 gal = 3.79 L. NA: Not applicable. NP: Not permitted. [400: Table 15.3.2.4.12.1(B)]
22.37.1.4.4.2 Storage Protection for Class 3 Oxidizers In-Rack Sprinkler Criteria. [move to 26.37.1.4.4.2]

(A)
Where required by Table 22.37.1.4.4.1(B), in-rack sprinkler protection shall be as follows:
(1) In-rack sprinklers shall be installed above every level of oxidizer storage.
(2) In-rack sprinklers shall be spaced at maximum 4 ft (1.2 m) intervals to provide one sprinkler in each flue space.
(3) In-rack sprinklers shall be quick-response sprinklers with an ordinary-temperature rating and have a K-factor of not less than K = 8.0.
(4) In-rack sprinklers shall be designed to provide 25 psi (172 kPa) for the six most hydraulically remote sprinklers on each level. [400:15.3.2.4.13.3(A)]

22.37.1.4.4.3 Class 3 Oxidizers Greater than or Equal to 2300 lb (1043 kg). [move to 26.37.1.4.4.3]
The sprinkler protection shall be in accordance with Table 22.37.1.4.4.3. [400:15.3.2.4.13.4(B)]

Table 22.37.1.4.4.3 Sprinkler Protection of Class 3 Oxidizers Stored in Total Quantities of Greater than or Equal to 2300 lb (1043 kg)

<table>
<thead>
<tr>
<th>Storage Parameters</th>
<th>Bulk or Pile</th>
<th>Rack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum storage height</td>
<td>5 ft (1.5 m)</td>
<td>10 ft (3 m)</td>
</tr>
<tr>
<td>Maximum ceiling height</td>
<td>25 ft (7.6 m)</td>
<td>NP</td>
</tr>
<tr>
<td>Aisles — pile separation</td>
<td>8 ft (2.4 m) min. clear aisles</td>
<td>8 ft (2.4 m) min. clear aisles</td>
</tr>
<tr>
<td>Ceiling design criteria</td>
<td>0.35 gpm/ft²/5000 ft² (1.32 L/min/m²/464.5 m²)</td>
<td>Predominant for other commodities but not less than ordinary hazard Group II</td>
</tr>
<tr>
<td>In-rack sprinklers</td>
<td>NP</td>
<td>See 15.3.2.4.12.4</td>
</tr>
<tr>
<td>Hose stream demand</td>
<td>500 gpm (1893 L/min)</td>
<td>500 gpm (1893 L/min)</td>
</tr>
<tr>
<td>Duration</td>
<td>120 minutes</td>
<td>120 minutes</td>
</tr>
</tbody>
</table>

NP: Not permitted. [400: Table 15.3.2.4.12.3(B)]

22.37.1.4.4.4 Special In-Rack Sprinkler Protection for Class 3 Oxidizers. [move to 26.37.1.4.4.4]

(A) Where required by Table 22.37.1.4.4.3, special in-rack sprinkler protection shall be as shown in Figure 22.37.1.4.4.4(A). [400:15.3.2.4.13.5(A)]
Figure 22.37.1.4.4.4(A) Arrangement of Barriers and In-Rack Sprinklers for Special Fire Protection Provisions. [400: Figure 15.3.2.4.13.5(A)]
In-rack automatic sprinklers shall be provided under each horizontal barrier and arranged in accordance with 22.37.1.4.4.4(C) through 22.37.1.4.4.4(I). [400:15.3.2.4.13.5(K)]

(C) For double-row racks, two lines of in-rack sprinklers shall be provided between the face of the rack and the longitudinal vertical barrier located in the center of the rack. [400:15.3.2.4.13.5(L)]

(D) For single-row racks, two lines of in-rack sprinklers shall be provided between each rack face. [400:15.3.2.4.13.5(M)]

(E) Three in-rack sprinklers shall be provided on each in-rack sprinkler line as follows:
   (1) Two sprinklers on each line shall be spaced approximately 1 1/2 in. (38.1 mm) from each transverse vertical barrier.
   (2) One in-rack sprinkler on each in-rack sprinkler line shall be located approximately equidistant between the transverse vertical barriers. [400:15.3.2.4.13.5(N)]

(F) In-rack sprinklers shall be of the upright or pendent type, with the fusible element located no more than 6 in. (152.4 mm) from the horizontal barrier. [400:15.3.2.4.13.5(O)]

(G) In-rack sprinklers shall be K = 8.0, quick-response, ordinary-temperature-rated sprinklers. [400:15.3.2.4.13.5(Q)]

(H) The in-rack sprinkler system shall be designed to supply 6 sprinklers on each line, with a total of 12 sprinklers operating at gauge pressure of 25 psi (172 kPa). [400:15.3.2.4.13.5(R)]

(I) The design of the in-rack sprinkler system shall be independent of, and shall not be required to be balanced with, ceiling sprinkler systems. [400:15.3.2.4.13.5(S)]

22.37.1.4.4.5 Sprinkler Criteria for Class 4 Oxidizers. [move to 26.37.1.4.4.5]

(A) Sprinkler protection for Class 4 oxidizers shall be installed on a deluge sprinkler system to provide water density of 0.35 gpm/ft² (14.4 L/min/m²) over the entire storage area. [400:15.3.2.5.4.6(A)]

(B) Sprinkler protection shall be installed in accordance with NFPA 13. [400:15.3.2.5.4.6(B)]

22.37.2 Installation Requirements. [move to 26.37.2]
See attached file for the reorganization of existing Chapter 23.

Supplemental Information

<table>
<thead>
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<th>File Name</th>
<th>Description</th>
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</tr>
</tbody>
</table>

Submitter Information Verification

Submitter Full Name: AUT-SSD  
Organization: [Not Specified]  
Street Address:  
City:  
State:  
Zip:  
Submittal Date: Fri Aug 05 17:37:24 EDT 2016

Committee Statement

Committee Statement: Chapter 23 consolidates all of the Early Suppression Fast Response (ESFR) sprinkler criteria into one Chapter. A benefit of this is to have all of the charts, curves and tables relative to ESFR in one spot and not intermixed with other sprinkler technologies.
Chapter 23  Plans and Calculations

23.1*  Working Plans. [move to 4.6]

23.1.1*  [move to 4.6.1]
Working plans shall be submitted for approval to the authority having jurisdiction before any equipment is installed or remodeled.

23.1.2 [move to 4.6.2]
Deviation from approved plans shall require permission of the authority having jurisdiction.

23.1.3 [move to 4.6.3]
Working plans shall be drawn to an indicated scale, on sheets of uniform size, with a plan of each floor, and shall show those items from the following list that pertain to the design of the system:
(1)  Name of owner and occupant.
(2)  Location, including street address.
(3)  Point of compass.
(4)  Full height cross section or schematic diagram, including structural member information if required for clarity and including ceiling construction and method of protection for nonmetallic piping.
(5)  Location of partitions.
(6)  Location of fire walls.
(7)  Occupancy class of each area or room.
(8)  Location and size of concealed spaces, closets, attics, and bathrooms.
(9)  Any small enclosures in which no sprinklers are to be installed.
(10) Size of city main in street and whether dead end or circulating; if dead end, direction and distance to nearest circulating main; and city main test results and system elevation relative to test hydrant.
(11) Other sources of water supply, with pressure or elevation.
(12) Make, type, model, and nominal K-factor of sprinklers, including sprinkler identification number.
(13) Temperature rating and location of high-temperature sprinklers.
(14) Total area protected by each system on each floor.
(15) Number of sprinklers on each riser per floor.
(16) Total number of sprinklers on each dry pipe system, preaction system, combined dry pipe–preaction system, or deluge system.
(17) Approximate capacity in gallons of each dry pipe system.
(18) Pipe type and schedule of wall thickness.
(19) Nominal pipe size and cutting lengths of pipe (or center-to-center dimensions). Where typical branch lines prevail, it shall be necessary to size only one typical line.
(20) Location and size of riser nipples.
(21) Type of fittings and joints and location of all welds and bends. The contractor shall specify on drawing any sections to be shop welded and the type of fittings or formations to be used.
(22) Type and locations of hangers, sleeves, braces, and methods of securing sprinklers when applicable.
(23) All control valves, check valves, drain pipes, and test connections.
(24) Make, type, model, and size of alarm or dry pipe valve.
(25) Make, type, model, and size of preaction or deluge valve.
(26) Kind and location of alarm bells.
(27) Size and location of standpipe risers, hose outlets, hand hose, monitor nozzles, and related equipment.
(28) Private fire service main sizes, lengths, locations, weights, materials, point of connection to city main; the sizes, types and locations of valves, valve indicators, regulators, meters, and valve pits; and the depth that the top of the pipe is laid below grade.
(29) Piping provisions for flushing.
(30) Where the equipment is to be installed as an addition to an existing system, enough of the existing system indicated on the plans to make all conditions clear.
(31) For hydraulically designed systems, the information on the hydraulic data nameplate.
(32) A graphic representation of the scale used on all plans.
(33) Name and address of contractor.
(34) Hydraulic reference points shown on the plan that correspond with comparable reference points on the hydraulic calculation sheets.
(35) The minimum rate of water application (density or flow or discharge pressure), the design area of water application, in-rack sprinkler demand, and the water required for hose streams both inside and outside.
(36) The total quantity of water and the pressure required noted at a common reference point for each system.
(37) Relative elevations of sprinklers, junction points, and supply or reference points.
(38) If room design method is used, all unprotected wall openings throughout the floor protected.
(39) Calculation of loads for sizing and details of sway bracing.
(40) The setting for pressure-reducing valves.
(41) Information about backflow preventers (manufacturer, size, type).
(42) Information about listed antifreeze solution used (type and amount).
(43) Size and location of hydrants showing size and number of outlets and if outlets are to be equipped with independent gate valves. Whether hose houses and equipment are to be provided, and by whom, shall be indicated. Static and residual hydrants that were used in flow tests shall be shown.
(44) Size, location, and piping arrangement of fire department connections.
(45) Ceiling/roof heights and slopes not shown in the full height cross section.
(46) Edition year of NFPA 13 to which the sprinkler system is designed.

23.1.4* [move to 4.6.4]
A signed copy of the owner's certificate and the working plan submittal shall include the manufacturer's installation instructions for any specially listed equipment, including descriptions, applications, and limitations for any sprinklers, devices, piping, or fittings.

23.1.5* Working Plans for Automatic Sprinkler Systems with Non–Fire Protection Connections. [move to 4.6.5]

23.1.5.1 [move to 4.6.5.1]
Special symbols shall be used and explained for auxiliary piping, pumps, heat exchangers, valves, strainers, and the like, clearly distinguishing these devices and piping runs from those of the sprinkler system.

23.1.5.2 [move to 4.6.5.2]
Model number, type, and manufacturer's name shall be identified for each piece of auxiliary equipment.

23.2 Water Supply Information. [move to 4.7]

23.2.1 Water Supply Capacity Information. [move to 4.7.1]
The following information shall be included:
(1) Location and elevation of static and residual test gauge with relation to the riser reference point
(2) Flow location
(3) Static pressure, psi (bar)
(4) Residual pressure, psi (bar)
(5) Flow, gpm (L/min)
(6) Date
(7) Time
(8) Name of person who conducted the test or supplied the information
(9) Other sources of water supply, with pressure or elevation

23.2.1.1* [move to 4.7.1.1]
Where a waterflow test is used for the purposes of system design, the test shall be conducted no more than 12 months prior to working plan submittal unless otherwise approved by the authority having jurisdiction.

23.2.2 Water Supply Treatment Information. [move to 4.7.2]
The following information shall be included when water supply treatment is provided in accordance with 24.1.5:
(1) Type of condition that requires treatment
(2) Type of treatment needed to address the problem
(3) Details of treatment plan

23.3 Hydraulic Calculation Forms. [move to 19.7]

23.3.1 General. [move to 19.7.1]
Hydraulic calculations shall be prepared on form sheets that include a summary sheet, detailed worksheets, and a graph sheet. [See Figure A.23.3.2(a), Figure A.23.3.3, and Figure A.23.3.4 for copies of typical forms.]

23.3.2* Summary Sheet. [move to 19.7.2]
The summary sheet shall contain the following information, where applicable:
(1) Date
(2) Location
(3) Name of owner and occupant  
(4) Building number or other identification  
(5) Description of hazard (for storage applications, the commodity classification, storage height, and rack configuration shall be included)  
(6) Name and address of contractor or designer  
(7) Name of approving agency  
(8) System design requirements, as follows: 
   (a) Design area of water application, ft² (m²).  
   (b) Minimum rate of water application (density), gpm/ft² (mm/min). Where sprinklers are listed with minimum water application in gpm (L/min) or pressure in psi (bar), the minimum rate of water application shall be indicated in gpm (L/min) or pressure, psi (bar).  
   (c) Area per sprinkler, ft² (m²).  
(9) Total water requirements as calculated, including allowance for inside hose, outside hydrants, and water curtain and exposure sprinklers  
(10) Allowance for in-rack sprinklers, gpm (L/min)  
(11) Limitations (dimension, flow, and pressure) on extended coverage or other listed special sprinklers

23.3.3* Detailed Worksheets. [move to 19.7.3]
Detailed worksheets or computer printout sheets shall contain the following information:
   (1) Sheet number  
   (2) Sprinkler description and discharge constant (K)  
   (3) Hydraulic reference points  
   (4) Flow in gpm (L/min)  
   (5) Pipe size  
   (6) Pipe lengths, center-to-center of fittings  
   (7) Equivalent pipe lengths for fittings and devices  
   (8) Friction loss in psi/ft (bar/m) of pipe  
   (9) Total friction loss between reference points  
   (10) In-rack sprinkler demand balanced to ceiling demand  
   (11) Elevation head in psi (bar) between reference points  
   (12) Required pressure in psi (bar) at each reference point  
   (13) Velocity pressure and normal pressure if included in calculations  
   (14) Notes to indicate starting points or reference to other sheets or to clarify data shown  
   (15) *Diagram to accompany gridded system calculations to indicate flow quantities and directions for lines with sprinklers operating in the remote area  
   (16) Combined K-factor calculations for sprinklers on drops, armovers, or sprigs where calculations do not begin at the sprinkler

23.3.4* Graph Sheet. [move to 19.7.4]
A graphic representation of the complete hydraulic calculation shall be plotted on semiexponential graph paper ($Q^{1.85}$) and shall include the following:
   (1) Water supply curve  
   (2) Sprinkler system demand  
   (3) Hose allowance (where applicable)  
   (4) In-rack sprinkler demand (where applicable)
23.3.5  Hydraulic Reports. [move to 19.7.5]

23.3.5.1* General. [move to 19.7.5.1]

23.3.5.1.1 [move to 19.7.5.1.1]
Hydraulic calculations shall be prepared on form sheets that include a summary sheet, a graph sheet, a water supply analysis, a node analysis, and detailed worksheets.

23.3.5.1.2 [move to 19.7.5.1.2]
The data shall be presented in the order shown in Figure 23.3.5.1.2(a) through Figure 23.3.5.1.2(d).

Figure 23.3.5.1.2(a) Summary Sheet.
HYDRAULIC CALCULATIONS
for

Project name: ____________________________

Location: ______________________________

Drawing no.: ____________________________ Date: ____________

Design

Remote area number: ______________________

Remote area location: _____________________

Occupancy classification: ________________

Density: ______________________ gpm/ft² (mm/min)

Area of application: ________________ ft² (m²)

Coverage per sprinkler: ________________ ft² (m²)

Type of sprinklers calculated: ____________

No. of sprinklers calculated: ______________

In-rack demand: _________________________

Hose streams:

Total water required (including hose streams): __________ gpm (mm/min) @ __________ psi (bar)

Type of system: _________________________

Volume of dry or preaction system: __________ gal (l)

Water supply information

Date: _________________________________

Location: ______________________________

Source: ________________________________

Name of contractor: ______________________

Address: ______________________________

Phone number: __________________________

Name of designer: _______________________ Authority having jurisdiction: _______________________

Notes: (Include peaking information or gridded systems here.) ______________________________

______________________________________

______________________________________

______________________________________

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Figure 23.3.5.1.2(b) Graph Sheet.
Figure 23.3.5.1.2(c) Supply and Node Analysis Sheet.
<table>
<thead>
<tr>
<th>Node at Source</th>
<th>Static Pressure</th>
<th>Residual Pressure</th>
<th>Flow</th>
<th>Available Pressure</th>
<th>Total Demand</th>
<th>Required Pressure</th>
</tr>
</thead>
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<thead>
<tr>
<th>Node Tag</th>
<th>Elevation</th>
<th>Node Type</th>
<th>Pressure at Node</th>
<th>Discharge at Node</th>
<th>Notes</th>
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Figure 23.3.5.1.2(d) Detailed Worksheet.
### PIPE INFORMATION

<table>
<thead>
<tr>
<th>Node 1</th>
<th>Elev 1 (ft)</th>
<th>K-Factor</th>
<th>Flow added — this step (q)</th>
<th>Nominal ID</th>
<th>Fittings — quantity and length</th>
<th>L ft (m)</th>
<th>C Factor</th>
<th>P_f per foot (m) (psi) (bar)</th>
<th>total (P_f)</th>
<th>Notes</th>
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### 23.3.5.2 Summary Sheet.

The summary sheet as shown in Figure 23.3.5.1.2(a) shall contain the following information, where applicable:

1. Project name and date
(2) Location (including street address)
(3) Owner or expected occupant of space being designed
(4) Name, address, and phone number of installing contractor
(5) Name and phone number of designer
(6) Authority having jurisdiction
(7) Standard or document system is being designed to, including the edition of the document
(8) Design area number and location
(9) Drawing or sheet number where design area is located
(10) Occupancy or commodity classification and information
(11) For storage applications (including miscellaneous), additional information including storage height, ceiling height, storage configuration, aisle width, orientation of upright or pendant, sprinkler K-factor and sprinkler temperature, and the table and or curve utilized in the design
(12) System type, including the system volume with type of protection system indicated in the notes
(13) Sprinkler type, including coverage and response type
(14) Slope of roof or ceiling within the design area
(15) System design requirements, as follows:
   (a) Design area of application, ft² (m²)
   (b) Minimum rate of water application (density), gpm/ft² (mm/min)
   (c) Area per sprinkler, ft² (m²)
   (d) Number of sprinklers calculated
(16) Total water requirements as calculated, including allowance for inside hose, outside hydrants, water curtain, and exposure sprinklers, and allowance for in-rack sprinklers, gpm (L/min)
(17) Ceiling height if used for quick response sprinkler reduction
(18) Elevation of highest calculated sprinkler
(19) Water supply information, including the following:
   (a) Date and time of test
   (b) Location of the test and flow hydrant(s)
   (c) Source of the water for the flow test
   (d) Elevation of the test hydrant relative to the finished floor
   (e) Size of fire pump, gpm @ psi
   (f) Size of on-site water tank
(20) Notes that include peaking information for calculations performed by a computer program, type of preaction system, limitations (dimension, flow, and pressure) on extended-coverage or other listed special sprinklers, system type, including the system volume.

23.3.5.3 Graph Sheet. [move to 19.7.5.3]
A graphic representation of the complete hydraulic calculation shall be plotted on semiexponential graph paper ($Q^{1.85}$) as shown in Figure 23.3.5.1.2(b) and shall include the following:
(1) Water supply curve
(2) Sprinkler system demand
(3) Hose demand (where applicable)
(4) In-rack sprinkler demand (where applicable)
(5) Additional pressures supplied by a fire pump or other source (when applicable)

23.3.5.4 Supply Analysis. [move to 19.7.5.4]
Information summarized from the graph sheet as shown in Figure 23.3.5.1.2(c) shall include the following:
(1) Node tag at the source
(2) Static pressure [psi (bar)] available at the source
(3) Residual pressure [psi (bar)] available at the source
(4) Total flow [gpm (L/min)] available at the source
(5) Available pressure [psi (bar)] at the source when the total calculated demand is flowing
(6) Total calculated demand [gpm (L/min)] at the source
(7) Required pressure [psi (bar)] when flowing total calculated demand

23.3.5.5 Node Analysis. [move to 19.7.5.5]
Organized information as shown in Figure 23.3.5.1.2(c) regarding the node tags given to each hydraulic reference point on the system as indicated on the shop drawings shall include the following information:
(1) Node tag for each specific point on the system used in the hydraulic calculations
(2) Elevation in ft (m) of each node tag
(3) K-factor of flowing nodes (such as sprinklers)
(4) Hose allowance in gpm (L/min) requirements for the node tag
(5) Pressure in psi (bar) at the node
(6) Discharge in gpm (L/min) calculated at the node
(7) Notes that indicate any special requirements for the node

23.3.5.6 Detailed Worksheets. [move to 19.7.5.6]
Detailed worksheets as shown in Figure 23.3.5.1.2(d) or computer printout sheets shall contain the following information:
(1) Sheet number
(2) Hydraulic reference points used in each step
(3) Elevation in ft (m) at each hydraulic reference point
(4) Sprinkler description and discharge constant ($K$) for the flowing reference point
(5) Flow in gpm (L/min) for the flowing reference point (when applicable)
(6) Total flow in gpm (L/min) through each step
(7) Nominal pipe size in in. (mm)
(8) Actual internal diameter of pipe in in. (mm)
(9) Quantity and length in ft (m) of each type of fitting and device
(10) Pipe lengths in ft (m), center-to-center of fittings
(11) Equivalent pipe lengths in ft (m) of fittings and devices for the step
(12) Total equivalent length in ft (m) of pipes and fitting for the step
(13) C-factor used in each step
(14) Friction loss in psi/ft (bar/m) of pipe
(15) Sum of the pressures from the previous step (starting pressure at beginning)
(16) Elevation head in psi (bar) between reference points
(17) Total friction loss in psi (bar) between reference points
(18) Required pressure in psi (bar) at each reference point
(19) Notes and other information shall include the following:
(a) Velocity pressure and normal pressure if included in calculations
(b) In-rack sprinkler demand balanced to ceiling demand
(c) Notes to indicate starting points or reference to other sheets or to clarify data shown
(d) Diagram to accompany gridded system calculations to indicate flow quantities and
directions for lines with sprinklers operating in the remote area
(e) Combined K-factor calculations for sprinklers on drops, armovers, or sprigs where
calculations do not begin at the sprinkler
(f) The pressure [psi/(bar)] loss assigned the backflow device when included on a system
(g) Friction factor and Reynolds number when the Darcy–Weisbach equation is used

23.4 Hydraulic Calculation Procedures. [move to 19.5]

23.4.1* General. [move to 19.5.1]

23.4.1.1 [move to 19.5.1.1]
A calculated system for a building, or a calculated addition to a system in an existing sprinklered
building, shall supersede the rules in this standard governing pipe schedules, except that all
systems shall continue to be limited by area.

23.4.1.2 [move to 19.5.1.2]
Pipe sizes shall be no less than 1 in. (25 mm) nominal for black or galvanized steel piping and
3/4 in. (20 mm) nominal for copper tubing or brass, stainless steel, or nonmetallic piping listed
for fire sprinkler service unless permitted by 8.15.20.4 and 8.15.20.5.

23.4.1.3 [move to 19.5.1.3]
The size of pipe, number of sprinklers per branch line, and number of branch lines per cross
main shall otherwise be limited only by the available water supply.

23.4.1.4* [move to 19.5.1.4]
Unless required by other NFPA standards, the velocity of water flow shall not be limited when
hydraulic calculations are performed using the Hazen–Williams or Darcy Weisbach formulas.

23.4.1.5 [move to 19.5.1.5]
However, sprinkler spacing and all other rules covered in this and other applicable standards
shall be observed.

23.4.1.6 [move to 19.5.1.6]
Hydraulic calculations shall extend to the effective point of the water supply where the
characteristics of the water supply are known.

23.4.2 Formulas. [move to 19.5.2]

23.4.2.1 Friction Loss Formula. [move to 19.5.2.1]

23.4.2.1.1 [move to 19.5.2.1.1]
Pipe friction losses shall be determined on the basis of the Hazen–Williams formula, as follows:

\[ p = \frac{4.52Q^{1.85}}{C^{1.85}d^{4.87}} \] [23.4.2.1.1]

where:
\( p \) = frictional resistance (psi/ft of pipe)
\( Q \) = flow (gpm)
\( C \) = friction loss coefficient
\( d \) = actual internal diameter of pipe (in.)

23.4.2.1.2 [move to 19.5.2.1.2]
For SI units, the following equation shall be used:

\[ p_m = 6.05 \left( \frac{Q_m^{1.85}}{C^{1.85}d_m^{4.87}} \right) 10^5 \] [23.4.2.1.2]

where:
\( p_m \) = frictional resistance (bar/m of pipe)
\( Q_m \) = flow (L/min)
\( C \) = friction loss coefficient
\( d_m \) = actual internal diameter (mm)

23.4.2.1.3 [move to 19.5.2.1.3]
For antifreeze systems greater than 40 gal (150 L) in size, the friction loss shall also be calculated using the Darcy–Weisbach formula:

\[ \Delta P = 0.000216f \frac{l \rho Q^2}{d^5} \] [23.4.2.1.3]

where:
\( \Delta P \) = friction loss (psi)
\( f \) = friction loss factor from Moody diagram
\( l \) = length of pipe or tube (ft)
\( \rho \) = density of fluid (lb/ft³)
\( Q \) = flow in pipe or tube (gpm)
\( d \) = inside diameter of tube (in.)

23.4.2.2 Velocity Pressure Formula. [move to 19.5.2.2]
Velocity pressure shall be determined on the basis of the following formula:

\[ P_v = \frac{0.001123Q^2}{D^4} \] [23.4.2.2]

where:
\( P_v \) = velocity pressure (psi) (SI, 1 psi = 0.0689 bar)
\( Q \) = flow (gpm) (SI, 1 gal = 3.785 L)
$$D = \text{inside diameter (in.) (SI, 1 in. = 25.4 mm)}$$

23.4.2.3 Normal Pressure Formula. [move to 19.5.2.3]
Normal pressure ($P_n$) shall be determined on the basis of the following formula:
$$P_n = P_t - P_v \quad [23.4.2.3]$$
where:
- $P_n = \text{normal pressure}$
- $P_t = \text{total pressure [psi (bar)]}$
- $P_v = \text{velocity pressure [psi (bar)]}$

23.4.2.4 Hydraulic Junction Points. [move to 19.5.2.4]

23.4.2.4.1 [move to 19.5.2.4.1]
Pressures at hydraulic junction points shall balance within 0.5 psi (0.03 bar).

23.4.2.4.2 [move to 19.5.2.4.2]
The highest pressure at the junction point, and the total flows as adjusted, shall be carried into the calculations.

23.4.2.4.3 [move to 19.5.2.4.3]
Pressure balancing shall be permitted through the use of a K-factor developed for branch lines or portions of systems using the formula in 23.4.2.5.

23.4.2.5 K-Factor Formula. [move to 19.5.2.5]
K-factors, flow from an orifice, or pressure from an orifice shall be determined on the basis of the following formula:
$$K_n = \frac{Q}{\sqrt{P}} \quad [23.4.2.5]$$
where:
- $K_n = \text{equivalent } K \text{ at a node}$
- $Q = \text{flow at the node}$
- $P = \text{pressure at the node}$

23.4.3 Equivalent Pipe Lengths of Valves and Fittings. [move to 19.5.3]

23.4.3.1 Pipe and Fittings. [move to 19.5.3.1]

23.4.3.1.1 [move to 19.5.3.1.1]
Table 23.4.3.1.1 shall be used to determine the equivalent length of pipe for fittings and devices unless manufacturer's test data indicate that other factors are appropriate.

Table 23.4.3.1.1 Equivalent Schedule 40 Steel Pipe Length Chart
### Fittings and Valves Expressed in Equivalent Feet (Meters) of Pipe

<table>
<thead>
<tr>
<th>Fittings and Valves</th>
<th>1/2 in.</th>
<th>3/4 in.</th>
<th>1 in.</th>
<th>1 1/4 in.</th>
<th>1 1/2 in.</th>
<th>2 in.</th>
<th>2 1/2 in.</th>
<th>3 in.</th>
<th>3 1/2 in.</th>
<th>4 in.</th>
<th>5 in.</th>
<th>6 in.</th>
<th>8 in.</th>
<th>10 in.</th>
<th>12 in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(15 mm)</td>
<td>(20 mm)</td>
<td>(25 mm)</td>
<td>(32 mm)</td>
<td>(40 mm)</td>
<td>(50 mm)</td>
<td>(65 mm)</td>
<td>(80 mm)</td>
<td>(90 mm)</td>
<td>(100 mm)</td>
<td>(125 mm)</td>
<td>(150 mm)</td>
<td>(200 mm)</td>
<td>(250 mm)</td>
<td>(300 mm)</td>
<td></td>
</tr>
<tr>
<td>45° elbow</td>
<td>—</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>11</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>(0.3)</td>
<td>(0.3)</td>
<td>(0.3)</td>
<td>(0.6)</td>
<td>(0.6)</td>
<td>(0.9)</td>
<td>(0.9)</td>
<td>(0.9)</td>
<td>(1.2)</td>
<td>(1.5)</td>
<td>(2.1)</td>
<td>(2.7)</td>
<td>(3.3)</td>
<td>(4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90° standard elbow</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>18</td>
<td>22</td>
<td>27</td>
</tr>
<tr>
<td>(0.3)</td>
<td>(0.6)</td>
<td>(0.6)</td>
<td>(0.9)</td>
<td>(1.2)</td>
<td>(1.5)</td>
<td>(1.8)</td>
<td>(2.1)</td>
<td>(2.4)</td>
<td>(3)</td>
<td>(3.7)</td>
<td>(4.3)</td>
<td>(5.5)</td>
<td>(6.7)</td>
<td>(8.2)</td>
<td></td>
</tr>
<tr>
<td>90° long-turn elbow</td>
<td>0.5</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>13</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>(0.2)</td>
<td>(0.3)</td>
<td>(0.6)</td>
<td>(0.6)</td>
<td>(0.9)</td>
<td>(1.2)</td>
<td>(1.5)</td>
<td>(1.8)</td>
<td>(2.1)</td>
<td>(2.4)</td>
<td>(2.7)</td>
<td>(4)</td>
<td>(4.9)</td>
<td>(5.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tee or cross (flow turned 90°)</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>15</td>
<td>17</td>
<td>20</td>
<td>25</td>
<td>30</td>
<td>35</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>(0.9)</td>
<td>(1.2)</td>
<td>(1.5)</td>
<td>(1.8)</td>
<td>(2.4)</td>
<td>(3)</td>
<td>(3.7)</td>
<td>(4.6)</td>
<td>(5.2)</td>
<td>(6.1)</td>
<td>(7.6)</td>
<td>(9.1)</td>
<td>(10.7)</td>
<td>(15.2)</td>
<td>(18.3)</td>
<td></td>
</tr>
<tr>
<td>Butterfly valve</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>6</td>
<td>7</td>
<td>10</td>
<td>—</td>
<td>—</td>
<td>12</td>
<td>9</td>
<td>10</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>(1.8)</td>
<td>(2.1)</td>
<td>(3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(3.7)</td>
<td>(2.7)</td>
<td>(3.7)</td>
<td>(3.7)</td>
<td>(5.8)</td>
</tr>
<tr>
<td>Gate valve</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>(0.3)</td>
<td>(0.3)</td>
<td>(0.3)</td>
<td>(0.6)</td>
<td>(0.6)</td>
<td>(0.9)</td>
<td>(1.2)</td>
<td>(1.5)</td>
<td>(1.8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swing check*</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>11</td>
<td>14</td>
<td>16</td>
<td>19</td>
<td>22</td>
<td>27</td>
<td>32</td>
</tr>
<tr>
<td>(1.5)</td>
<td>(2.1)</td>
<td>(2.7)</td>
<td>(3.3)</td>
<td>(4.3)</td>
<td>(4.9)</td>
<td>(5.8)</td>
<td>(6.7)</td>
<td>(8.2)</td>
<td>(9.7)</td>
<td>(13.7)</td>
<td>(16.8)</td>
<td>(19.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Information on 1/2 in. pipe is included in this table only because it is allowed under 8.15.19.4 and 8.15.19.5.

*Due to the variation in design of swing check valves, the pipe equivalents indicated in this table are considered average.

### 23.4.3.1.2 [move to 19.5.3.1.2]

For saddle-type fittings having friction loss greater than that shown in Table 23.4.3.1.1, the increased friction loss shall be included in hydraulic calculations.

### 23.4.3.1.3 Equivalent Length Modifier. [move to 19.5.3.1.3]

#### 23.4.3.1.3.1 [move to 19.5.3.1.3.1]

For internal pipe diameters different from Schedule 40 steel pipe [Schedule 30 for pipe diameters 8 in. (200 mm) and larger], the equivalent length shown in Table 23.4.3.1.1 shall be multiplied by a factor derived from the following formula:

\[
\text{Factor} = \left( \frac{\text{Actual inside diameter}}{\text{Schedule 40 steel pipe inside diameter}} \right)^{4.87}
\]

[23.4.3.1.3.1]
23.4.3.1.3.2 [move to 19.5.3.1.3.2]
The factor thus obtained shall be further modified as required by Table 23.4.3.1.1. This table shall apply to other types of pipe listed in Table 23.4.3.1.1 only where modified by factors from 23.4.3.1.1 and 23.4.3.2.

23.4.3.2 C Factors. [move to 19.5.3.2]
Table 23.4.3.1.1 shall be used with a Hazen–Williams C factor of 120 only.

23.4.3.2.1 [move to 19.5.3.2.1]
For other values of C, the values in Table 23.4.3.1.1 shall be multiplied by the factors indicated in Table 23.4.3.2.1.

Table 23.4.3.2.1 C Value Multiplier

<table>
<thead>
<tr>
<th>Value of C</th>
<th>100</th>
<th>130</th>
<th>140</th>
<th>150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiplying factor</td>
<td>0.713</td>
<td>1.16</td>
<td>1.33</td>
<td>1.51</td>
</tr>
</tbody>
</table>

Note: These factors are based upon the friction loss through the fitting being independent of the C factor available to the piping.

23.4.3.3 Valves. [move to 19.5.3.3]
Specific friction loss values or equivalent pipe lengths for alarm valves, dry pipe valves, deluge valves, strainers, and other devices shall be made available to the authority having jurisdiction.

23.4.3.4 Differing Values. [move to 19.5.3.4]—double check number (also for 11.3.3.4)
Specific friction loss values or equivalent pipe lengths for listed fittings not in Table 6.4.1 shall be used in hydraulic calculations where these losses or equivalent pipe lengths are different from those shown in Table 23.4.3.1.1.

23.4.4* Calculation Procedure. [move to 19.5.4]

23.4.4.1* [move to 19.5.4.1]
For all systems the design area shall be the hydraulically most demanding based on the criteria of Chapter 11, Chapter 12, or the special design approaches in accordance with the requirements of Chapter 22.

23.4.4.1.1 Room Design Method. [move to 19.5.4.1.1]
Where the design is based on the room design method, the calculation shall be based on the room and communicating space, if any, that is hydraulically the most demanding.

23.4.4.2 Density/Area Method. [move to 19.5.4.2]

23.4.4.2.1* [move to 19.5.4.2.1]
Where the design is based on the density/area method, the design area shall be a rectangular area having a dimension parallel to the branch lines at least 1.2 times the square root of the area of sprinkler operation (A) used, which shall permit the inclusion of sprinklers on both sides of the cross main.
23.4.4.2.2  [move to 19.5.4.2.2]
Any fractional sprinkler shall be carried to the next higher whole sprinkler.

23.4.4.2.3  [move to 19.5.4.2.3]
In systems having branch lines with an insufficient number of sprinklers to fulfill the 1.2 requirement, the design area shall be extended to include sprinklers on adjacent branch lines supplied by the same cross main.

23.4.4.2.4*  [move to 19.5.4.2.4]
Where the available floor area for a specific area/density design criteria, including any extension of area as required by 11.1.2 and Section 12.3, is less than the required minimum design area, the design area shall be permitted to only include those sprinklers within the available design area.

23.4.4.2.5  [move to 19.5.4.2.5]
Where the total design discharge from these operating sprinklers is less than the minimum required discharge determined by multiplying the required design density times the required minimum design area, an additional flow shall be added at the point of connection of the branch line to the cross main furthest from the source to increase the overall demand, not including hose stream allowance, to the minimum required discharge.

23.4.4.3  CMSA Sprinkler Method.  [move to 19.5.4.3]

23.4.4.3.1  [move to 19.5.4.3.1]
For CMSA sprinklers, the design area shall be a rectangular area having a dimension parallel to the branch lines at least 1.2 times the square root of the area protected by the number of sprinklers to be included in the design area. The design area protected by the number of sprinklers to be used by the 1.2 rule shall be based on the maximum allowable area per sprinkler.

23.4.4.3.2  [move to 19.5.4.3.2]
Any fractional sprinkler shall be carried to the next higher whole sprinkler.

23.4.4.3.3  [move to 19.5.4.3.3]
In systems having branch lines with an insufficient number of sprinklers to fulfill the 1.2 requirement, the design area shall be extended to include sprinklers on adjacent branch lines supplied by the same cross main.

23.4.4.4  ESFR Sprinkler Method.  [move to 19.5.4.4]
For ESFR sprinklers, the design area shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of three branch lines, unless other specific numbers of design sprinklers are required in other sections of this standard.

23.4.4.5*  Gridded Systems.  [move to 19.5.4.5]

23.4.4.5.1  [move to 19.5.4.5.1]
For gridded systems, the designer shall verify that the hydraulically most demanding area is being used.
23.4.4.5.2 [move to 19.5.4.5.2]
A minimum of two additional sets of calculations shall be submitted to demonstrate peaking of demand area friction loss when compared to areas immediately adjacent on either side along the same branch lines, unless the requirements of 23.4.4.5.3 are met.

23.4.4.5.3 [move to 19.5.4.5.3]
Computer programs that show the peaking of the demand area friction loss shall be acceptable based on a single set of calculations.

23.4.4.6 Design Densities. [move to 19.5.4.6]

23.4.4.6.1* [move to 19.5.4.6.1]
System piping shall be hydraulically designed using design densities and areas of operation in accordance with 11.2.3.2 or Chapter 12 as required for the occupancies or hazards involved.

23.4.4.6.2* [move to 19.5.4.6.2]
The density shall be calculated on the basis of floor area of sprinkler operation. Where sprinklers are installed under a sloped ceiling, the area used for this calculation shall be the horizontal plane below the sprinklers.

23.4.4.6.3 [move to 19.5.4.6.3]
The area covered by any sprinkler used in hydraulic design and calculations shall be the horizontal distances measured between the sprinklers on the branch line and between the branch lines in accordance with 8.5.2.

23.4.4.6.4 [move to 19.5.4.6.4]
Where sprinklers are installed above and below a ceiling or in a case where more than two areas are supplied from a common set of branch lines, the branch lines and supplies shall be calculated to supply the largest water demand.

23.4.4.6.5* [move to 19.5.4.6.5]
For sloped ceiling applications, the area of sprinkler application for density calculations shall be based upon the projected horizontal area.

23.4.4.7* Design Area Sprinklers. [move to 19.5.4.7]

23.4.4.7.1 [move to 19.5.4.7.1]
Each sprinkler in the design area and the remainder of the hydraulically designed system shall discharge at a flow rate at least equal to the stipulated minimum water application rate (density) multiplied by the area of sprinkler operation.

23.4.4.7.1.1 [move to 19.5.4.7.1.1]
Where sprinklers are required to discharge a specific flow or pressure rather than a density, each sprinkler in the design area shall discharge at a flow or pressure at least equal to the minimum required.
23.4.4.7.2* [move to 19.5.4.7.2]

Where the design area is equal to or greater than the area in Table 23.4.4.7.2 for the hazard being protected by the sprinkler system, the discharge for sprinklers protecting small compartments 55 ft² (5.1 m²) or less, such as closets, washrooms, and similar compartments that are in the design area, shall be permitted to be omitted from the hydraulic calculations.

<table>
<thead>
<tr>
<th>Occupancy Hazard Classification</th>
<th>Minimum Design Area to Omit Discharge from Sprinklers in Small Compartments in Design Area [ft² (m²)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light hazard–wet pipe system</td>
<td>1500 (139)</td>
</tr>
<tr>
<td>Light hazard–dry pipe system</td>
<td>1950 (181)</td>
</tr>
<tr>
<td>Ordinary hazard–wet pipe system</td>
<td>1500 (139)</td>
</tr>
<tr>
<td>Ordinary hazard–dry pipe system</td>
<td>1950 (181)</td>
</tr>
<tr>
<td>Extra hazard–wet pipe system</td>
<td>2500 (232)</td>
</tr>
<tr>
<td>Extra hazard–dry pipe system</td>
<td>3250 (300)</td>
</tr>
</tbody>
</table>

23.4.4.7.2.1 [move to 19.5.4.7.2.1]
The sprinklers in these small compartments shall be capable of discharging the minimum density appropriate for the hazard they protect in accordance with Figure 11.2.3.1.1.

23.4.4.7.2.2 [move to 19.5.4.7.2.2]
The requirements of 23.4.4.7.2 shall only apply where the area of application is equal to or greater than the area shown in Table 23.4.4.7.2 for the appropriate hazard classification (including a 30 percent increase for dry pipe systems).

23.4.4.7.3 [move to 19.5.4.7.3]
The requirements of 23.4.4.7.1 to include every sprinkler in the design area shall not apply where sprinklers are provided above and below obstructions such as wide ducts or tables.

23.4.4.7.3.1 [move to 19.5.4.7.3.1]
Sprinklers under the obstruction shall not be required to be included in the hydraulic calculation of the ceiling sprinklers.

23.4.4.7.3.2 [move to 19.5.4.7.3.2]
Where the piping to sprinklers under obstructions follows the same sizing pattern as the branch lines, no additional hydraulic calculations shall be required for sprinklers under obstructions.

23.4.4.7.4 [move to 19.5.4.7.4]
Water demand of sprinklers installed in concealed spaces shall not be required to be added to the ceiling demand.

23.4.4.7.5 [move to 19.5.4.7.5]
Calculations shall begin at the hydraulically most remote sprinkler.

23.4.4.7.6 [move to 19.5.4.7.6]
The calculated pressure at each sprinkler shall be used to determine the discharge flow rate for that particular sprinkler.

23.4.4.7.7 [move to 19.5.4.7.7]
Where sprinklers are installed under a sloped ceiling, the area shall be calculated on a horizontal plane below the sprinklers.

23.4.4.8 Friction Loss. [move to 19.5.4.8]

23.4.4.8.1 [move to 19.5.4.8.1]
Pipe friction loss shall be calculated in accordance with the Hazen–Williams formula with $C$ values from Table 23.4.4.8.1, as follows:

1. Pipe, fittings, and devices such as valves, meters, flow switches in pipes 2 in. (50 mm) or less in size, and strainers shall be included, and elevation changes that affect the sprinkler discharge shall be calculated.
2. Tie-in drain piping shall not be included in the hydraulic calculations.
3. The loss for a tee or a cross shall be calculated where flow direction change occurs based on the equivalent pipe length of the piping segment in which the fitting is included.
4. The tee at the top of a riser nipple shall be included in the branch line, the tee at the base of a riser nipple shall be included in the riser nipple, and the tee or cross at a cross main–feed main junction shall be included in the cross main.
5. Fitting loss for straight-through flow in a tee or cross shall not be included.
6. The loss of reducing elbows based on the equivalent feet value of the smallest outlet shall be calculated.
7. The equivalent feet value for the standard elbow on any abrupt 90-degree turn, such as the screw-type pattern shall be used.
8. The equivalent feet value for the long-turn elbow on any sweeping 90-degree turn, such as a flanged, welded, or mechanical joint-elbow typeshall be used. (See Table 23.4.3.1.1.)
9. Friction loss shall be excluded for the fitting directly connected to a sprinkler.
10. Losses through a pressure-reducing valve shall be included based on the normal inlet pressure condition. Pressure loss data from the manufacturer's literature shall be used.

Table 23.4.4.8.1 Hazen–Williams $C$ Values

<table>
<thead>
<tr>
<th>Pipe or Tube</th>
<th>$C$ Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlined cast or ductile iron</td>
<td>100</td>
</tr>
<tr>
<td>Black steel (dry systems including preaction)</td>
<td>100</td>
</tr>
<tr>
<td>Black steel (wet systems including deluge)</td>
<td>120</td>
</tr>
<tr>
<td>Galvanized steel (dry systems including preaction)</td>
<td>100</td>
</tr>
<tr>
<td>Pipe or Tube</td>
<td>C Value*</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Galvanized steel (wet systems including deluge)</td>
<td>120</td>
</tr>
<tr>
<td>Plastic (listed) all</td>
<td>150</td>
</tr>
<tr>
<td>Cement-lined cast- or ductile iron</td>
<td>140</td>
</tr>
<tr>
<td>Copper tube, brass or stainless steel</td>
<td>150</td>
</tr>
<tr>
<td>Asbestos cement</td>
<td>140</td>
</tr>
<tr>
<td>Concrete</td>
<td>140</td>
</tr>
</tbody>
</table>

*The authority having jurisdiction is permitted to allow other C values.

23.4.4.8.2* [move to 19.5.4.8.2]
For antifreeze systems greater than 40 gal (150 L) in size, the pipe friction loss shall be calculated using the Darcy-Weisbach equation shown in 23.4.2.1.3 using a Moody diagram and $\varepsilon$-factors that are representative of aged pipe otherwise following the methodology presented in 23.4.4.8.1.

23.4.4.9* Orifice Plates. [move to 19.5.4.9]

23.4.4.9.1 [move to 19.5.4.9.1]
Orifice plates shall not be used for balancing the system.

23.4.4.9.2 [move to 19.5.4.9.2]
Unless the requirements of 23.4.4.9.3 or 23.4.4.9.4 are met, mixing of sprinklers of different K-factors by reducing the K-factor of adjacent sprinklers on the same branch line leading back to the main for the purpose of minimizing sprinkler over discharge shall not be permitted.

23.4.4.9.3 [move to 19.5.4.9.3]
Sprinklers with different K-factors shall be acceptable for special use such as exposure protection, small rooms or enclosures, or directional discharge. *(See 3.3.22 for definition of small rooms.)*

23.4.4.9.4 [move to 19.5.4.9.4]
Extended-coverage and residential sprinklers with a different K-factor shall be acceptable for part of the protection area where installed in accordance with their listing.

23.4.4.10* Pressures. [move to 19.5.4.10]

23.4.4.10.1 [move to 19.5.4.10.1]
When calculating flow from an orifice, the total pressure ($P_t$) shall be used, unless the calculation method of 23.4.4.10.2 is utilized.

23.4.4.10.2 [move to 19.5.4.10.2]
Use of the normal pressure ($P_n$) calculated by subtracting the velocity pressure from the total pressure shall be permitted. Where the normal pressure is used, it shall be used on all branch lines and cross mains where applicable.
23.4.4.10.3 [move to 19.5.4.10.3]
Flow from a sprinkler shall be calculated using the nominal K-factor except that the manufacturer's adjusted K-factors shall be utilized for dry-type sprinklers.

23.4.4.11 Minimum Operating Pressure. [move to 19.5.4.11]

23.4.4.11.1 [move to 19.5.4.11.1]
Minimum operating pressure of any sprinkler shall be 7 psi (0.5 bar).

23.4.4.11.2 [move to 19.5.4.11.2]
Where a higher minimum operating pressure for the desired application is specified in the listing of the sprinkler, this higher pressure shall be required.

23.4.4.12 Maximum Operating Pressure. [move to 19.5.4.12]
For extra hazard occupancies, palletized, solid-piled, bin box, back-to-back shelf storage, shelf storage, or rack storage, the maximum operating pressure of any sprinkler shall be 175 psi (12 bar).

23.4.5 In-Rack Sprinklers. [move to 19.5.5]

23.4.5.1 [move to 19.5.5.1]
Pipes to in-rack sprinklers shall be sized by hydraulic calculations.

23.4.5.2 being deleted with an FR
Water demand of sprinklers installed in racks shall be added to ceiling sprinkler water demand over the same protected area at the point of connection.

23.4.5.3 [deleted with an FR]
The demand shall be balanced to the higher pressure.

23.4.5.4 [move to 19.5.5.2]
Water demand of sprinklers installed in racks or water curtains shall be added to the ceiling sprinkler water demand at the point of connection. Demands shall be balanced to the higher pressure. (See Chapter 8.)

23.4.6 Hose Allowance. [move to 19.5.6]
Water allowance for outside hose shall be added to the sprinkler and inside hose requirement at the connection to the city water main or a yard hydrant, whichever is closer to the system riser.

23.5 Deluge Systems. [move to 19.6]
Open sprinkler and deluge systems shall be hydraulically calculated according to applicable standards.

23.6* Exposure Protection Sprinkler Systems. [move to 8.7.9]

23.6.1 [move to 8.7.9.1]
Exposure protection sprinkler systems shall be hydraulically calculated using Table 23.6.1 based on severity of exposure as indicated by a relative classification of guide number or other approved source.

### Table 23.6.1 Exposure Protection

<table>
<thead>
<tr>
<th>Exposure Severity</th>
<th>Guide Number</th>
<th>Level of Wall or Window Sprinklers</th>
<th>Minimum Nominal K-Factor</th>
<th>Discharge Coefficient (K-Factor)</th>
<th>Minimum Average Application Rate Over Protected Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Top 2 levels</td>
<td>2.8 (40)</td>
<td>2.8 (40)</td>
<td>0.20 8.1</td>
</tr>
<tr>
<td>Light 1.50 or</td>
<td>Top 2 levels</td>
<td>Next lower 2 levels</td>
<td>1.9 (27)</td>
<td>1.9 (27)</td>
<td>0.15 6.1</td>
</tr>
<tr>
<td>less</td>
<td></td>
<td>Next lower 2 levels</td>
<td>1.4 (20)</td>
<td>1.4 (20)</td>
<td>0.10 4.1</td>
</tr>
<tr>
<td>Moderate 1.5–2.20</td>
<td>Top 2 levels</td>
<td>Next lower 2 levels</td>
<td>5.6 (80)</td>
<td>5.6 (80)</td>
<td>0.30 12.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Next lower 2 levels</td>
<td>4.2 (60)</td>
<td>4.2 (60)</td>
<td>0.25 10.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Next lower 2 levels</td>
<td>2.8 (40)</td>
<td>2.8 (40)</td>
<td>0.20 8.1</td>
</tr>
<tr>
<td>Severe &gt;2.20</td>
<td>Top 2 levels</td>
<td>Next lower 2 levels</td>
<td>11.2 (161)</td>
<td>11.2 (161)</td>
<td>0.40 16.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Next lower 2 levels</td>
<td>8.0 (115)</td>
<td>8.0 (115)</td>
<td>0.35 14.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Next lower 2 levels</td>
<td>5.6 (80)</td>
<td>5.6 (80)</td>
<td>0.30 12.2</td>
</tr>
</tbody>
</table>

### Section B — Cornice Sprinklers

<table>
<thead>
<tr>
<th>Guide Number</th>
<th>Cornice Sprinkler Minimal Nominal K-Factor</th>
<th>Application Rate per Lineal Foot (gpm)</th>
<th>Application Rate per Lineal Meter (L/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.50 or less</td>
<td>2.8 (40)</td>
<td>0.75</td>
<td>9.3</td>
</tr>
<tr>
<td>&gt;1.51–2.20</td>
<td>5.6 (80)</td>
<td>1.50</td>
<td>18.6</td>
</tr>
<tr>
<td>&gt;2.20</td>
<td>11.2 (161)</td>
<td>3.00</td>
<td>37.3</td>
</tr>
</tbody>
</table>

23.6.2 [move to 8.7.9.2]  
In no case shall compliance with Table 23.6.1 result in a sprinkler discharge pressure below 7 psi (0.5 bar).
23.6.3 [move to 8.7.9.3]
Only half of the flow from upright, pendent, and other nondirectional sprinklers shall be used in
determining the minimum average application rate over the protected surface.

23.6.4 [move to 8.7.9.4]
The water supply shall be capable of simultaneously supplying the total demand of sprinklers
along an exposure to a maximum length of 300 ft (90 m). Where systems of open sprinklers are
used, the water supply shall be capable of simultaneously flowing all sprinklers that would flow
as part of all systems that could be actuated within any 300 ft (90 m) length.

23.6.5 [move to 8.7.9.5]
The water supply duration for an exposure protection sprinkler system shall be a minimum of
60 minutes.

23.6.6 [move to 8.7.9.6]
A level of window sprinklers as described in Table 23.6.1 shall be defined as a floor level of the
building being protected.

23.6.7 [move to 8.7.9.7]
Window sprinklers shall be permitted to cover more than 25 ft² (2.3 m²) of window area per
level.

23.6.7.1 [move to 8.7.9.7.1]
The starting pressure shall be calculated based on the application rate over 25 ft² (2.3 m²) of
window area as indicated in Table 23.6.1.

23.6.7.2 [move to 8.7.9.7.2]
The maximum spacing between window sprinklers shall not exceed 8 ft (2.4 m) unless listed for
a greater distance.

23.7 Pipe Schedules. [move to 19.8]
Pipe schedules shall not be used, except in existing systems and in new systems or extensions to
existing systems described in Chapter 11. Water supplies shall conform to 11.2.2.

23.7.1* General. [move to 19.8.1]

23.7.1.1 [move to 19.8.1.1]
The pipe schedule sizing provisions shall not apply to hydraulically calculated systems.

23.7.1.2 [move to 19.8.1.2]
Sprinkler systems having sprinklers with K-factors other than 5.6 nominal, listed piping material
other than that covered in Table 6.3.1.1, extra hazard Group 1 and Group 2 systems, and
exposure protection systems shall be hydraulically calculated.

23.7.1.3 [move to 19.8.1.3]
The number of automatic sprinklers on a given pipe size on one floor shall not exceed the number given in 23.7.2, 23.7.3, or 23.7.4 for a given occupancy.

23.7.1.4* Size of Risers. [move to 19.8.1.4]
Each system riser shall be sized to supply all sprinklers on the riser on any one floor as determined by the standard schedules of pipe sizes in 23.7.2, 23.7.3, or 23.7.4.

23.7.1.5 Slatted Floors, Large Floor Openings, Mezzanines, and Large Platforms. [move to 19.8.1.5]
Buildings having slatted floors or large unprotected floor openings without approved stops shall be treated as one area with reference to pipe sizes, and the feed mains or risers shall be of the size required for the total number of sprinklers.

23.7.1.6 Stair Towers. [move to 19.8.1.6]
Stair towers, or other construction with incomplete floors, if piped on independent risers, shall be treated as one area with reference to pipe sizes.

23.7.2 Schedule for Light Hazard Occupancies. [move to 19.8.2]

23.7.2.1 Branch Lines. [move to 19.8.2.1]

23.7.2.1.1 [move to 19.8.2.1.1]
Unless permitted by 23.7.2.1.2 or 23.7.2.1.3, branch lines shall not exceed eight sprinklers on either side of a cross main.

23.7.2.1.2 [move to 19.8.2.1.2]
Where more than eight sprinklers on a branch line are necessary, lines shall be permitted to be increased to nine sprinklers by making the two end lengths 1 in. (25 mm) and 1 1/4 in. (32 mm), respectively, and the sizes thereafter standard.

23.7.2.1.3 [move to 19.8.2.1.3]
Ten sprinklers shall be permitted to be placed on a branch line, making the two end lengths 1 in. (25 mm) and 1 1/4 in. (32 mm), respectively, and feeding the tenth sprinkler by a 2 1/2 in. (65 mm) pipe.

23.7.2.2 Pipe Sizes. [move to 19.8.2.2]

23.7.2.2.1 [move to 19.8.2.2.1]
Pipe sizes shall be in accordance with Table 23.7.2.2.1.

Table 23.7.2.2.1 Light Hazard Pipe Schedules

<table>
<thead>
<tr>
<th>Steel</th>
<th>Copper</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in. (25 mm)</td>
<td>1 in. (25 mm)</td>
</tr>
<tr>
<td>1 1/4 in. (32 mm)</td>
<td>1 1/4 in. (32 mm)</td>
</tr>
<tr>
<td>1 1/2 in. (40 mm)</td>
<td>1 1/2 in. (40 mm)</td>
</tr>
<tr>
<td>2 in. (50 mm)</td>
<td>2 in. (50 mm)</td>
</tr>
<tr>
<td>Steel</td>
<td>Copper</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>21/2 in. (65 mm)</td>
<td>21/2 in. (65 mm)</td>
</tr>
<tr>
<td>30 sprinklers</td>
<td>40 sprinklers</td>
</tr>
<tr>
<td>3 in. (80 mm)</td>
<td>3 in. (80 mm)</td>
</tr>
<tr>
<td>60 sprinklers</td>
<td>65 sprinklers</td>
</tr>
<tr>
<td>31/2 in. (90 mm)</td>
<td>31/2 in. (90 mm)</td>
</tr>
<tr>
<td>100 sprinklers</td>
<td>115 sprinklers</td>
</tr>
<tr>
<td>4 in. (100 mm)</td>
<td>4 in. (100 mm)</td>
</tr>
<tr>
<td>See Section 8.2</td>
<td>See Section 8.2</td>
</tr>
</tbody>
</table>

23.7.2.2 [move to 19.8.2.2.2]
Each area requiring more sprinklers than the number specified for 31/2 in. (90 mm) pipe in Table 23.7.2.2.1 and without subdividing partitions (not necessarily fire walls) shall be supplied by mains or risers sized for ordinary hazard occupancies.

23.7.2.3 [move to 19.8.2.3]
Where sprinklers are installed above and below ceilings in accordance with Figure 23.7.2.3(a) through Figure 23.7.2.3(c), and such sprinklers are supplied from a common set of branch lines or separate branch lines from a common cross main, such branch lines shall not exceed eight sprinklers above and eight sprinklers below any ceiling on either side of the cross main.

Figure 23.7.2.3(a) Arrangement of Branch Lines Supplying Sprinklers Above and Below Ceiling.

Figure 23.7.2.3(b) Sprinkler on Riser Nipple from Branch Line in Lower Fire Area.
Figure 23.7.2.3(c) Arrangement of Branch Lines Supplying Sprinklers Above, Between, and Below Ceilings.
23.7.2.4 [move to 19.8.2.4]
Unless the requirements of 23.7.2.5 are met, pipe sizing up to and including 2 1/2 in. (65 mm) shall be as shown in Table 23.7.2.4 utilizing the greatest number of sprinklers to be found on any two adjacent levels.

Table 23.7.2.4 Number of Sprinklers Above and Below Ceiling

<table>
<thead>
<tr>
<th>Steel</th>
<th>Copper</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in. (25 mm)</td>
<td>1 in. (25 mm)</td>
</tr>
<tr>
<td>1 1/4 in. (32 mm)</td>
<td>1 1/4 in. (32 mm)</td>
</tr>
<tr>
<td>1 1/2 in. (40 mm)</td>
<td>1 1/2 in. (40 mm)</td>
</tr>
<tr>
<td>2 in. (50 mm)</td>
<td>2 in. (50 mm)</td>
</tr>
</tbody>
</table>

A ≥ 3D
23.7.2.5 [move to 19.8.2.5]
Branch lines and cross mains supplying sprinklers installed entirely above or entirely below ceilings shall be sized in accordance with Table 23.7.2.2.1.

23.7.2.6* [move to 19.8.2.6]
Where the total number of sprinklers above and below a ceiling exceeds the number specified in Table 23.7.2.4 for 2 1/2 in. (65 mm) pipe, the pipe supplying such sprinklers shall be increased to 3 in. (75 mm) and sized thereafter according to the schedule shown in Table 23.7.2.4 for the number of sprinklers above or below a ceiling, whichever is larger.

23.7.3 Schedule for Ordinary Hazard Occupancies. [move to 19.8.3]

23.7.3.1 [move to 19.8.3.1]
Unless permitted by 23.7.3.2 or 23.7.3.3, branch lines shall not exceed eight sprinklers on either side of a cross main.

23.7.3.2 [move to 19.8.3.2]
Where more than eight sprinklers on a branch line are necessary, lines shall be permitted to be increased to nine sprinklers by making the two end lengths 1 in. (25 mm) and 1 1/4 in. (32 mm), respectively, and the sizes thereafter standard.

23.7.3.3 [move to 19.8.3.3]
Ten sprinklers shall be permitted to be placed on a branch line, making the two end lengths 1 in. (25 mm) and 1 1/4 in. (32 mm), respectively, and feeding the tenth sprinkler by a 2 1/2 in. (65 mm) pipe.

23.7.3.4 [move to 19.8.3.4]
Pipe sizes shall be in accordance with Table 23.7.3.4.

Table 23.7.3.4 Ordinary Hazard Pipe Schedule

<table>
<thead>
<tr>
<th>Steel</th>
<th>Copper</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in. (25 mm)</td>
<td>1 in. (25 mm)</td>
</tr>
<tr>
<td>1/4 in. (32 mm)</td>
<td>1/4 in. (32 mm)</td>
</tr>
<tr>
<td>1/2 in. (40 mm)</td>
<td>1/2 in. (40 mm)</td>
</tr>
<tr>
<td>2 in. (50 mm)</td>
<td>2 in. (50 mm)</td>
</tr>
<tr>
<td>2 1/2 in. (65 mm)</td>
<td>2 1/2 in. (65 mm)</td>
</tr>
<tr>
<td>3 in. (80 mm)</td>
<td>3 in. (80 mm)</td>
</tr>
<tr>
<td>3 1/2 in. (90 mm)</td>
<td>3 1/2 in. (90 mm)</td>
</tr>
<tr>
<td>4 in. (100 mm)</td>
<td>4 in. (100 mm)</td>
</tr>
<tr>
<td>5 in. (125 mm)</td>
<td>5 in. (125 mm)</td>
</tr>
<tr>
<td>6 in. (150 mm)</td>
<td>6 in. (150 mm)</td>
</tr>
</tbody>
</table>
23.7.3.5 [move to 19.8.3.5]
Where the distance between sprinklers on the branch line exceeds 12 ft (3.7 m) or the distance between the branch lines exceeds 12 ft (3.7 m), the number of sprinklers for a given pipe size shall be in accordance with Table 23.7.3.5.

<table>
<thead>
<tr>
<th>Steel</th>
<th>Copper</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 in. (200 mm)</td>
<td>See Section 8.2</td>
</tr>
<tr>
<td>8 in. (200 mm)</td>
<td>See Section 8.2</td>
</tr>
</tbody>
</table>

Table 23.7.3.5 Number of Sprinklers — Greater Than 12 ft (3.7 m) Separations

<table>
<thead>
<tr>
<th>Steel</th>
<th>Copper</th>
</tr>
</thead>
<tbody>
<tr>
<td>21/2 in. (65 mm)</td>
<td>15 sprinklers</td>
</tr>
<tr>
<td>3 in. (80 mm)</td>
<td>30 sprinklers</td>
</tr>
<tr>
<td>31/2 in. (90 mm)</td>
<td>60 sprinklers</td>
</tr>
<tr>
<td>21/2 in. (65 mm)</td>
<td>20 sprinklers</td>
</tr>
<tr>
<td>3 in. (80 mm)</td>
<td>35 sprinklers</td>
</tr>
<tr>
<td>31/2 in. (90 mm)</td>
<td>65 sprinklers</td>
</tr>
</tbody>
</table>

Note: For other pipe and tube sizes, see Table 22.5.3.4.

23.7.3.6 [move to 19.8.3.6]
Where sprinklers are installed above and below ceilings and such sprinklers are supplied from a common set of branch lines or separate branch lines supplied by a common cross main, such branch lines shall not exceed eight sprinklers above and eight sprinklers below any ceiling on either side of the cross main.

23.7.3.7 [move to 19.8.3.7]
Pipe sizing up to and including 3 in. (76 mm) shall be as shown in Table 23.7.3.7 in accordance with Figure 23.7.2.3(a), Figure 23.7.2.3(b), and Figure 23.7.2.3(c) utilizing the greatest number of sprinklers to be found on any two adjacent levels.

<table>
<thead>
<tr>
<th>Steel</th>
<th>Copper</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in. (25 mm)</td>
<td>2 sprinklers</td>
</tr>
<tr>
<td>11/4 in. (32 mm)</td>
<td>4 sprinklers</td>
</tr>
<tr>
<td>11/2 in. (40 mm)</td>
<td>7 sprinklers</td>
</tr>
<tr>
<td>2 in. (50 mm)</td>
<td>15 sprinklers</td>
</tr>
<tr>
<td>21/2 in. (65 mm)</td>
<td>30 sprinklers</td>
</tr>
<tr>
<td>3 in. (80 mm)</td>
<td>60 sprinklers</td>
</tr>
<tr>
<td>1 in. (25 mm)</td>
<td>2 sprinklers</td>
</tr>
<tr>
<td>11/4 in. (32 mm)</td>
<td>4 sprinklers</td>
</tr>
<tr>
<td>11/2 in. (40 mm)</td>
<td>7 sprinklers</td>
</tr>
<tr>
<td>2 in. (50 mm)</td>
<td>18 sprinklers</td>
</tr>
<tr>
<td>21/2 in. (65 mm)</td>
<td>40 sprinklers</td>
</tr>
<tr>
<td>3 in. (80 mm)</td>
<td>65 sprinklers</td>
</tr>
</tbody>
</table>

23.7.3.8 [move to 19.8.3.8]
Branch lines and cross mains supplying sprinklers installed entirely above or entirely below ceilings shall be sized in accordance with Table 23.7.3.4 or Table 23.7.3.5.

23.7.3.9* [move to 19.8.3.9]
Where the total number of sprinklers above and below a ceiling exceeds the number specified in Table 23.7.3.7 for 3 in. (75 mm) pipe, the pipe supplying such sprinklers shall be increased to 31/2 in. (90 mm) and sized thereafter according to the schedule shown in Table 23.7.3.5 or Table 23.7.3.4 for the number of sprinklers above or below a ceiling, whichever is larger.
23.7.3.10 [move to 19.8.3.10]
Where the distance between the sprinklers protecting the occupied area exceeds 12 ft (3.7 m) or
the distance between the branch lines exceeds 12 ft (3.7 m), the branch lines shall be sized in
accordance with either Table 23.7.3.5, taking into consideration the sprinklers protecting the
occupied area only, or Table 23.7.3.7, whichever requires the greater size of pipe.

23.7.4* Extra Hazard Occupancies. [move to 19.8.4]
Extra hazard occupancies shall be hydraulically calculated.
First Revision No. 652-NFPA 13-2016 [ Global Input ]

See attached file for the reorganization of existing Chapter 24.

Supplemental Information

<table>
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<th>Description</th>
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</tr>
</tbody>
</table>

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Aug 05 17:38:26 EDT 2016

Committee Statement

Committee Statement: Chapter 24 is simply a renumber exercise from Chapter 21 of the 2016 edition.

Response Message:
Chapter 24  Water Supplies

24.1  General. [move to 5.1]

24.1.1  Number of Supplies. [move to 5.1.1]
Every automatic sprinkler system shall have at least one automatic water supply.

24.1.2  Capacity. [move to 5.1.2]
Water supplies shall be capable of providing the required flow and pressure for the remote design area determined using the requirements and procedures as specified in Chapters 11 through 22 including hose stream allowance where applicable for the required duration.

24.1.3*  Size of Fire Mains. [move to 5.1.3]

24.1.3.1  [move to 5.1.3.1]
Except as provided in 24.1.3.2 or 24.1.3.3, no pipe smaller than 6 in. (150 mm) in diameter shall be installed as a private service main.

24.1.3.2  [move to 5.1.3.2]
For mains that do not supply hydrants, sizes smaller than 6 in. (150 mm) shall be permitted to be used subject to the following restrictions:
(1) The main supplies only automatic sprinkler systems, open sprinkler systems, water spray fixed systems, foam systems, or Class II standpipe systems.
(2) Hydraulic calculations show that the main will supply the total demand at the appropriate pressure. Systems that are not hydraulically calculated shall have a main at least as large as the system riser.

24.1.3.3  [move to 5.1.3.3]
Where a single main less than 4 in. (100 mm) in diameter serves both fire systems and other uses, the non-fire demand shall be added to the hydraulic calculations for the fire system at the point of connection unless provisions have been made to automatically isolate the non-fire demand during a fire event.

24.1.4  Underground Supply Pipe. [move to 5.1.4]
For pipe schedule systems, the underground supply pipe shall be at least as large as the system riser.

24.1.5*  Water Supply Treatment.  [move to 5.1.5]

24.1.5.1  [move to 5.1.5.1]
Water supplies and environmental conditions shall be evaluated for the existence of microbes and conditions that contribute to microbiologically influenced corrosion (MIC). Where conditions are found that contribute to MIC, the owner(s) shall notify the sprinkler system installer and a plan shall be developed to treat the system using one of the following methods:
(1) Install a water pipe that will not be affected by the MIC microbes
(2) Treat all water that enters the system using an approved biocide
(3) Implement an approved plan for monitoring the interior conditions of the pipe at established
time intervals and locations
(4) Install corrosion monitoring station and monitor at established intervals

24.1.5.2 [move to 5.1.5.2]
Water supplies and environmental conditions shall be evaluated for conditions that contribute to
unusual corrosive properties. Where conditions are found that contribute to unusual corrosive
properties, the owner(s) shall notify the sprinkler system installer and a plan shall be developed
to treat the system using one of the following methods:
(1) Install a water pipe that is corrosion resistant
(2) Treat all water that enters the system using an approved corrosion inhibitor
(3) Implement an approved plan for monitoring the interior conditions of the pipe at established
intervals and locations
(4) Install corrosion monitoring station and monitor at established intervals

24.1.5.3 [move to 5.1.5.3]
Where listed biocides and/or corrosion inhibitors are used, they shall be compatible with system
components. Where used together, they shall also be compatible with each other.

24.1.6 Arrangement. [move to 5.1.6]

24.1.6.1 Connection Between Underground and Aboveground Piping. [move to 5.1.6.1]

24.1.6.1.1 [move to 5.1.6.1.1]
The connection between the system piping and underground piping shall be made with a suitable
transition piece and shall be properly strapped or fastened by approved devices.

24.1.6.1.2 [move to 5.1.6.1.2]
Where required due to specific mechanical or environmental conditions, the transition piece shall
be protected against possible damage from corrosive agents, solvent attack, or mechanical
damage.

24.1.6.2* Connection Passing Through or Under Foundation Walls. [move to 5.1.6.2]
When system piping pierces a foundation wall below grade or is located under the foundation
wall, clearance shall be provided to prevent breakage of the piping due to building settlement.

24.1.7* Meters. [move to 5.1.7]
Where meters are required by other authorities, they shall be listed.

24.1.8* Connection from Waterworks System. [move to 5.1.8]

24.1.8.1 [move to 5.1.8.1]
The requirements of the public health authority having jurisdiction shall be determined and
followed.

24.1.8.2 [move to 5.1.8.2]
Where equipment is installed to guard against possible contamination of the public water system, such equipment and devices shall be listed for fire protection service.

24.2 Types. [move to 5.2]

24.2.1* [move to 5.2.1]
Water supplies for sprinkler systems shall be one of the following or any combination:

1) A connection to an approved public or private waterworks system in accordance with 24.2.2
2) A connection including a fire pump in accordance with 24.2.3
3) A connection to a water storage tank at grade or below grade installed in accordance with NFPA 22 and filled from an approved source
4) A connection to a pressure tank in accordance with 24.2.4 and filled from an approved source
5) A connection to a gravity tank in accordance with 24.2.5 and filled from an approved source
6) A penstock, flume, river, lake, pond, or reservoir in accordance with 24.2.6
7) *A source of recycled or reclaimed water where the building owner (or their agent) has analyzed the source of the water and the treatment process (if any) that the water undergoes before being made available to the sprinkler system and determined that any materials, chemicals, or contaminants in the water will not be detrimental to the components of the sprinkler system it comes in contact with

24.2.2* Connections to Waterworks Systems. [move to 5.2.2]

24.2.2.1 [move to 5.2.2.1]
A connection to a reliable waterworks system shall be an acceptable water supply source.

24.2.2.2* [move to 5.2.2.2.]
The volume and pressure of a public water supply shall be determined from waterflow test data or other approved method.

24.2.3* Pumps. [move to 5.2.3]
A single automatically controlled fire pump installed in accordance with NFPA 20 shall be an acceptable water supply source.

24.2.4 Pressure Tanks. [move to 5.2.4]

24.2.4.1 Acceptability. [move to 5.2.4.1]

24.2.4.1.1 [move to 5.2.4.1.1]
A pressure tank installed in accordance with NFPA 22 shall be an acceptable water supply source.

24.2.4.1.2 [move to 5.2.4.1.2]
Pressure tanks shall be provided with an approved means for automatically maintaining the required air pressure.
24.2.4.1.3 [move to 5.2.4.1.3]
Where a pressure tank is the sole water supply, an approved trouble alarm shall also be provided to indicate low air pressure and low water level with the alarm supplied from an electrical branch circuit independent of the air compressor.

24.2.4.1.4 [move to 5.2.4.1.4]
Pressure tanks shall not be used to supply other than sprinklers and hand hose attached to sprinkler piping.

24.2.4.2 Capacity. [move to 5.2.4.2]

24.2.4.2.1 [move to 5.2.4.2.1]
In addition to the requirements of 24.1.2, the water capacity of a pressure tank shall include the extra capacity needed to fill dry pipe or preaction systems where installed.

24.2.4.2.2 [move to 5.2.4.2.2]
The total volume shall be based on the water capacity plus the air capacity required by 24.2.4.3.

24.2.4.3* Water Level and Air Pressure. [move to 5.2.4.3]

24.2.4.3.1 [move to 5.2.4.3.1]
Pressure tanks shall be kept with a sufficient supply of water to meet the demand of the fire protection system as calculated in Chapter 23 for the duration required by Chapter 11, Chapter 12, or Chapter 22.

24.2.4.3.2 [move to 5.2.4.3.2]
The pressure shall be sufficient to push all of the water out of the tank while maintaining the necessary residual pressure (required by Chapter 23) at the top of the system.

24.2.5 Gravity Tanks. [move to 5.2.5]
An elevated tank installed in accordance with NFPA 22 shall be an acceptable water supply source.

24.2.6 Penstocks, Flumes, Rivers, or Lakes. [move to 5.2.6]
Water supply connections from penstocks, flumes, rivers, lakes, or reservoirs shall be arranged to avoid mud and sediment and shall be provided with approved double removable screens or approved strainers installed in an approved manner.
See attached file for the reorganization of existing Chapter 25.

Supplemental Information

<table>
<thead>
<tr>
<th>File Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-Chapter_25.docx</td>
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</tr>
</tbody>
</table>

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [ Not Specified ]
Street Address:  
City:  
State:  
Zip:  
Submittal Date: Fri Aug 05 17:39:22 EDT 2016

Committee Statement

Committee Statement: Chapter 25 is new and consolidates all of the In-Rack sprinkler design criteria into one chapter, eliminating redundancy and confusion.
Chapter 25 Systems Acceptance

25.1 Approval of Sprinkler Systems and Private Fire Service Mains. [move to 27.1]
The installing contractor shall do the following:
(1) Notify the authority having jurisdiction and the property owner or the property owner's authorized representative of the time and date testing will be performed
(2) Perform all required acceptance tests (see Section 25.2)
(3) Complete and sign the appropriate contractor’s material and test certificate(s) (see Figure 25.1)
(4) Remove all caps and straps prior to placing the sprinkler system in service

Figure 25.1 Contractor’s Material and Test Certificate for Aboveground Piping.
## Contractor’s Material and Test Certificate for Aboveground Piping

**PROCEDURE**
Upon completion of work, inspection and tests shall be made by the contractor’s representative and witnessed by the property owner or their authorized agent. All defects shall be corrected and system left in service before contractor’s personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners, and contractor. If it is understood the owner’s representative’s signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority’s requirements or local ordinances.

<table>
<thead>
<tr>
<th>Property name</th>
<th>Date</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Plans</th>
<th>Accepted by approving authorities (names)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Address</td>
</tr>
<tr>
<td></td>
<td>Installation conforms to accepted plans</td>
</tr>
<tr>
<td></td>
<td>☐ Yes ☐ No</td>
</tr>
<tr>
<td></td>
<td>Equipment used is approved</td>
</tr>
<tr>
<td></td>
<td>☐ Yes ☐ No</td>
</tr>
<tr>
<td></td>
<td>If no, explain deviations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructions</th>
<th>Has person in charge of fire equipment been instructed as to location of control valves and care and maintenance of this new equipment?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>☐ Yes ☐ No</td>
</tr>
<tr>
<td></td>
<td>If no, explain</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Have copies of the following been left on the premises?</th>
<th>☐ Yes ☐ No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. System components instructions</td>
<td>☐ Yes ☐ No</td>
</tr>
<tr>
<td>2. Care and maintenance instructions</td>
<td>☐ Yes ☐ No</td>
</tr>
<tr>
<td>3. NFPA 25</td>
<td>☐ Yes ☐ No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location of system</th>
<th>Supplies buildings</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Sprinklers</th>
<th>Make</th>
<th>Model</th>
<th>Year of manufacture</th>
<th>Orifice size</th>
<th>Quantity</th>
<th>Temperature rating</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Pipe and fittings</th>
<th>Type of pipe</th>
<th>Type of fittings</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Alarm valve or flow indicator</th>
<th>Alarm device</th>
<th>Maximum time to operate through test connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Make</td>
<td>Model</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dry valve</th>
<th>Q. O. D.</th>
<th>Make</th>
<th>Model</th>
<th>Serial no.</th>
<th>Make</th>
<th>Model</th>
<th>Serial no.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Dry pipe operating test</th>
<th>Time to trip through test connection</th>
<th>Water pressure</th>
<th>Air pressure</th>
<th>Trip point air pressure</th>
<th>Time water reached test outlet</th>
<th>Alarm operated properly</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minutes</td>
<td>Seconds</td>
<td>psig</td>
<td>psig</td>
<td>psig</td>
<td>Minutes</td>
</tr>
<tr>
<td>Without O. O. D.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With O. O. D.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If no, explain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Notes:**

1. Measured from time inspector’s test connection is opened.
2. NFPA 13 only requires the 60-second limitation in specific sections.
<table>
<thead>
<tr>
<th>Operation</th>
<th>Pneumatic</th>
<th>Electric</th>
<th>Hydraulics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piping supervised</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Detecting media supervised</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Does valve operate from the manual trip, remote, or both control stations?

<table>
<thead>
<tr>
<th>Make</th>
<th>Model</th>
<th>Does each circuit operate supervision loss alarm?</th>
<th>Does each circuit operate valve release?</th>
<th>Maximum time to operate release</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Is there an accessible facility in each circuit for testing? If no, explain:

<table>
<thead>
<tr>
<th>Pressure-reducing valve test</th>
<th>Location and floor</th>
<th>Make and model</th>
<th>Setting</th>
<th>Static pressure</th>
<th>Residual pressure (flowing)</th>
<th>Flow rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inlet (psi)</td>
<td>Outlet (psi)</td>
<td>Inlet (psi)</td>
<td>Outlet (psi)</td>
<td>Flow (gpm)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Backflow device forward flow test</th>
<th>Indicate means used for forward flow test of backflow device:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>When means to test device was opened, was system flow demand created?</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
</tr>
</tbody>
</table>

Test description

Hydrostatic: Hydrostatic tests shall be made at not less than 200 psi (13.8 bar) for 2 hours or 50 psi (3.4 bar) above static pressure in excess of 150 psi (10.3 bar) for 2 hours. Differential dry pipe valve clappers shall be left open during the test to prevent damage. All aboveground piping leakage shall be stopped.

Pneumatic: Establish 40 psi (2.7 bar) air pressure and measure drop, which shall not exceed 1½ psi (0.1 bar) in 24 hours. Test pressure tanks at normal water level and air pressure and measure air pressure drop, which shall not exceed 1½ psi (0.1 bar) in 24 hours.

Tests

All piping hydrostatically tested at ________ psi (______ bar) for ________ hours

Dry piping pneumatically tested

Equipment operates properly

Yes | No

<table>
<thead>
<tr>
<th>Drain test</th>
<th>Reading of gauge located near water supply test connection:</th>
<th>Residual pressure with valve in test connection open wide.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>psi (______ bar)</td>
<td>psi (______ bar)</td>
</tr>
</tbody>
</table>

Underground mains and lead-in connections to system risers flushed before connection made to sprinkler piping

Verified by copy of the Contractor's Material and Test Certificate for Underground Piping

Plumbed by installer of underground sprinkler piping

Yes | No

If powder-driven fasteners are used in concrete, has representative sample testing been satisfactorily completed?

Yes | No

Blank testing gaskets

<table>
<thead>
<tr>
<th>Number used</th>
<th>Locations</th>
<th>Number removed</th>
</tr>
</thead>
</table>

Welding piping

Yes | No

If yes...

Do you certify as the sprinkler contractor that welding procedures used complied with the minimum requirements of AWS B2.1, ASME Section IX Welding and Brazing Qualifications, or other applicable qualification standard as required by the AHU?

Yes | No

Do you certify that all welding was performed by welders or welding operators qualified in accordance with the minimum requirements of AWS B2.1, ASME Section IX Welding and Brazing Qualifications, or other applicable qualification standard as required by the AHU?

Yes | No

Do you certify that the welding was conducted in compliance with a documented quality control procedure to ensure that (1) all discs are retrieved, (2) that openings in piping are smooth, that slag and other welding residue are removed, (3) the internal diameters of piping are not penetrated; (4) completed welds are free from cracks, incomplete fusion, surface porosity greater than 1/4 in. (1.6 mm) diameter, undersize deeper than the lesser of 25% of the wall thickness or 1/4 in. (0.6 mm); and (5) completed circumferential but weld reinforcement does not exceed 1/4 in. (2.4 mm)?

Yes | No

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NFPA 13 (p. 2 of 3)
### 25.2 Acceptance Requirements. [move to 27.2]

#### 25.2.1* Hydrostatic Tests. [move to 27.2.1]

#### 25.2.1.1 [move to 27.2.1.1]
Unless permitted by 25.2.1.2 through 25.2.1.5, all piping and attached appurtenances subjected to system working pressure shall be hydrostatically tested at 200 psi (13.8 bar) and shall maintain that pressure without loss for 2 hours.

25.2.1.2  [move to 27.2.1.2]
Portions of systems normally subjected to system working pressures in excess of 150 psi (10.3 bar) shall be tested as described in 25.2.1.1, at a pressure of 50 psi (3.4 bar) in excess of system working pressure.

25.2.1.3  [move to 27.2.1.3]
Where cold weather will not permit testing with water, an interim air test shall be permitted to be conducted as described in 25.2.2. This provision shall not remove or replace the requirement for conducting the hydrostatic test as described in 25.2.1.1.

25.2.1.4  [move to 28.7.1]
Modifications to existing piping systems shall require testing at system working pressure.

25.2.1.4.1  [move to 28.7.1.1]
Where modification is made to an existing system affecting more than 20 sprinklers, the new portion shall be isolated and tested at not less than 200 psi (13.8 bar) for 2 hours.

25.2.1.4.2  [move to 28.7.1.2]
Modifications that cannot be isolated, such as relocated drops, shall require testing at system working pressure.

25.2.1.5*  [move to 27.2.1.4]
The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested. The pressures in piping at higher elevations shall be permitted to be less than 200 psi (13.8 bar) when accounting for elevation losses. Systems or portions of systems that can be isolated shall be permitted to be tested separately.

25.2.1.6*  [move to 27.2.1.5]
Additives, corrosive chemicals such as sodium silicate, or derivatives of sodium silicate, brine, or similar acting chemicals shall not be used while hydrostatically testing systems or for stopping leaks.

25.2.1.7  [move to 27.2.1.6]
Piping between the exterior fire department connection and the check valve in the fire department inlet pipe shall be hydrostatically tested in the same manner as the balance of the system. After repair or replacement work affecting the fire department connection, the piping between the exterior and the check valve in the fire department inlet pipe shall be isolated and hydrostatically tested at 150 psi (10.3 bar).

25.2.1.8*  [move to 27.2.1.7]
When systems are being hydrostatically tested, tests shall be permitted to be conducted with pendent or horizontal sidewall sprinklers or plugs installed in fittings. Any plugs shall be replaced with pendent or horizontal sidewall sprinklers after the test is completed.

25.2.1.9 [move to 27.2.1.8]
When deluge systems are being hydrostatically tested, plugs shall be installed in fittings and replaced with open sprinklers after the test is completed, or the operating elements of automatic sprinklers shall be removed after the test is completed.

25.2.1.10 [move to 27.2.1.9]
Provision shall be made for the proper disposal of water used for flushing or testing.

25.2.1.11* Test Blanks. [move to 27.2.1.10]

25.2.1.11.1 [move to 27.2.1.10.1]
Test blanks shall have painted lugs protruding in such a way as to clearly indicate their presence.

25.2.1.11.2 [move to 27.2.1.10.2]
The test blanks shall be numbered, and the installing contractor shall have a recordkeeping method ensuring their removal after work is completed.

25.2.1.12 [move to 27.2.1.11]
When subject to hydrostatic test pressures, the clapper of a differential-type valve shall be held off its seat to prevent damaging the valve.

25.2.2 Dry Pipe and Double Interlock Preaction System(s) Air Test. [move to 27.2.2]

25.2.2.1 [move to 27.2.2.1]
In addition to the standard hydrostatic test, an air pressure leakage test at 40 psi (2.7 bar) shall be conducted for 24 hours. Any leakage that results in a loss of pressure in excess of 1 1/2 psi (0.1 bar) for the 24 hours shall be corrected.

25.2.2.1.1 [move to 28.7.2]
Modifications to existing systems shall be tested for air leakage using one of the following test methods:
(1) An air pressure test at 40 psi (2.7 bar) shall be performed for 2 hours.
   (a) The system shall be permitted to lose up to 3 psi (0.2 bar) during the duration of the test.
   (b) Air leaks shall be addressed if the system loses more than 3 psi (0.2 bar) during this test.
(2) With the system at normal system air pressure, the air source shall be shut off for 4 hours. If the low pressure alarm goes off within this period, the leaks shall be addressed.

25.2.2.2 [move to 27.2.2.2]
Where systems are installed in spaces that are capable of being operated at temperatures below 32°F (0°C), air or nitrogen gas pressure leakage tests required in 25.2.2 shall be conducted at the lowest nominal temperature of the space.
25.2.3 System Operational Tests. [move to 27.2.3]

25.2.3.1 Waterflow Devices. [move to 27.2.3.1]
Waterflow detecting devices including the associated alarm circuits shall be flow tested through the inspector's test connection and shall result in an audible alarm on the premises within 5 minutes after such flow begins and until such flow stops.

25.2.3.2* Dry Pipe Systems. [move to 27.2.3.2]

25.2.3.2.1 [move to 27.2.3.2.1]
A working test of the dry pipe valve shall be made by opening the inspector's test connection.

25.2.3.2.2 [move to 27.2.3.2.2]
Where a quick opening device is present, the trip test described in 25.2.3.2.1 shall be sufficient to test the quick opening device as long as the device trips properly during the test.

25.2.3.2.3* [move to 27.2.3.2.3]
The test shall measure the time to trip the valve and the time for water to be discharged from the inspector's test connection. All times shall be measured from the time the inspector's test connection is completely opened.

25.2.3.2.3.1* [move to 27.2.3.2.3.1]
Dry systems calculated for water delivery in accordance with 7.2.3.6 shall be exempt from any specific delivery time requirement.

25.2.3.2.4 [move to 27.2.3.2.4]
The results shall be recorded using the contractor's material and test certificate for aboveground piping (see Figure 25.1) and the general information sign (see Figure A.25.6).

25.2.3.3 Deluge and Preaction Systems. [move to 27.2.3.3]

25.2.3.3.1 [move to 27.2.3.3.1]
The automatic operation of a deluge or preaction valve shall be tested in accordance with the manufacturer's instructions.

25.2.3.3.2 [move to 27.2.3.3.2]
The manual and remote control operation, where present, shall also be tested.

25.2.3.4 Main Drain Valves. [move to 27.2.3.4]

25.2.3.4.1 [move to 27.2.3.4.1]
The main drain valve shall be opened and remain open until the system pressure stabilizes.

25.2.3.4.2* [move to 27.2.3.4.2]
The static and residual pressures shall be recorded on the contractor's material and test certificate (see Figure 25.1) and the sprinkler system general information placard (see Figure A.25.6).
25.2.3.5 Operating Test for Control Valves. [move to 27.2.3.5]
All control valves shall be fully closed and opened under system water pressure to ensure proper operation.

25.2.4 Pressure-Reducing Valves. [move to 27.2.4]

25.2.4.1 Each pressure-reducing valve shall be tested upon completion of installation to ensure proper operation under flow and no-flow conditions.

25.2.4.2 Testing shall verify that the device properly regulates outlet pressure at both maximum and normal inlet pressure conditions.

25.2.4.3 The results of the flow test of each pressure-reducing valve shall be recorded on the contractor's material and test certificate (see Figure 25.1).

25.2.4.4 The results shall include the static and residual inlet pressures, static and residual outlet pressures, and the flow rate.

25.2.5 Backflow Prevention Assemblies. [move to 27.2.5]

25.2.5.1 The backflow prevention assembly shall be forward flow tested to ensure proper operation.

25.2.5.2 The minimum flow rate shall be the system demand, including hose stream allowance where applicable.

25.2.6 Exposure Systems. [move to 27.2.6]
Operating tests shall be made of exposure protection systems upon completion of the installation, where such tests do not risk water damage to the building on which they are installed or to adjacent buildings.

25.3 Circulating Closed Loop Systems. [move to 27.3]

25.3.1 For sprinkler systems with non–fire protection connections, additional information shall be appended to the contractor's material and test certificate for aboveground piping shown in Figure 25.1 as follows:
(1) Certification that all auxiliary devices, such as heat pumps, circulating pumps, heat exchangers, radiators, and luminaires, if a part of the system, have a pressure rating of at least 175 psi or 300 psi (12.1 bar or 20.7 bar) if exposed to pressures greater than 175 psi (12.1 bar).
(2) All components of sprinkler system and auxiliary system have been pressure tested as a composite system in accordance with 25.2.2.
(3) Waterflow tests have been conducted and waterflow alarms have operated while auxiliary equipment is in each of the possible modes of operation.
(4) With auxiliary equipment tested in each possible mode of operation and with no flow from sprinklers or test connection, waterflow alarm signals did not operate.
(5) Excess temperature controls for shutting down the auxiliary system have been properly field tested.

25.3.2 [move to 27.3.2]
Discharge tests of sprinkler systems with non–fire protection connections shall be conducted using system test connections described in 6.8.1.

25.3.3 [move to 27.3.3]
Pressure gauges shall be installed at critical points and readings shall be taken under various modes of auxiliary equipment operation.

25.3.4 [move to 27.3.4]
Waterflow alarm signals shall be responsive to discharge of water through system test pipes while auxiliary equipment is in each of the possible modes of operation.

25.4 Instructions. [move to 27.4]
The installing contractor shall provide the property owner or the property owner's authorized representative with the following:
(1) All literature and instructions provided by the manufacturer describing proper operation and maintenance of any equipment and devices installed
(2) NFPA 25

25.5* Hydraulic Design Information Sign. [move to 27.5]

25.5.1 [move to 27.5.1]
The installing contractor shall identify a hydraulically designed sprinkler system with a permanently marked weatherproof metal or rigid plastic sign secured with corrosion-resistant wire, chain, or other approved means. Such signs shall be placed at the alarm valve, dry pipe valve, preaction valve, or deluge valve supplying the corresponding hydraulically designed area.

25.5.2 [move to 27.5.2]
The sign shall include the following information:
(1) Location of the design area or areas
(2) Discharge densities over the design area or areas
(3) Required flow and residual pressure demand at the base of the riser
(4) Occupancy classification or commodity classification and maximum permitted storage height and configuration
(5) Hose stream allowance included in addition to the sprinkler demand
(6) The name of the installing contractor
25.6* General Information Sign. [move to 27.6]

25.6.1 [move to 27.6.1]
The installing contractor shall provide a general information sign used to determine system design basis and information relevant to the inspection, testing, and maintenance requirements required by NFPA 25.

25.6.1.1 [move to 27.6.1.1]
Such general information shall be provided with a permanently marked weatherproof metal or rigid plastic sign, secured with corrosion-resistant wire, chain, or other acceptable means.

25.6.1.2 [move to 27.6.1.2]
Such signs shall be placed at each system control riser, antifreeze loop, and auxiliary system control valve.

25.6.2 [move to 27.6.2]
The sign shall include the following information:
(1) Name and location of the facility protected
(2) Occupancy classification
(3) Commodity classification
(4) Presence of high-piled and/or rack storage
(5) Maximum height of storage planned
(6) Aisle width planned
(7) Encapsulation of pallet loads
(8) Presence of solid shelving
(9) Flow test data
(10) Presence of flammable/combustible liquids
(11) Presence of hazardous materials
(12) Presence of other special storage
(13) Location of venting valve
(14) Location of auxiliary drains and low point drains on dry pipe and preaction systems
(15) Original results of main drain flow test
(16) Original results of dry pipe and double interlock preaction valve test
(17) Name of installing contractor or designer
(18) Indication of presence and location of antifreeze or other auxiliary systems
(19) Where injection systems are installed to treat MIC or corrosion, the type of chemical, concentration of the chemical, and where information can be found as to the proper disposal of the chemical
See attached file for the reorganization of existing Chapter 26.

<table>
<thead>
<tr>
<th>File Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
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Submitter Information Verification

- **Submitter Full Name:** AUT-SSD
- **Organization:** [Not Specified]
- **Street Address:**
- **City:**
- **State:**
- **Zip:**
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Committee Statement

- **Committee Statement:** Chapter 26 Formerly Chapter 22 of the 2016 edition.
- **Response Message:**
Chapter 26  Marine Systems

26.1 General. [move to 29.1]

26.1.1 [move to 29.1.1]
Chapter 26 outlines the deletions, modifications, and additions that shall be required for marine application. The applicability of Chapter 26 shall be determined by the authority having jurisdiction.

26.1.2 [move to 29.1.2]
All other requirements of this standard shall apply to merchant vessel systems except as modified by this chapter.

26.1.3 [move to 29.1.3]
The following definitions shall be applicable to this chapter (see Section 3.10):
(1) *A-Class Boundary* — A boundary designed to resist the passage of smoke and flame for 1 hour when tested in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*.
(2) *B-Class Boundary* — A boundary designed to resist the passage of flame for 1/2 hour when tested in accordance with ASTM E119.
(3) *Central Safety Station* — A continuously manned control station from which all of the fire control equipment is monitored. If this station is not the bridge, direct communication with the bridge shall be provided by means other than the ship's service telephone.
(4) *Heat-Sensitive Material* — A material whose melting point is below 1700°F (925°C).
(5) *Heel* — The inclination of a ship to one side.
(6) *Heel Angle* — The angle defined by the intersection of a vertical line through the center of a vessel and a line perpendicular to the surface of the water.
(7) *International Shore Connection* — A universal connection to the vessel's fire main to which a shoreside fire-fighting water supply can be connected.
(8) *Marine System* — A sprinkler system installed on a ship, boat, or other floating structure that takes its supply from the water on which the vessel floats.
(9) *Marine Thermal Barrier* — An assembly that is constructed of noncombustible materials and made intact with the main structure of the vessel, such as shell, structural bulkheads, and decks. A marine thermal barrier shall meet the requirements of a B-Class boundary. In addition, a marine thermal barrier shall be insulated such that, if tested in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, for 15 minutes, the average temperature of the unexposed side does not rise more than 250°F (120°C) above the original temperature, nor does the temperature at any one point, including any joint, rise more than 405°F (205°C) above the original temperature.
(10) *Supervision* — A visual and audible alarm signal given at the central safety station to indicate when the system is in operation or when a condition that would impair the satisfactory operation of the system exists. Supervisory alarms shall give a distinct indication for each individual system component that is monitored.
(11) *Survival Angle* — The maximum angle to which a vessel is permitted to heel after the assumed damage required by stability regulations is imposed.
(12) **Type 1 Stair** — A fully enclosed stair that serves all levels of a vessel in which persons can be employed.

(13) **Marine Water Supply** — The supply portion of the sprinkler system from the water pressure tank or the sea suction of the designated sprinkler system pump up to and including the valve that isolates the sprinkler system from these two water sources.

26.1.4* **Occupancy Classifications.** [move to 29.1.4]
Marine environment classifications shall be in accordance with Section 5.1.

26.1.5* **Partial Installations.** [move to 29.1.5]

26.1.5.1 [move to 29.1.5.1]
Partial installation of automatic sprinklers shall not be permitted, unless the requirements of 26.1.5.2 or 26.1.5.3 are met.

26.1.5.2 [move to 29.1.5.2]
Spaces shall be permitted to be protected with an alternative, approved fire suppression system where such areas are separated from the sprinklered areas with a 1 hour–rated assembly.

26.1.5.3 [move to 29.1.5.3]
The requirements of 26.1.5.1 shall not apply where specific sections of this standard permit the omission of sprinklers.

26.2 **System Components, Hardware, and Use.** [move to 29.2]

26.2.1* [move to 29.2.1]
Sprinklers shall have a K-factor of K-2.8 (40) or greater.

26.2.2* [move to 29.2.2]
Sprinkler piping penetrations shall be designed to preserve the fire integrity of the ceiling or bulkhead penetrated.

26.2.3 **Spare Sprinklers.** [move to 29.2.3]

26.2.3.1 [move to 29.2.3.1]
The required stock of spare sprinklers shall be carried for each type of sprinkler installed onboard the vessel.

26.2.3.2 [move to 29.2.3.2]
Where fewer than six sprinklers of a particular type are installed, 100 percent spares shall be kept in stock.

26.2.3.3 [move to 29.2.3.3]
Where applicable, at least one elastometric gasket shall be kept in the cabinet for each fire department connection that is installed onboard the vessel.
26.2.3.4  [move to 29.2.3.4]
The cabinet containing spare sprinklers, special wrenches, and elastometric gaskets shall be located in the same central safety station that contains the alarm annunciator panel(s) and supervisory indicators.

26.2.4  System Pipe and Fittings. [move to 29.2.4]

26.2.4.1*  [move to 29.2.4.1]
When ferrous materials are used for piping between the sea chest and zone control valves, these materials shall be protected against corrosion by hot dip galvanizing or by the use of Schedule 80 piping.

26.2.4.2  [move to 29.2.4.2]
Maximum design pressure for copper and brass pipe shall not exceed 250 psi (17.2 bar).

26.2.5  Pipe Support. [move to 29.2.5]

26.2.5.1*  [move to 29.2.5.1]
Pipe supports shall comply with the following:
(1) Pipe supports shall be designed to provide adequate lateral, longitudinal, and vertical sway bracing.
(2) The design shall account for the degree of bracing, which varies with the route and operation of the vessel.
(3) Bracing shall be designed to ensure the following:
(a) Slamming, heaving, and rolling will not shift sprinkler piping, potentially moving sprinklers above ceilings, bulkheads, or other obstructions.
(b) Piping and sprinklers will remain in place at a steady heel angle at least equal to the maximum required damaged survival angle.
(4) Pipe supports shall be welded to the structure.
(5) Hangers that can loosen during ship motion or vibration, such as screw-down-type hangers, shall not be permitted.
(6) Hangers that are listed for seismic use shall be permitted to be used in accordance with their listing.

26.2.5.2  [move to 29.2.5.2]
Sprinkler piping shall be supported by the primary structural members of the vessel such as beams, girders, and stiffeners.

26.2.5.3*  [move to 29.2.5.3]
The components of hanger assemblies that are welded directly to the ship structure shall not be required to be listed.

26.2.5.4*  [move to 29.2.5.4]
U-hook sizes shall be no less than that specified in Table 9.1.2.4.

26.2.6  Valves. [move to 29.2.6]
26.2.6.1* [move to 29.2.6.1]
All indicating, supply, and zone control valves shall be supervised open from a central safety station.

26.2.6.2 [move to 29.2.6.2]
Drain and test valves shall meet the applicable requirements of 46 CFR 56.20 and 56.60.

26.2.6.3 [move to 29.2.6.3]
Valve markings shall include the information required by 46 CFR 56.20-5(a).

26.2.7 Fire Department Connections and International Shore Connections. [move to 29.2.7]

26.2.7.1* [move to 29.2.7.1]
A fire department connection and an International Shore Connection shall be installed.

26.2.7.2 [move to 29.2.7.2]
The requirements for a fire department connection in 26.2.7.1 shall not apply to vessels that operate primarily on international voyages.

26.2.7.3 [move to 29.2.7.3]
Connections shall be located near the gangway or other shore access point so that they are accessible to the land-based fire department.

26.2.7.4 [move to 29.2.7.4]
Fire department and International Shore Connections shall be colored and marked so that the connections are easily located from the shore access point (i.e., gangway location) and will not be confused with a firemain connection.

26.2.7.5 [move to 29.2.7.5]
An 18 in. × 18 in. (450 mm × 450 mm) sign displaying the symbol for fire department connection as shown in Table 5.2.1 of NFPA 170 shall be placed at the connection so that it is in plain sight from the shore access point.

26.2.7.6 [move to 29.2.7.6]
Connections on both sides of the vessel shall be provided where shore access arrangements make it necessary.

26.2.7.7* [move to 29.2.7.7]
Fire department connection thread type shall be compatible with fire department equipment.

26.2.7.8 [move to 29.2.7.8]
26.3 System Requirements. [move to 29.3]

26.3.1* Relief Valves. [move to 29.3.1]
Relief valves shall be provided on all wet pipe systems.

26.3.2 Spare Detection Devices. [move to 29.3.2]
The number of spare detection devices or fusible elements used for protection systems that shall be carried per temperature rating is as follows:
(1) Vessels shall have two spare detection devices or fusible elements when operating voyages are normally less than 24 hours.
(2) Vessels shall have four spare detection devices or fusible elements when operating voyages are normally more than 24 hours.

26.3.3 System Piping Supervision. [move to 29.3.3]
All preaction sprinkler systems shall be supervised regardless of the number of sprinklers supplied.

26.3.4 Circulating Closed Loop Systems. [move to 29.3.4]
Circulating closed loop systems shall not be permitted.

26.4 Installation Requirements. [move to 29.4]

26.4.1 Temperature Zones. [move to 29.4.1]
Intermediate temperature–rated sprinklers shall be installed under a noninsulated steel deck that is exposed to sunlight.

26.4.2* Residential Sprinklers. [move to 29.4.2]
Residential sprinklers shall be permitted for use only in sleeping accommodation areas.

26.4.3 Window Protection. [move to 29.4.3]
Where required, windows shall be protected by sprinklers installed at a distance not exceeding 1 ft (300 mm) from the glazing at a spacing not exceeding 6 ft (1.8 m) such that the entire glazing surface is wetted at a linear density not less than 6 gpm/ft (75 mm/min), unless listed window sprinkler protection systems are installed in accordance with their installation and testing criteria.

26.4.4* Concealed Spaces. [move to 29.4.4]

26.4.4.1 [move to 29.4.4.1]
Concealed spaces that are constructed of combustible materials, or materials with combustible finishes or that contain combustible materials, shall be sprinklered.

26.4.4.2 [move to 29.4.4.2]
The requirements of 26.4.4.1 shall not apply to concealed spaces that contain only nonmetallic piping that is continuously filled with water.
26.4.5 Vertical Shafts. [move to 29.4.5]

26.4.5.1 [move to 29.4.5.1]
Sprinklers shall not be required in vertical shafts used as duct, electrical, or pipe shafts that are nonaccessible, noncombustible, and enclosed in an A-Class-rated assembly.

26.4.5.2 [move to 29.4.5.2]
Stairway enclosures shall be fully sprinklered.

26.4.6 Bath Modules. [move to 29.4.6]
Sprinklers shall be installed in bath modules (full room modules) constructed with combustible materials, regardless of room fire load.

26.4.7 Ceiling Types. [move to 29.4.7]
Drop-out ceilings shall not be used in conjunction with sprinklers.

26.4.8 Return Bends. [move to 29.4.8]

26.4.8.1 [move to 29.4.8.1]
To prevent sediment buildup, return bends shall be installed in all shipboard sprinkler systems where pendent-type or dry pendent-type sprinklers are used in wet systems (see Figure 8.15.19.2).

26.4.8.2 [move to 29.4.8.2]
Consideration shall be given concerning the intrusion of saltwater into the system.

26.4.8.3 [move to 29.4.8.3]
Specifically, sprinklers shall not be rendered ineffective by corrosion related to saltwater entrapment within the return bend.

26.4.9 Hose Connections. [move to 29.4.9]
Sprinkler system piping shall not be used to supply hose connections or hose connections for fire department use.

26.4.10 Heat-Sensitive Piping Materials. [move to 29.4.10]

26.4.10.1 [move to 29.4.10.1]
Portions of the piping system constructed with a heat-sensitive material shall be subject to the following restrictions:
(1) Piping shall be of non–heat-sensitive type from the sea suction up through the penetration of the last A-Class barrier enclosing the space(s) in which the heat-sensitive piping is installed.
(2) B-Class draft stops shall be fitted not more than 45 ft (14 m) apart between the marine thermal barrier (see definitions in Chapter 3 and 26.1.3) and the deck or shell.
(3) Portions of a system that are constructed from heat-sensitive materials shall be installed behind a marine thermal barrier, unless the provisions of item (4) are met.
(4) *Piping materials with brazed joints shall not be required to be installed behind a marine thermal barrier, provided the following conditions are met:
(a) The system is of the wet pipe type.
(b) The piping is not located in spaces containing boilers, internal combustion engines, or piping containing flammable or combustible liquids or gases under pressure, cargo holds, or vehicle decks.
(c) A relief valve in compliance with 7.1.2 is installed in each section of piping that is capable of being isolated by a valve(s).
(d) A valve(s) isolating the section of piping from the remainder of the system is installed in accordance with 26.4.10.2 and 26.4.10.3.

26.4.10.2 [move to 29.4.10.2]
Each zone in which heat-sensitive piping is installed shall be fitted with a valve capable of segregating that zone from the remainder of the system.

26.4.10.3 [move to 29.4.10.3]
The valve shall be supervised and located outside of the zone controlled and within an accessible compartment having A-Class boundaries or within a Type 1 stair.

26.4.11 Discharge of Drain Lines. [move to 29.4.11]

26.4.11.1 [move to 29.4.11.1]
Drain lines shall not be connected to housekeeping, sewage, or deck drains. Drains shall be permitted to be discharged to bilges.

26.4.11.2 [move to 29.4.11.2]
Overboard discharges shall meet the requirements of 46 CFR 56.50-95 and shall be corrosion resistant in accordance with 46 CFR 56.60.

26.4.11.3 [move to 29.4.11.3]
Systems that contain water additives that are not permitted to be discharged into the environment shall be specially designed to prevent such discharge.

26.4.11.4 [move to 29.4.11.4]
Discharges shall be provided with a down-turned elbow.

26.4.12 Alarm Signals and Devices. [move to 29.4.12]

26.4.12.1* [move to 29.4.12.1]
A visual and audible alarm signal shall be given at the central safety station to indicate when the system is in operation or when a condition that would impair the satisfactory operation of the system exists.

26.4.12.2 [move to 29.4.12.2]
Alarm signals shall be provided for, but not limited to, each of the following: monitoring position of control valves, fire pump power supplies and operating condition, water tank levels and temperatures, zone waterflow alarms, pressure of tanks, and air pressure on dry pipe valves.

26.4.12.3 [move to 29.4.12.3]
Alarms shall give a distinct indication for each individual system component that is monitored.

26.4.12.4 [move to 29.4.12.4]
An audible alarm shall be given at the central safety station within 30 seconds of waterflow.

26.4.12.5 [move to 29.4.12.5]
Waterflow alarms shall be installed for every zone of the sprinkler system.

26.4.12.6 [move to 29.4.12.6]
Sprinkler zones shall not encompass more than two adjacent decks or encompass more than one main vertical zone.

26.4.12.7 [move to 29.4.12.7]
Electrically operated alarm attachments shall comply with, meet, and be installed in accordance with the requirements of 46 CFR, Subchapter J, “Electrical Engineering.”

26.4.12.8 [move to 29.4.12.8]
All wiring shall be chosen and installed in accordance with IEEE 45, *Recommended Practice for Electrical Installations on Shipboard*.

26.4.13 Test Connections. [move to 29.4.13]
Where test connections are below the bulkhead deck, they shall comply with the overboard discharge arrangements of 46 CFR 56.50-95.

26.4.14 Protection of Copper Tubing. [move to 29.4.14]
Copper tubing materials shall be protected against physical damage in areas where vehicles and stores handling equipment operate.

26.5 Design Approaches. [move to 29.5]

26.5.1 Design Options. [move to 29.5.1]

26.5.1.1 [move to 29.5.1.1]
Marine sprinkler systems shall be designed using the hydraulic calculation procedure of Chapter 23.

26.5.1.2 [move to 29.5.1.2]
The pipe schedule method shall not be used to determine the water demand requirements.

26.5.2* Window Protection. [move to 29.5.2]
Minimum water demand requirements shall include sprinklers that are installed for the protection of windows as described in 26.4.3.

26.5.3* Hose Stream Allowance. [move to 29.5.3]
No allowance for hose stream use shall be required.

26.6 Plans and Calculations. [move to 29.6]

26.6.1 Additional Information. [move to 29.6.1]  
The pressure tank size, high-pressure relief setting, high- and low-water alarm settings, low-pressure alarm setting, and pump start pressure shall be provided.

26.6.2 [move to 29.6.2]  
Sprinklers specifically installed for the protection of windows under 26.4.3 shall be permitted to be of a different size from those protecting the remainder of the occupancy classification.

26.6.3 [move to 29.6.3]  
All of the window sprinklers, however, shall be of the same size.

26.6.4* [move to 29.6.4]  
Marine sprinkler systems shall be designed and installed to be fully operational without a reduction in system performance when the vessel is upright and inclined at the angles of inclination specified in 46 CFR 58.01-40.

26.7 Water Supplies. [move to 29.7]

26.7.1 General. [move to 29.7.1]  
The water supply requirements for marine applications shall be in accordance with Section 26.7.

26.7.2 Pressure Tank. [move to 29.7.2]

26.7.2.1 [move to 29.7.2.1]  
Unless the requirements of 26.7.2.2 are met, a pressure tank shall be provided. The pressure tank shall be sized and constructed so that the following occurs:
(1) The tank shall contain a standing charge of freshwater equal to that specified by Table 26.7.2.1.
(2) The pressure tank shall be sized in accordance with 24.2.4.
(3) A glass gauge shall be provided to indicate the correct level of water within the pressure tank.
(4) Arrangements shall be provided for maintaining an air pressure in the tank such that, while the standing charge of water is being expended, the pressure will not be less than that necessary to provide the design pressure and flow of the hydraulically most remote design area.
(5) Suitable means of replenishing the air under pressure and the freshwater standing charge in the tank shall be provided.
(6) Tank construction shall be in accordance with the applicable requirements of 46 CFR, Subchapter F, “Marine Engineering.”
### Table 26.7.2.1 Required Water Supply

<table>
<thead>
<tr>
<th>System Type</th>
<th>Additional Water Volume</th>
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<tr>
<td>Wet pipe system</td>
<td>Flow requirement of the hydraulically most remote system demand for 1 minute</td>
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<tr>
<td>Preaction system</td>
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<tr>
<td>Deluge system</td>
<td>Flow requirement of the hydraulically most remote system demand for 1 minute of system demand plus the volume needed to fill all dry piping</td>
</tr>
<tr>
<td>Dry pipe system</td>
<td></td>
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</tbody>
</table>

#### 26.7.2.2 Pressure Tank Alternative. [move to 29.7.2.2]

In lieu of a pressure tank, a dedicated pump connected to a freshwater tank shall be permitted to be used, provided the following conditions are met:

1. The pump is listed for marine use and is sized to meet the required system demand.
2. The suction for the fire pump is located below the suction for the freshwater system so that there shall be a minimum water supply of at least 1 minute for the required system demand.
3. Pressure switches are provided in the system and the controller for the pump that automatically start the pump within 10 seconds after detection of a pressure drop of more than 5 percent.
4. There shall be a reduced pressure zone backflow preventer to prevent contamination of the potable water system by saltwater.
5. This pump has at least two sources of power. Where the sources of power are electrical, these shall be a main generator and an emergency source of power. One supply shall be taken from the main switchboard, by separate feeder reserved solely for that purpose. This feeder shall be run to an automatic changeover switch situated near the sprinkler unit, and the switch shall normally be kept closed to the feeder from the emergency switchboard. The changeover switch shall be clearly labeled, and no other switch shall be permitted in these feeders.

#### 26.7.2.3 Relief Valves. [move to 29.7.2.3]

26.7.2.3.1 [move to 29.7.2.3.1]

Relief valves shall be installed on the tank to avoid overpressurization and false actuation of any dry pipe valve.

26.7.2.3.2 [move to 29.7.2.3.2]

Relief valves shall comply with 46 CFR 54.15-10.

#### 26.7.2.4 Power Source. [move to 29.7.2.4]

26.7.2.4.1 [move to 29.7.2.4.1]

There shall be not less than two sources of power for the compressors that supply air to the pressure tank.
26.7.2.4.2  Where the sources of power are electrical, these shall be a main generator and an emergency source of power.

26.7.2.4.3  One supply shall be taken from the main switchboard, by separate feeders reserved solely for that purpose.

26.7.2.4.4  Such feeders shall be run to a changeover switch situated near the air compressor, and the switch normally shall be kept closed to the feeder from the emergency switchboard.

26.7.2.4.5  The changeover switch shall be clearly labeled, and no other switch shall be permitted in these feeders.

26.7.2.5  Multiple Tanks.

26.7.2.5.1  More than one pressure tank can be installed, provided that each is treated as a single water source when determining valve arrangements.

26.7.2.5.2  Check valves shall be installed to prohibit flow from tank to tank or from pump to tank, unless the tank is designed to hold only pressurized air.

26.7.2.6  In systems subject to use with saltwater, valves shall be so arranged as to prohibit contamination of the pressure tank with saltwater.

26.7.2.7*  Where applicable, a means shall be provided to restrict the amount of air that can enter the pressure tank from the air supply system. A means shall also be provided to prevent water from backflowing into the air supply system.

26.7.3  Fire Pump.

26.7.3.1  A dedicated, automatically controlled pump that is listed for marine service, which takes suction from the sea, shall be provided to supply the sprinkler system.

26.7.3.2  Where two pumps are required to ensure the reliability of the water supply, the pump that supplies the fire main shall be allowed to serve as the second fire pump.

26.7.3.3*
The pump shall be sized to meet the water demand of the hydraulically most demanding area.

26.7.3.4  [move to 29.7.3.4]
Pumps shall be designed to not exceed 120 percent of the rated capacity of the pump.

26.7.3.5  [move to 29.7.3.5]
The system shall be designed so that, before the supply falls below the design criteria, the fire pump shall be automatically started and shall supply water to the system until manually shut off.

26.7.3.6  [move to 29.7.3.6]
Where pump and freshwater tank arrangement is used in lieu of the pressure tank, there must be a pressure switch that senses a system pressure drop of 25 percent, and the controller must automatically start the fire pump(s) if pressure is not restored within 20 seconds.

26.7.3.7  [move to 29.7.3.7]
There shall be not less than two sources of power supply for the fire pumps. Where the sources of power are electrical, these shall be a main generator and an emergency source of power.

26.7.3.8  [move to 29.7.3.8]
One supply shall be taken from the main switchboard by separate feeders reserved solely for that purpose.

26.7.3.9  [move to 29.7.3.9]
Such feeders shall be run to a changeover switch situated near to the sprinkler unit, and the switch normally shall be kept closed to the feeder from the emergency switchboard.

26.7.3.10  [move to 29.7.3.10]
The changeover switch shall be clearly labeled, and no other switch shall be permitted in these feeders.

26.7.3.11  Test Valves.  [move to 29.7.3.11]

26.7.3.11.1  [move to 29.7.3.11.1]
A test valve(s) shall be installed on the discharge side of the pump with a short open-ended discharge pipe.

26.7.3.11.2  [move to 29.7.3.11.2]
The area of the pipe shall be adequate to permit the release of the required water output to supply the demand of the hydraulically most remote area.

26.7.3.12  Multiple Pumps.  [move to 29.7.3.12]

26.7.3.12.1  [move to 29.7.3.12.1]
Where two fire pumps are required to ensure the reliability of the water supply, each fire pump shall meet the requirements of 26.7.3.1 through 26.7.3.4.
26.7.3.12.2  [move to 29.7.3.12.2]
In addition, a system that is required to have more than one pump shall be designed to accommodate the following features:
(1) *Pump controls and system sensors shall be arranged such that the secondary pump will automatically operate if the primary pump fails to operate or deliver the required water pressure and flow. [Figure A.26.7.3.12.2(1) is an example of an acceptable dual pump arrangement.]
(2) Both pumps shall be served from normal and emergency power sources. However, where approved by the authority having jurisdiction, the secondary pump shall be permitted to be nonelectrically driven.
(3) Pump failure or operation shall be indicated at the central safety station.

26.7.3.13*  [move to 29.7.3.13]
If not specifically prohibited, the fire pump that supplies the fire main shall be permitted to be used as the second pump, provided the following conditions are met:
(1) The pump is adequately sized to meet the required fire hose and sprinkler system pressure and flow demands simultaneously.
(2) The fire main system is segregated from the sprinkler system by a normally closed valve that is designed to automatically open upon failure of the designated fire pump.
(3) The fire pump that supplies the fire main is automatically started in the event of dedicated fire pump failure or loss of pressure in the sprinkler main. (See Figure A.26.7.3.13.)

26.7.4 Water Supply Configurations. [move to 29.7.4]

26.7.4.1  [move to 29.7.4.1]
The pressure tank and fire pump shall be located in a position reasonably remote from any machinery space of Category A.

26.7.4.2  [move to 29.7.4.2]
All valves within the water supply piping system shall be supervised.

26.7.4.3  [move to 29.7.4.3]
Only freshwater shall be used as the initial charge within the piping network.

26.7.4.4  [move to 29.7.4.4]
The sprinkler system shall be cross-connected with the ship's fire main system and fitted with a lockable screw-down nonreturn valve such that backflow from the sprinkler system to the fire main is prevented.

26.7.4.5  [move to 29.7.4.5]
The piping, tanks, and pumps that make up the water supply shall be installed in accordance with the applicable requirements of 46 CFR, Subchapter F, “Marine Engineering.”

26.7.4.6*  [move to 29.7.4.6]
When a shorewater supply is to be used during extended dockside periods, the water supply shall be qualified in the manner described in 24.2.2.
26.7.4.7 [move to 29.7.4.7]  Tests shall be conducted in accordance with the requirements of the local shore-based authority having jurisdiction.

26.7.4.8 [move to 29.7.4.8]  The water supply information listed in Section 23.2 shall then be provided to the authority having jurisdiction.

26.8 System Acceptance. [move to 29.8]

26.8.1 Hydrostatic Tests. [move to 29.8.1]  In addition to the interior piping, the test required by 25.2.1.7 shall also be conducted on all external water supply connections including international shore and fireboat connections.

26.8.2 Alarm Test. [move to 29.8.2]  A waterflow test shall result in an alarm at the central safety station within 30 seconds after flow through the test connection begins.

26.8.3 Operational Tests. [move to 29.8.3]

26.8.3.1 [move to 29.8.3.1]  Pressure tank and pump operation, valve actuation, and waterflow shall also be tested.

26.8.3.2 [move to 29.8.3.2]  Pump operation and performance shall be tested in accordance with Chapter 14 of NFPA 20.

26.9 System Instructions and Maintenance. [move to 29.9]

26.9.1 [move to 29.9.1]  Instructions for operation, inspection, maintenance, and testing shall be kept on the vessel.

26.9.2 [move to 29.9.2]  Records of inspections, tests, and maintenance required by NFPA 25 shall also be kept on the vessel.
First Revision No. 764-NFPA 13-2016 [Global Input]

See attached file for TIA 16-4

Supplemental Information

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Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Mon Aug 15 17:35:38 EDT 2016

Committee Statement

Committee Statement: NOTE: This public input originates from Tentative Interim Amendment No. 16-4 (Log 1184) issued by the Standards Council on August 18, 2015 and per the NFPA Regs., needs to be reconsidered by the Technical Committee for the next edition of the Document.

Response Message:

Public Input No. 134-NFPA 13-2016 [Global Input]
1. Revise Table A.5.6.3 to read as follows:

<table>
<thead>
<tr>
<th>Textile Materials/Products</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Cloth; natural fibers; baled</td>
<td>Class III</td>
</tr>
<tr>
<td>Cloth; synthetic cloth</td>
<td>Class IV</td>
</tr>
<tr>
<td>Clothing; natural fibers (e.g. wool, cotton) and viscose</td>
<td>Class III</td>
</tr>
<tr>
<td>Cotton; cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td>Diapers; cotton or linen</td>
<td>Class III</td>
</tr>
<tr>
<td>Diapers; plastic or nonwoven fabric; cartoned</td>
<td>Class IV</td>
</tr>
<tr>
<td>Diapers; plastic or nonwoven fabric; plastic-wrapped; uncartoned</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td>Fabric; rayon and nylon</td>
<td>Class IV</td>
</tr>
<tr>
<td>Fabric; synthetic (except rayon and nylon); greater than 50/50 blend</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td>Fabric; synthetic (except rayon and nylon); up to 50/50 blend</td>
<td>Class III</td>
</tr>
<tr>
<td>Fabric; vinyl-coated (e.g. tablecloth); cartoned</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td>Fibers; rayon and nylon; baled</td>
<td>Class IV</td>
</tr>
<tr>
<td>Fibers; synthetic (except rayon and nylon); baled</td>
<td>Group A Nonexpanded</td>
</tr>
</tbody>
</table>
### 2. Revise Table A.5.6.4 to read as follows:

<table>
<thead>
<tr>
<th>Textile Materials/Products</th>
<th>Cloth; synthetic cloth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Diapers; plastic or nonwoven fabric; cartoned</td>
</tr>
<tr>
<td></td>
<td>Fabric; rayon and nylon</td>
</tr>
<tr>
<td></td>
<td>Fibers; rayon and nylon; baled</td>
</tr>
<tr>
<td></td>
<td>Thread or yarn; rayon and nylon; wood or paper spools</td>
</tr>
<tr>
<td></td>
<td>Thread or yarn; synthetic (except rayon and nylon); greater than 50/50 blend; paper or wood spools</td>
</tr>
</tbody>
</table>

### 3. Revise Table A.5.6.4.1 to read as follows:

<table>
<thead>
<tr>
<th>Textile Materials/Products</th>
<th>Diapers; plastic or nonwoven fabric; plastic-wrapped; uncartoned Nonexpanded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fabric; vinyl-coated (e.g. tablecloth); cartoned Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Fabric; synthetic (except rayon and nylon); greater than 50/50 blend Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Fibers; synthetic (except rayon and nylon); baled Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Thread or yarn; rayon or nylon; plastic spools Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Thread or yarn; synthetic (except rayon and nylon); greater than 50/50 blend; plastic spools Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Thread or yarn; synthetic (except rayon and nylon); up to 50/50 blend; plastic spools Nonexpanded</td>
</tr>
</tbody>
</table>
See attached for TIA 16-3

### Supplemental Information

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### Submitter Information Verification

- **Submitter Full Name:** AUT-SSD
- **Organization:** National Fire Protection Assoc
- **Street Address:**
- **City:**
- **State:**
- **Zip:**
- **Submittal Date:** Mon Aug 15 17:37:20 EDT 2016

### Committee Statement

- **Committee Statement:**
  NOTE: This public input originates from Tentative Interim Amendment No. 16-3 (Log 1183) issued by the Standards Council on August 18, 2015 and per the NFPA Regs., needs to be reconsidered by the Technical Committee for the next edition of the Document.

### Response Message:

Public Input No. 135-NFPA 13-2016 [Global Input]
Reference: 5.6.3.3, Figure 5.6.3.4.2, Figure 5.6.3.3.2(new), 5.6.3.4, 5.6.4, A.5.6 and Table A.5.6.1.1
TIA 16-3
(SC 15-8-16 / TIA Log #1183)

Note: Text of the TIA was issued and incorporated into the document prior to printing, therefore no separate publication is necessary.

1. Revise Subsection 5.6.3.3 to read as follows:

5.6.3.3* Class III.
5.6.3.3.1 A Class III commodity shall be defined as a product fashioned from wood, paper, natural fibers, or Group C plastics with or without cartons, boxes, or crates and with or without pallets.

5.6.3.3.2* A Class III commodity shall be permitted to contain a limited amount (5 percent or less by weight of unexpanded plastic or 5 percent or less by volume of expanded plastic) of Group A or Group B plastics.

A.5.6.3.3.2 Where the commodity includes a single type of plastic, the five percent limit applies to the unexpanded or expanded type, but not both. For commodities with a mixture of expanded and unexpanded plastics, see 5.6.3.3.3 and the associated figures.

5.6.3.3.3 Class III commodities containing a mix of both Group A expanded and unexpanded plastics shall comply with Figure 5.6.3.3.3.1 where they are within cartons, boxes, or crates, or Figure 5.6.3.3.3.2 where they are exposed.
2. Revise Figure 5.6.3.4.2 to read as follows:

![Figure 5.6.3.4.2](image)

- **III** - Class III Commodity. Refer to 5.6.2 if a plastic pallet is used.
- **IV** - Class IV Commodity. Refer to 5.6.2 if a plastic pallet is used.

3. Add a new Figure 5.6.3.3.3.2 to read as follows:

![Figure 5.6.3.3.3.2](image)

*Figure 5.6.3.3.3.2 Exposed Commodities Containing a Mixture of Expanded and Unexpanded Group A Plastics*

- **III** - Class III Commodity. Refer to 5.6.2 if a plastic pallet is used.
- **IV** - Class IV Commodity. Refer to 5.6.2 if a plastic pallet is used.
4. Revise Subsection 5.6.3.4 to read as follows:

5.6.3.4* Class IV.
5.6.3.4.1 A Class IV commodity shall be defined as a product, with or without pallets, that meets one of the following criteria:
(1) Constructed partially or totally of Group B plastics
(2) Consists of free-flowing Group A plastic materials
(3) Cartoned, or within a wooden container, that contains (greater than 5 percent and up to 15 percent by weight of Group A unexpanded plastic.
(4) Cartoned, or within a wooden container, that contains greater than 5 percent and up to 25 percent by volume of expanded Group A plastics.
(5) Cartoned, or within a wooden container, that contains a mix of Group A expanded and unexpanded plastics and complies with Figure 5.6.3.3.3.1.
(6) Exposed, that contains greater than 5 percent and up to 15 percent by weight of Group A unexpanded plastic.
(7) Exposed, that contains a mix of Group A expanded and unexpanded plastics and complies with Figure 5.6.3.3.3.2.

5.6.3.4.2 The remaining materials shall be permitted to be noncombustible, wood, paper, natural or fibers, or Group B or Group C plastics.

5. Revise Subsection 5.6.4 to read as follows:

5.6.4* Classification of Plastics, Elastomers, and Rubber. Plastics, elastomers, and rubber shall be classified as Group A, Group B, or Group C.

5.6.4.1* Group A. The following materials shall be classified as Group A:
(1) ABS ((acrylonitrile-butadiene-styrene copolymer)
(2) Acetal (polyformaldehyde)
(3) Acrylic (polymethyl methacrylate)
(4) Butyl rubber
(5) Cellulosics (cellulose acetate, cellulose acetate butyrate, ethyl cellulose)
(6) EPDM (ethylene-propylene rubber)
(7) FRP (fiberglass-reinforced polyester)
(8) Natural rubber
(9) Nitrile-rubber (acrylonitrile-butadiene-rubber)
(10) Nylon (nylon 6, nylon 66)
(11) PET (thermoplastic polyester)
(12) Polybutadiene
(13) Polycarbonate
(14) Polyester elastomer
(15) Polyethylene
(16) Polypropylene
(17) Polystyrene
(18) Polyurethane
(19) PVC (polyvinyl chloride – highly plasticized, with plasticizer content greater than 20 percent)(rarely found)
(20) PVF (polyvinyl fluoride)
(21) SAN (styrene acrylonitrile)  
(22) SBR (styrene-butadiene rubber)

5.6.4.1.1* Group A plastics shall be further subdivided as either expanded or unexpanded.

5.6.4.1.1.1 A Group A expanded plastic commodity shall be defined as a product, with or without pallets, that meets one of the following criteria:
   (1) Cartoned, or within a wooden container, that contains greater than 40 percent by volume of Group A expanded plastic.
   (2) Exposed, that contains greater than 25 percent by volume of Group A expanded plastic.

5.6.4.1.1.2 A Group A unexpanded plastic commodity shall be defined as a product, with or without pallets, that meets one of the following criteria:
   (1) Cartoned, or within a wooden container, that contains greater than 15 percent by weight of Group A unexpanded plastic.
   (2) Cartoned, or within a wooden container, that contains greater than 25 percent and up to 40 percent by volume of Group A expanded plastic.
   (3) Cartoned, or within a wooden container, that contains a mix of Group A unexpanded and expanded plastics, in compliance with Figure 5.6.3.3.3.1.
   (4) Exposed, that contains greater than 15 percent by weight of Group A unexpanded plastic.
   (5) Exposed, that contains greater than 5 percent and up to 25 percent by volume of Group A expanded plastic.
   (6) Exposed, that contains a mix of Group A unexpanded and expanded plastics, in compliance with Figure 5.6.3.3.3.2.

5.6.4.1.1.3 The remaining materials shall be permitted to be noncombustible, wood, paper, natural or synthetic fibers, or Group A, Group B, or Group C plastics.

5.6.4.2 Group B.
The following materials shall be classified as Group B:
   (1) Chloroprene rubber
   (2) Fluoroplastics (ECTFE – ethylene-chlorotrifluoro-ethylene copolymer; ETFE – ethylene-tetrafluoroethylene-copolymer; FEP – fluorinated ethylene-propylene copolymer)
   (3) Silicone rubber

5.6.4.3 Group C.
The following materials shall be classified as Group C:
   (1) Fluoroplastics (PCTFE – polychlorotrifluoroethylene; PTFE – polytetrafluoroethylene)
   (2) Melamine (melamine formaldehyde)
   (3) Phenolic
   (4) PVC (polyvinyl chloride – flexible – PVC’s with plasticizer content up to 20 percent)
   (5) PVDC (polyvinylidene chloride)
   (6) PVDF (polyvinylidene fluoride)
   (7) Urea (urea formaldehyde)

6. Revise A.5.6 to read as follows:

A.5.6 Specification of the type, amount, and arrangement of combustibles for any commodity classification is essentially an attempt to define the potential fire severity, based on its burning
characteristics, so the fire can be successfully controlled by the prescribed sprinkler protection for the commodity class. In actual storage situations, however, many storage arrays do not fit precisely into one of the fundamental classifications; therefore, the user needs to make judgments after comparing each classification to the existing storage conditions. Storage arrays consist of thousands of products, which makes it impossible to specify all the acceptable variations for any class. As an alternative, a variety of common products are classified in this annex based on judgment, loss experience, and fire test results. Table A.5.6 provides examples of commodities not addressed by the classifications in Section 5.6. The commodities listed in Table A.5.6 are outside the scope of NFPA 13 protection. Table A.5.6.3 is an alphabetized list of commodities with corresponding classifications. Tables A.5.6.3.1, A.5.6.3.2, A.5.6.3.3, A.5.6.3.4, and A.5.6.4.1 provide examples of commodities within a specific class.

7. Revise Table A.5.6.1.1 to read as follows:

**Table A.5.6.1.1 General Guide to Identifying the Commodity Class for Solid Combustibles**

<table>
<thead>
<tr>
<th>Characteristics of Unit Load</th>
<th>Commodity Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Used to Construct Product</td>
<td>Packaging Material</td>
</tr>
<tr>
<td>Noncombustible Product</td>
<td></td>
</tr>
<tr>
<td>Entirely noncombustible</td>
<td>None or single-layer corrugated cartons</td>
</tr>
<tr>
<td>Entirely noncombustible</td>
<td>None or single-layer corrugated cartons</td>
</tr>
<tr>
<td>Entirely noncombustible</td>
<td>Multiple-layered corrugated cartons, wooden crates, or wood boxes</td>
</tr>
<tr>
<td>Entirely noncombustible</td>
<td>Multiple-layered corrugated cartons, wooden crates, or wood boxes</td>
</tr>
<tr>
<td>Entirely noncombustible</td>
<td>Corrugated cartons, wooden crates, or wood boxes, with internal plastic packaging</td>
</tr>
<tr>
<td>Entirely noncombustible</td>
<td>Corrugated cartons, wooden crates, or wooden boxes, with internal plastic packaging</td>
</tr>
<tr>
<td>Wood, Paper, Natural Fibers, or Group C Plastics</td>
<td></td>
</tr>
<tr>
<td>Entirely wood, paper, natural fibers, or Group C plastics, or a mix of these with noncombustible materials.</td>
<td>None, corrugated cartons, wooden crates, or wood boxes</td>
</tr>
<tr>
<td>Entirely wood, paper, natural fibers, or Group C plastics, or a mix of these with noncombustible materials.</td>
<td>Corrugated cartons, wooden crates, or wood boxes, with internal plastic packaging</td>
</tr>
<tr>
<td>Entirely wood, paper, natural fibers, or Group C plastics, or a mix of these with noncombustible materials.</td>
<td>None, corrugated cartons, wooden crates, or wood boxes</td>
</tr>
<tr>
<td>Material Used to Construct Product</td>
<td>Packaging Material</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Entirely wood, paper, natural fibers, or Group C plastics, or a mix of these with noncombustible materials.</td>
<td>Corrugated cartons, wooden crates, or wood boxes, with internal plastic packaging</td>
</tr>
<tr>
<td>Group B Plastics</td>
<td></td>
</tr>
<tr>
<td>Entirely Group B plastics, or a mix of these with noncombustible, wood, paper, natural fibers, or Group C plastics materials.</td>
<td>None, corrugated cartons, wooden crates, or wood boxes</td>
</tr>
<tr>
<td>Entirely Group B plastics, or a mix of these with noncombustible, wood, paper, natural fibers, or Group C plastics materials.</td>
<td>Corrugated cartons, wooden crates, or wood boxes</td>
</tr>
<tr>
<td>Entirely Group B plastics, or a mix of these with noncombustible, wood, paper, natural fibers, or Group C plastics materials.</td>
<td>None</td>
</tr>
<tr>
<td>Entirely Group B plastics, or a mix of these with noncombustible, wood, paper, natural fibers, or Group C plastics materials.</td>
<td>Corrugated cartons, wooden crates, or wood boxes, with plastic internal packaging</td>
</tr>
<tr>
<td>Group A Plastics</td>
<td></td>
</tr>
<tr>
<td>Free-flowing Group A plastic materials</td>
<td>Corrugated cartons, wooden crates, wood boxes, or bagged</td>
</tr>
<tr>
<td>Free-flowing Group A plastic materials</td>
<td>Corrugated cartons, wooden crates, wood boxes, or bagged</td>
</tr>
<tr>
<td>Entirely unexpanded Group A plastic</td>
<td>Corrugated cartons, wooden crates, or wood boxes</td>
</tr>
<tr>
<td>Entirely unexpanded Group A plastic</td>
<td>None</td>
</tr>
<tr>
<td>Entirely unexpanded Group A plastic</td>
<td>Corrugated cartons, wooden crates, or wood boxes, with internal plastic packaging</td>
</tr>
<tr>
<td>Entirely expanded Group A plastic</td>
<td>Corrugated cartons, wooden crates, or wood boxes, with or without internal plastic packaging</td>
</tr>
<tr>
<td>Entirely expanded Group A plastic</td>
<td>None</td>
</tr>
</tbody>
</table>
### Characteristics of Unit Load

<table>
<thead>
<tr>
<th>Material Used to Construct Product</th>
<th>Packaging Material</th>
<th>Pallet Material</th>
<th>Commodity Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mix of Group A plastics, noncombustible, wood, paper, natural fibers, Group B or C plastics materials.</td>
<td>Corrugated cartons, wooden crates, or wood boxes, with or without internal plastic packaging</td>
<td>None, metal or wood</td>
<td>See Figure 5.6.3.3.3.1</td>
</tr>
<tr>
<td>Mix of Group A plastics, noncombustible, wood, paper, natural fibers, Group B or C plastics materials.</td>
<td>Corrugated cartons, wooden crates, or wood boxes</td>
<td>Plastic</td>
<td>See Figure 5.6.3.3.3.1 and Section 5.6.2</td>
</tr>
<tr>
<td>Mix of Group A plastics, noncombustible, wood, paper, natural fibers, Group B or C plastics materials.</td>
<td>None</td>
<td>None, metal or wood</td>
<td>See Figure 5.6.3.3.3.2</td>
</tr>
<tr>
<td>Mix of Group A plastics, noncombustible, wood, paper, natural fibers, Group B or C plastics materials.</td>
<td>None</td>
<td>Plastic</td>
<td>See Figure 5.6.3.3.3.2 and Section 5.6.2</td>
</tr>
</tbody>
</table>

**Issue Date:** August 18, 2015  
**Effective Date:** September 7, 2015

(Note: For further information on NFPA Codes and Standards, please see [www.nfpa.org/codelist](http://www.nfpa.org/codelist))

Copyright © 2015 All Rights Reserved  
NATIONAL FIRE PROTECTION ASSOCIATION
Throughout the standard, when referring to Group A plastic commodities, revise the word “uncartoned” to “exposed” and similarly revise “unexpanded” to “nonexpanded”.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 16 11:21:01 EDT 2016

Committee Statement

Committee Statement: During the previous cycle, First Revision No. 177 took the action to revise the word “uncartoned” to “exposed” and similarly revise “unexpanded” to “nonexpanded” throughout the standard. However the term “uncartoned” is still in place in several places and the term “unexpanded” was retained in numerous locations. Therefore, for this cycle the change of terminology should be completed. For clarity, the verbiage used should always be consistent.

Response Message:

Public Input No. 526-NFPA 13-2016 [Global Input]
First Revision No. 781-NFPA 13-2016 [Global Input]

See attached file for TIA 16-1

Supplemental Information

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Submitter Information Verification

Submitter Full Name: AUT-SSD
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City: 
State: 
Zip: 
Submittal Date: Tue Aug 16 13:56:12 EDT 2016

Committee Statement

NOTE: This public input originates from Tentative Interim Amendment No. 16-1 (Log 1165) issued by the Standards Council on August 18, 2015 and per the NFPA Regs., needs to be reconsidered by the Technical Committee for the next edition of the Document.

Response
Message:

Public Input No. 133-NFPA 13-2016 [Global Input]
1. Revise section 17.2.3.5.6 to read as follows:

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

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

b) 60 psi (4.1 bar) for storage heights up to 25 ft. (7.6 m) with a maximum ceiling height of 40 ft (12.2 m).

2. Revise section A.17.2.3.5 to read as follows:

**A.17.2.3.5** The Fire Protection Research Foundation conducted a series of full-scale fire tests at Underwriters Laboratories to develop protection criteria for the rack storage of exposed expanded Group A plastic commodities. The tests are documented in the report, “Protection of Rack Stored Exposed Expanded Group A Plastics with ESFR Sprinklers and Vertical Barriers.” The criteria for exposed expanded plastics are based on Tests 2, 3, 7 and 8 of the series, which investigated a 40 ft (12.2 m) ceiling with a range of storage heights. The tests used K-25.2 intermediate-temperature ESFR sprinklers with vertical barriers attached to the rack uprights at nominal 16 ft (4.9 m) apart. Vertical barriers of sheet metal and 3/8 -in. plywood were both investigated. In Tests 1 through 6, transverse flue spaces between commodities were blocked. Comparing the results of Test 6 with blocked transverse flue spaces and Test 7 with no blocking of transverse flue spaces, the number of operated sprinklers decreased from 11 to 7 and improved suppression of the fire. The criteria for exposed expanded plastics are based on Tests 9 and 10 of the series, which investigated a 30 ft (9.1 m) ceiling with a range of storage heights. The tests used K-25.2 intermediate-temperature ESFR sprinklers with vertical barriers attached to the rack uprights at 16 ft (4.9 m) (nominal) apart. Vertical barriers of 3/8 -in. plywood was investigated.

The area limitation between the vertical barriers and aisles indicated in 17.3.3.5.9.2 will limit the depth of a multiple-row rack arrangement. The hose stream allowance and water supply duration requirements considered the burning characteristics of the exposed expanded plastic commodity that generates a high rate of heat release very quickly, but the commodity involved in the combustion process is then quickly consumed after fire suppression or control is achieved.
3. Revise section A.17.3.3.5 to read as follows:

A.17.3.3.5 The Fire Protection Research Foundation conducted a series of full-scale fire tests at Underwriters Laboratories to develop protection criteria for the rack storage of exposed expanded Group A plastic commodities. The tests are documented in the report, “Protection of Rack Stored Exposed Expanded Group A Plastics with ESFR Sprinklers and Vertical Barriers.” The criteria for exposed expanded plastics are based on Tests 2, 3, 7 and 8 of the series, which investigated a 40 ft (12.2 m) ceiling with a range of storage heights. The tests used K-25.2 intermediate-temperature ESFR sprinklers with vertical barriers attached to the rack uprights at nominal 16 ft (4.9 m) apart. Vertical barriers of sheet metal and $\frac{3}{8}$-in. plywood were both investigated. In Tests 1 through 6, transverse flue spaces between commodities were blocked. Comparing the results of Test 6 with blocked transverse flue spaces and Test 7 with no blocking of transverse flue spaces, the number of operated sprinklers decreased from 11 to 7 and improved suppression of the fire.

The area limitation between the vertical barriers and aisles indicated in 17.3.3.5.9.2 will limit the depth of a multiple-row rack arrangement. The hose stream allowance and water supply duration requirements considered the burning characteristics of the exposed expanded plastic commodity that generates a high rate of heat release very quickly, but the commodity involved in the combustion process is then quickly consumed after fire suppression or control is achieved.

Issue Date: August 18, 2015
Effective Date: September 7, 2015

(Note: For further information on NFPA Codes and Standards, please see www.nfpa.org/codelist)
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NATIONAL FIRE PROTECTION ASSOCIATION
Figure 15.2.2.1 [21.3.1]: Note

Note: Cartons that contain Group A plastic material are permitted to be treated as Class IV commodities under either of the following conditions:
- (2) The amount and arrangement of Group A plastic material within an ordinary a carton with a single layer of corrugation would not be expected to significantly increase the fire hazard.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 16 13:57:06 EDT 2016

Committee Statement

Committee Statement: This change clarifies that this is two independent conditions and the meaning of ordinary.
Response Message:

Public Input No. 482-NFPA 13-2016 [Global Input]
See attached word doc.

Supplemental Information

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- **Organization**: National Fire Protection Assoc
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- **City**: 
- **State**: 
- **Zip**: 
- **Submittal Date**: Wed Aug 31 08:57:59 EDT 2016

Committee Statement

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- **Response Message**: 

http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...
Chapter 12—General Requirements for Storage

12.1 General. The requirements of Section 12.1 shall apply to all storage arrangements and commodities other than miscellaneous storage (see Chapter 13) and as modified by specific sections in Chapter 14 through Chapter 20.

12.6* Storage Applications.

12.12.4 High-Expansion Foam—Reduction in Ceiling Density. A reduction in ceiling density to one-half that required for idle pallets shall be permitted without revising the design area, but the density shall be no less than 0.15 gpm/ft² (6.1 mm/min).
See attached word doc

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http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...
Chapter 13  Protection of Miscellaneous and Low-Piled Storage

13.1  General.

13.1.1  This chapter shall apply to any of the following situations:
(1)  Miscellaneous storage of Class I through Class IV commodities up to 12 ft (3.7 m) in height
(2)  Miscellaneous storage of Group A plastics up to 12 ft (3.7 m) in height
(3)  Miscellaneous storage of rubber tires up to 12 ft (3.7 m) in height
(4)  Miscellaneous storage of rolled paper up to 12 ft (3.7 m) in height
(5)  Storage of Class I through Class IV commodities up to 12 ft (3.7 m) in height as directed by 14.2.3.1 and 16.2.1.2.1
(6)  Storage of Group A plastics up to 5 ft (1.5 m) in height as directed by 15.2.1 and 17.2.1.1

13.1.3  Solid Shelf Racks.

13.2  Design Basis.

13.2.1  The protection criteria shall be selected from Table 13.2.1 and Figure 13.2.1.

Table 13.2.1 Discharge Criteria for Miscellaneous Storage Up to 12 ft (3.7 m) in Height

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Type of Storage</th>
<th>Storage Height</th>
<th>Maxim um-Ceiling Height</th>
<th>Design Curve Figure 13.2.1</th>
<th>Inside Hose gpm L/min</th>
<th>Outside Hose gpm L/min</th>
<th>Total Combined Inside and Outside Hose gpm L/min</th>
<th>Duration (minutes)</th>
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<tr>
<td>Class I to Class IV</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Class I</td>
<td>Solid-piled, palletized, bin-box, shelf, single-, double-, multiple-row rack, and back-to-back shelf storage</td>
<td>$\leq \frac{1}{2}$</td>
<td>$\leq \frac{3}{7}$</td>
<td>OH1</td>
<td>0, 50, 100</td>
<td>0, 190, 380</td>
<td>250</td>
<td>950</td>
</tr>
<tr>
<td>Class II</td>
<td>$\leq \frac{1}{2}$</td>
<td>$\leq \frac{3}{7}$</td>
<td>—</td>
<td>OH1</td>
<td>0, 50, 100</td>
<td>0, 190, 380</td>
<td>250</td>
<td>950</td>
</tr>
<tr>
<td>Class III</td>
<td>$\leq \frac{1}{2}$</td>
<td>$\leq \frac{3}{7}$</td>
<td>—</td>
<td>OH2</td>
<td>0, 50, 100</td>
<td>0, 190, 380</td>
<td>250</td>
<td>950</td>
</tr>
<tr>
<td>Commodity</td>
<td>Type of Storage</td>
<td>Storage Height</td>
<td>Maximum Ceiling Height</td>
<td>Design Curve Figure 13.2.1</td>
<td>Inside Hose</td>
<td>Inside and Outside Hose</td>
<td>Total Combined Inside and Outside Hose</td>
<td>Duration (minutes)</td>
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<tr>
<td>Class IV</td>
<td></td>
<td>ft m</td>
<td>ft m</td>
<td>Note</td>
<td>gp m</td>
<td>L/min</td>
<td>gp m L/min</td>
<td></td>
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<tr>
<td>Class IV</td>
<td>Palletized, bin-box, shelf, and solid-piled</td>
<td>≤1.0 ft 0 m</td>
<td>≤3.0 ft 0 m</td>
<td>OH2</td>
<td>0, 50, 100</td>
<td>0, 190, 380</td>
<td>250 950 90</td>
<td></td>
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<tr>
<td>Class IV</td>
<td>Single-, double-, multiple-row rack and back-to-back shelf storage</td>
<td>&gt;1.0 ft 0 m to ≤3.0 ft</td>
<td>&gt;3.0 ft 0 m to ≤3.7 ft</td>
<td>OH2</td>
<td>0, 50, 100</td>
<td>0, 190, 380</td>
<td>250 950 90</td>
<td></td>
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<td></td>
<td>Group A Plastic Storage</td>
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<tr>
<td>Cartoned Unexpanded and expanded Solid-piled, palletized, bin-box, shelf, single-, double-, multiple-row rack, and back-to-back shelf storage</td>
<td>≤1.5 ft</td>
<td>≤1.0 ft 0 m</td>
<td>≤3.0 ft</td>
<td>OH2</td>
<td>0, 50, 100</td>
<td>0, 190, 380</td>
<td>250 950 90</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥1.5 ft 0 m</td>
<td>≥3.0 ft 0 m</td>
<td>EH1</td>
<td>0, 50, 100</td>
<td>0, 190, 380</td>
<td>500 1900 120</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥1.5 ft 0 m</td>
<td>≥3.0 ft 0 m</td>
<td>EH2</td>
<td>0, 50, 100</td>
<td>0, 190, 380</td>
<td>500 1900 120</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥1.5 ft 0 m</td>
<td>≥3.0 ft 0 m</td>
<td>EH2</td>
<td>0, 50, 100</td>
<td>0, 190, 380</td>
<td>500 1900 120</td>
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<td></td>
<td></td>
<td>≥1.5 ft 0 m</td>
<td>≥3.0 ft 0 m</td>
<td>EH2</td>
<td>0, 50, 100</td>
<td>0, 190, 380</td>
<td>500 1900 120</td>
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<tr>
<td>Commodity</td>
<td>Type of Storage</td>
<td>Storage Height</td>
<td>Maximum Ceiling Height</td>
<td>Design Curve Figure 13.2.1</td>
<td>Note</td>
<td>Inside Hose</td>
<td>Outside Hose</td>
<td>Total Combined Inside and Outside Hose</td>
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<td>----------------------------------------</td>
</tr>
<tr>
<td>shelf, and back-to-back shelf storage</td>
<td>≤1.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Single-, double-, multiple-row rack</td>
<td>&gt;1.4 to ≤1.5</td>
<td>&gt;3.0 to ≤3.7</td>
<td>32</td>
<td>10</td>
<td>OH2</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Solid-piled, palletized, bin-box, shelf, single-, double-, multiple-row rack, and back-to-back shelf storage</td>
<td>≤5</td>
<td>≤4/5</td>
<td>-</td>
<td>-</td>
<td>OH2</td>
<td>0; 50; 100</td>
<td>0; 190; 380</td>
<td>250; 950</td>
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<td>&gt;5 to ≤8</td>
<td>&gt;1.5 to ≤2.4</td>
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<td>8.5</td>
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<td>0; 190; 380</td>
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<td>&gt;5 to ≤10</td>
<td>&gt;1.5 to ≤3.0</td>
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<td>4.6</td>
<td>EH2</td>
<td>0; 50; 100</td>
<td>0; 190; 380</td>
<td>500; 1900</td>
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<tr>
<td>Commodity</td>
<td>Type of Storage</td>
<td>Storage Height</td>
<td>Maximum-Ceiling Height</td>
<td>Design Curve Figure 13.2.1</td>
<td>Note</td>
<td>Inside Hose</td>
<td>Total Combined Inside and Outside Hose</td>
<td>Duration (minutes)</td>
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<tr>
<td>Unexpanded</td>
<td>Solid-piled, palletized, bin-box, shelf, single-, double-, multiple-row-rack, and back-to-back shelf storage</td>
<td>≥5 to ≤10</td>
<td>≥1.5 to ≤3</td>
<td>EH2</td>
<td>0.7</td>
<td>50, 100</td>
<td>0, 190, 380</td>
<td>500</td>
</tr>
<tr>
<td>Expanded</td>
<td>Single-, double-, multiple-row-rack</td>
<td>≥5 to ≤10</td>
<td>≥1.5 to ≤3</td>
<td>OH2</td>
<td>1.7</td>
<td>50, 100</td>
<td>0, 190, 380</td>
<td>250</td>
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<td>≥3.0 to ≤3.7</td>
<td>EH2</td>
<td>0.7</td>
<td>50, 100</td>
<td>0, 190, 380</td>
<td>500</td>
</tr>
<tr>
<td>Commodity</td>
<td>Type of Storage</td>
<td>Storage Height</td>
<td>Maximum-Ceiling Height</td>
<td>Design Curve Figure 13.2.1</td>
<td>Inside Hose</td>
<td>Total Combined Inside and Outside Hose</td>
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<tr>
<td></td>
<td>Single-, double-, multiple-row-rack</td>
<td>≥10 to ≤20</td>
<td>≥3 to ≤3.7</td>
<td>EH2</td>
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<td></td>
<td></td>
<td>32</td>
<td>10</td>
<td>OH2</td>
<td>0, 50, 100</td>
<td>0, 190, 380</td>
<td>250</td>
<td></td>
</tr>
</tbody>
</table>

**Tire Storage**

|                                 | On-floor, on-side                | ≥5 to ≤1        | ≥3 to ≤3.7             | EH1                        | 0, 50, 100  | 0, 190, 380                            | 500               |
|                                 |                                  | 32             | 10                     | OH2                        | 0, 50, 100  | 0, 190, 380                            | 250               |
|                                 | On-floor, on-tread, or on-side   | ≤5             | ≤1.5                   |                            | 0, 50, 100  | 0, 190, 380                            | 250               |
|                                 | Single-, double-, or multiple-row-rack on-tread or on-side | ≤5             | ≤1.5                   |                            | 0, 50, 100  | 0, 190, 380                            | 250               |

**Tires**

<p>|                                 | Single-row-rack, portable, on-tread or on-side | ≥5 to ≤1        | ≥3 to ≤3.7             | EH1                        | 0, 50, 100  | 0, 190, 380                            | 500               |
|                                 |                                              | 32             | 10                     |                            | 0, 50, 100  | 0, 190, 380                            | 250               |
|                                 | Single-row-rack, fixed, on-tread or on-side  | ≥5 to ≤1        | ≥3 to ≤3.7             | EH1                        | 0, 50, 100  | 0, 190, 380                            | 500               |
|                                 |                                              | 32             | 10                     | OH2                        | 0, 50, 100  | 0, 190, 380                            | 250               |</p>
<table>
<thead>
<tr>
<th>Commodity</th>
<th>Type of Storage</th>
<th>Storage Height</th>
<th>Maximum Ceiling Height</th>
<th>Design Curve Figure 13.2.1</th>
<th>Inside Hose</th>
<th>Total Combined Inside and Outside Hose</th>
<th>Duration (minutes)</th>
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<tr>
<td></td>
<td></td>
<td>ft  m</td>
<td>ft  m</td>
<td></td>
<td>gp m L/mi</td>
<td>gp m L/mi</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≤1/2 ≤3/7</td>
<td></td>
<td></td>
<td></td>
<td>min</td>
<td></td>
<td></td>
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<td>Rolled Paper Storage</td>
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<tr>
<td>Heavyweight and mediumweight</td>
<td>On-end</td>
<td>≤1/0 ≤3/6</td>
<td>30 9.1</td>
<td>OH2</td>
<td>0, 50, 100</td>
<td>0, 190, 380</td>
<td>250 950 90</td>
</tr>
<tr>
<td>Tissue and lightweight</td>
<td>On-end</td>
<td>≤1/0 ≤3/6</td>
<td>30 9.1</td>
<td>EH1</td>
<td>0, 50, 100</td>
<td>0, 190, 380</td>
<td>250 950 120</td>
</tr>
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</table>

Figure 13.2.1 Miscellaneous Storage Up to 12 ft (3.7 m) in Height — Design Curves (see Table 13.2.1).

13.2.2 Installation criteria as permitted by NFPA 13 and design criteria and modifiers as permitted by the density/area method of Chapter 11 for ordinary hazard Group 1, ordinary hazard Group 2, extra hazard Group 1, and extra hazard Group 2 occupancies shall be applicable.

13.3 In-Rack Sprinklers.

13.3.1 General. In-rack sprinklers required by Table 13.2.1 shall meet the requirements of this section and the applicable storage protection and arrangement sections of this chapter.
13.3.2 Discharge Criteria. In-rack sprinklers shall have a K-factor of 5.6 (80) or larger and operate at a minimum of 15 psi (1 bar).

13.3.3 Water Demand. Where one level of in-rack sprinklers is installed for miscellaneous storage, water demand shall be based on simultaneous operation of the hydraulically most demanding four adjacent sprinklers.

13.3.4 In-Rack Sprinkler Locations.

13.3.4.1 In-rack sprinklers for miscellaneous storage shall be located at the first tier level at or above one-half of the storage height.

13.3.4.2 Horizontal spacing of in-rack sprinklers shall not exceed 8 ft (2.4 m).

13.3.4.3 In-rack sprinklers shall be located in the longitudinal flue at the intersection of the transverse flues while not exceeding the maximum spacing rules.

13.3.4.3.1 If no longitudinal flue is provided in single and double-row racks, in-rack sprinklers shall be located within 12 in. (300 mm) of the center of the rack while not exceeding the maximum spacing.

13.3.4.4 Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

13.3.4.5 Where no transverse flues exist, in-rack sprinklers shall not exceed the maximum spacing rules.
First Revision No. 861-NFPA 13-2016 [ Global Input ]

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Submittal Date: Wed Aug 31 09:00:17 EDT 2016

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Chapter 16  Protection of Rack Storage of Class I Through Class IV Commodities

16.1  General.

16.1.1 This section shall apply to storage of materials representing the broad range of combustibles stored in racks. The requirements of Chapter 12 shall apply unless modified by this chapter. (See Section C.9.)

16.1.2* Sprinkler Protection Criteria.

16.1.2.1 Sprinkler protection criteria for the storage of materials on racks shall be in accordance with Section 16.2 for storage up to 25 ft (7.6 m) and Section 16.3 for storage over 25 ft (7.6 m).

16.1.4 Fire Protection of Steel Columns — Columns Within Storage Racks.
See Section C.10.

16.1.5 High-Expansion Foam.

16.1.5.1 High-Expansion Foam Ceiling Sprinkler Density.

16.1.6 Solid Shelving.

16.1.6.1 Where solid shelving in single-, double-, and multiple-row racks exceeds 20 ft² (1.9 m²) in area but does not exceed 64 ft² (5.9 m²) in area, sprinklers shall not be required below every shelf but shall be installed at the ceiling and below shelves at intermediate levels not more than 6 ft (1.8 m) apart vertically. (See Section C.11.)

16.1.6.2 Where solid shelving in single-, double-, and multiple-row racks exceeds 64 ft² (5.9 m²) in area or where the levels of storage exceed 6 ft (1.8 m), sprinklers shall be installed at the ceiling and below each level of shelving.

16.1.6.5 Where the criteria in 16.1.6.6 are not met, the water demand for the in-rack sprinklers shall be based on a minimum flow of 30 gpm (115 L/min) discharging from the following number of sprinklers balanced to the ceiling sprinkler demand in accordance with 23.4.5:
   (1) Six sprinklers where only one level of in-rack sprinklers is installed to protect Class I, Class II, or Class III commodity
   (2) Eight sprinklers where only one level of in-rack sprinklers is installed to protect Class IV commodity
   (3) Ten sprinklers (five on each of the top two levels) where more than one level of in-rack sprinklers is installed to protect Class I, Class II, or Class III commodity
   (4) Fourteen sprinklers (seven on each of the top two levels) where more than one level of in-rack sprinklers is installed to protect Class IV commodity

16.1.6.7* Where solid shelves obstruct only a portion of the rack, in-rack sprinklers shall be installed horizontally, within the flue a minimum of 4 ft (1.2 m) beyond the end of the solid shelf, and vertically as follows:
In accordance with 16.1.6.1 and 16.1.6.2 for CMDA sprinklers
Beneath all tiers under the highest solid shelf for CMSA and ESFR sprinklers

A.16.1.6.7 The adjustments in 16.2.1.3.4 apply to solid shelves where the minimum required level of in-rack sprinklers from an open rack option is exceeded.

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

16.1.7 Open-Top Containers.
The protection of open-top containers shall be considered outside the scope of Chapter 16. See Section C.12.

16.1.8 In-Rack Sprinklers.

16.1.8.1 The number of sprinklers and the pipe sizing on a line of sprinklers in racks shall be restricted only by hydraulic calculations and not by any piping schedule.

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

16.1.8.3 Where a storage rack, due to its length, requires less than the number of in-rack sprinklers specified, only those in-rack sprinklers in a single rack shall be included in the calculation.

16.1.8.4* In-rack sprinklers shall be located at an intersection of transverse and longitudinal flues while not exceeding the maximum spacing rules.

A.16.1.8.4

(A) Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

(B) Where no transverse flues exist, in-rack sprinklers shall not exceed the maximum spacing rules.

16.1.9* Horizontal Barriers and In-Rack Sprinklers.
16.1.9.1 Where required by other sections of this standard, horizontal barriers used in conjunction with in-rack sprinklers to impede vertical fire development shall be constructed of sheet metal, wood, or similar material and shall extend the full length and depth of the rack.

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

16.1.10 Flue Space Requirements for Storage Up to and Including 25 ft (7.6 m).
See Section C.13.

16.1.11 Flue Space Requirements for Storage Over 25 ft (7.6 m).

16.1.11.1 Nominal 6 in. (150 mm) transverse flue spaces between loads and at rack uprights shall be maintained in single-row, double-row, and multiple-row racks.

16.1.11.2 Random variations in the width of the flue spaces or in their vertical alignment shall be permitted.

16.2 Protection Criteria for Rack Storage of Class I Through Class IV Commodities Stored Up to and Including 25 ft (7.6 m) in Height.

16.2.1.1 The area and density for the hydraulically remote area and the water supply shall be determined as specified in 16.2.1.2 for storage up to 12 ft (3.7 m) and 16.2.1.3 to 16.2.1.3.4 for storage over 12 ft (3.7 m).

16.2.1.2 Protection Criteria for Rack Storage of Class I Through Class IV Commodities Stored Up to 12 ft (3.7 m) in Height.

16.2.1.2.1 The protection criteria for storage up to and including 12 ft (3.7 m) shall be the same as miscellaneous storage from Chapter 13.

16.2.1.2.2 The protection criteria in Chapter 13 shall be acceptable for storage of Class I through Class IV commodities up to and including 12 ft (3.7 m) in height. (See Table 13.2.1 for specific Class I through Class IV storage height protection criteria.)

16.2.1.2.3 For storage 12 ft (3.7 m) or less in height that does not meet the definition of Miscellaneous Storage that is on solid shelf racks, in-rack sprinklers shall be provided in accordance with 16.1.6, and ceiling sprinkler protection shall be provided in accordance with Chapter 13.

A.16.2.1.3.1

16.2.1.4 In-Rack Sprinklers for Rack Storage of Class I Through Class IV Commodities Stored Up to and Including 25 ft (7.6 m) in Height Protected with Control-Mode Density/Area Sprinklers at Ceiling.
16.2.1.4.1 In-Rack Sprinkler Location for Rack Storage of Class I Through Class IV Commodities Stored Up to and Including 25 ft (7.6 m) in Height.

16.2.1.4.1.1 In single- or double-row racks, in-rack sprinklers shall be installed in accordance with Table 16.2.1.3.2.

16.2.1.4.1.2 In multiple-row racks no deeper than 16 ft (4.9 m) with aisles 8 ft (2.4 m) or more in width, in-rack sprinklers shall be installed in accordance with Table 16.2.1.3.3.1.

16.2.1.4.1.3 In multiple-row racks deeper than 16 ft (4.9 m) or with aisles less than 8 ft (2.4 m) wide, in-rack sprinklers shall be installed in accordance with Table 16.2.1.3.3.2.

16.2.1.4.1.4 In-rack sprinklers at one level only for storage up to and including 25 ft (7.6 m) high shall be located at the first tier level at or above one-half of the storage height.

16.2.1.4.1.5 In-rack sprinklers at two levels only for storage up to and including 25 ft (7.6 m) high shall be located at the first tier level at or above one-third and two-thirds of the storage height.

16.2.1.4.2 In-Rack Sprinkler Spacing for Rack Storage of Class I Through Class IV Commodities Stored Up to and Including 25 ft (7.6 m) in Height Protected by Control Mode Density/Area Sprinklers at the Ceiling.

16.2.1.4.2.1* Maximum horizontal spacing of in-rack sprinklers in single- or double-row racks up to and including 25 ft (7.6 m) in height shall be in accordance with Table 16.2.1.4.2.1.

Table 16.2.1.4.2.1 In-Rack Sprinkler Spacing for Class I, II, III, and IV Commodities Stored in Single- or Double-Row Racks Up to 25 ft (7.6 m) in Height Protected by Control Mode Density/Area Sprinklers at the Ceiling

<table>
<thead>
<tr>
<th>Encapsulated</th>
<th>Aisle Widths</th>
<th>Commodity Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>No</td>
<td>8</td>
<td>2.4</td>
</tr>
<tr>
<td>No</td>
<td>4</td>
<td>1.2</td>
</tr>
<tr>
<td>Yes</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

16.2.1.4.2.2* Maximum horizontal spacing and maximum area of coverage of in-rack sprinklers on branch lines, in multiple-row racks with storage up to and including 25 ft (7.6 m) in height, shall be in accordance with Table 16.2.1.4.2.2.

Table 16.2.1.4.2.2 In-Rack Sprinkler Spacing for Class I, II, III, and IV Commodities Stored in Multi-Row Racks Up to 25 ft (7.6 m) in Height Protected by Control Mode Density/Area Sprinklers at the Ceiling
<table>
<thead>
<tr>
<th>Commodity Class</th>
<th>I, II, III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spacing</strong></td>
<td>ft  m</td>
<td>ft  m</td>
</tr>
<tr>
<td>12</td>
<td>3.7</td>
<td>8   2.4</td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>ft²  m²</td>
<td>ft²  m²</td>
</tr>
<tr>
<td>100</td>
<td>9.3</td>
<td>80   7.4</td>
</tr>
</tbody>
</table>

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

(B) The aisles shall not be included in area calculations.

16.2.1.4.2.3* The elevation of in-rack sprinkler deflectors with respect to storage shall not be a consideration in single- or double-row rack storage up to and including 20 ft (6.1 m) high. (See Section C.16.)

16.2.1.4.2.4* In single- or double-row racks without solid shelves with storage over 20 ft (6.1 m) high, or in multiple-row racks, or in single- or double-row racks with solid shelves and storage height up to and including 25 ft (7.6 m), a minimum of 6 in. (150 mm) vertical clear space shall be maintained between the in-rack sprinkler deflectors and the top of a tier of storage.

A.16.2.1.4.2.4

(A) Sprinkler discharge shall not be obstructed by horizontal rack members.

16.2.1.4.2.5 For multiple-row racks, a minimum of 6 in. (150 mm) shall be maintained between the in-rack sprinkler deflector and the top of a tier of storage.

(A) Sprinkler discharge shall not be obstructed by horizontal rack members.

16.2.1.4.2.6 Sprinklers installed in racks shall be spaced without regard to rack uprights. (See Section C.17.)

16.2.1.4.3 In-Rack Sprinkler Water Demand for Rack Storage of Class I Through Class IV Commodities Stored Up to and Including 25 ft (7.6 m) in Height Protected by Control Mode Density/Area Sprinklers in the Ceiling.
See Section C.18.

16.2.1.4.3.1 The water demand for sprinklers installed in racks shall be based on simultaneous operation of the most hydraulically remote sprinklers as follows:

1. Six sprinklers where only one level is installed in racks with Class I, Class II, or Class III commodities
2. Eight sprinklers where only one level is installed in racks with Class IV commodities
3. Ten sprinklers (five on each two top levels) where more than one level is installed in racks with Class I, Class II, or Class III commodities
4. Fourteen sprinklers (seven on each two top levels) where more than one level is installed in racks with Class IV commodities
16.2.1.4.4 In-Rack Sprinkler Discharge Pressure for Rack Storage of Class I Through Class IV Commodities Stored Up to and Including 25 ft (7.6 m) in Height Protected by Control Mode Density/Area Sprinklers at the Ceiling. Sprinklers in racks shall discharge at not less than 15 psi (1.0 bar) for all classes of commodities. (See Section C.19.)

16.2.2 CMSA Sprinklers for Rack Storage of Class I Through Class IV Commodities Stored Up to and Including 25 ft (7.6 m) in Height.

16.2.2.1.1 CMSA sprinklers shall not be permitted to protect storage on solid shelf racks unless the solid shelf racks are protected within-rack sprinklers in accordance with 16.1.6.

16.2.2.1.1.1 Where solid shelves are used, in-rack sprinklers shall be installed in every level below the highest solid shelf.

16.2.2.2 Where in-rack sprinklers are required by Table 16.2.2.1, in-rack sprinkler spacing, design pressure, and hydraulic calculation criteria shall be in accordance with the requirements of 16.2.2.7 as applicable for the commodity.

16.2.2.3 Protection shall be provided as specified in Table 16.2.2.1 or appropriate NFPA standards in terms of minimum operating pressure and the number of sprinklers to be included in the design area.

16.2.2.4 Open Wood Joist Construction.

16.2.2.4.1 Where CMSA sprinklers are installed under open wood joist construction, their minimum operating pressure shall be 50 psi (3.4 bar) for a K-11.2 (160) sprinkler or 22 psi (1.5 bar) for a K-16.8 (240) sprinkler.

16.2.2.4.2 Where each joist channel of open wood joist construction is fully firestopped to its full depth at intervals not exceeding 20 ft (6.1 m), the lower pressures specified in Table 16.2.2.1 shall be permitted to be used.

16.2.2.5 Preenaction Systems. For the purpose of using Table 16.2.2.1, preaction systems shall be classified as dry pipe systems.

16.2.2.6 Building steel shall not require special protection where Table 16.2.2.1 is applied as appropriate for the storage configuration.

16.2.2.7 In-Rack Sprinklers for Rack Storage of Class I Through Class IV Commodities Stored Up to and Including 25 ft (7.6 m) in Height Protected with Control Mode Specific Application Sprinklers at the Ceiling.

16.2.2.7.1 Where in-rack sprinklers are required by Table 16.2.2.1, in-rack sprinklers shall be installed at the first tier level at or above one-half of the storage height.
16.2.2.7.2 The minimum of 6 in. (150 mm) vertical clear space shall be maintained between the sprinkler deflectors and the top of a tier of storage.

(A) Sprinkler discharge shall not be obstructed by horizontal rack members.

16.2.2.7.3* In-rack sprinklers shall be located at an intersection of transverse and longitudinal flues.

16.2.2.7.4 The maximum horizontal distance between in-rack sprinklers shall be 8 ft (2.4 m).

16.2.2.7.5 Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

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

16.2.2.7.7 In-Rack Sprinkler Water Demand. The water demand for in-rack sprinklers shall be based on simultaneous operation of the most hydraulically remote eight sprinklers.

16.2.2.7.8 In-Rack Sprinkler Discharge Pressure. In-rack sprinklers shall discharge at not less than 15 psi (1.0 bar) for all classes of commodities. (See Section C.19.)

16.2.3.1 Protection of single-, double-, and multiple-row rack storage of Class I through Class IV commodities shall be in accordance with Table 16.2.3.1.

Table 16.2.3.1 ESFR Sprinkler Protection of Rack Storage of Class I Through Class IV Commodities Stored Up to and Including 25 ft (7.6 m) in Height

<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Commodity</th>
<th>Maximum Storage Height</th>
<th>Maximum Ceiling/roof Height</th>
<th>Nominal K-Factor</th>
<th>Orientation</th>
<th>Minimum Operating Pressure</th>
<th>In-Rack Sprinkler Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ft m</td>
<td>ft m</td>
<td></td>
<td></td>
<td>psi</td>
<td>bar</td>
</tr>
<tr>
<td>Single-row, double-row, and multiple-row racks (no open-top containers)</td>
<td>Class I, II, III, or IV, encapsulated or nonencapsulated</td>
<td>20 6.1</td>
<td>25 7.6</td>
<td>14.0 (200)</td>
<td>Upright/pendent</td>
<td>50 3.4</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16.8 (240)</td>
<td>Upright/pendent</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22.4 (320)</td>
<td>Pendent</td>
</tr>
<tr>
<td>Storage Arrangement</td>
<td>Commodity</td>
<td>Maximum Storage Height</td>
<td>Maximum Ceiling/roof Height</td>
<td>Nominal K-Factor</td>
<td>Orientation</td>
<td>Minimum Operating Pressure psi/bar</td>
<td>In-Rack Sprinkler Requirements</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------</td>
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<td>-----------------------------</td>
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<td></td>
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<td>ft m</td>
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<tr>
<td>25</td>
<td>7.6</td>
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<td>Pendent</td>
<td>15 1.0</td>
<td>No</td>
</tr>
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<td></td>
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<td>Upright/pendent</td>
<td>16.8</td>
<td>Pendent</td>
<td>25 1.7</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22.4 (320)</td>
<td>Pendent</td>
<td>22.4</td>
<td>Pendent</td>
<td>25 1.7</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25.2 (360)</td>
<td>Pendent</td>
<td>25.2</td>
<td>Pendent</td>
<td>25 1.7</td>
<td>No</td>
</tr>
<tr>
<td>30</td>
<td>9.1</td>
<td>14.0 (200)</td>
<td>Upright/pendent</td>
<td>14.0</td>
<td>Pendent</td>
<td>15 1.0</td>
<td>No</td>
</tr>
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<td>Upright/pendent</td>
<td>16.8</td>
<td>Pendent</td>
<td>35 2.4</td>
<td>No</td>
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<td>Pendent</td>
<td>22.4</td>
<td>Pendent</td>
<td>35 2.4</td>
<td>No</td>
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<tr>
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<td>Pendent</td>
<td>25.2</td>
<td>Pendent</td>
<td>15 1.0</td>
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<tr>
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<td>10.7</td>
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<td>Pendent</td>
<td>75 5.2</td>
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<td></td>
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<td>16.8</td>
<td>Pendent</td>
<td>52 3.6</td>
<td>No</td>
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<td>22.4</td>
<td>Pendent</td>
<td>35 2.4</td>
<td>No</td>
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<td>Pendent</td>
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<td>52 3.6</td>
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<tr>
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<td>Pendent</td>
<td>22.4</td>
<td>Pendent</td>
<td>40 2.8</td>
<td>No</td>
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<td>Pendent</td>
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<tr>
<td>45</td>
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<td>Pendent</td>
<td>14.0</td>
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<td>90 6.2</td>
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<td>Pendent</td>
<td>63 4.4</td>
<td>Yes</td>
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<td>22.4</td>
<td>Pendent</td>
<td>40 2.8</td>
<td>No</td>
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<tr>
<td></td>
<td></td>
<td>25.2 (360)</td>
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<td>25.2</td>
<td>Pendent</td>
<td>40 2.8</td>
<td>No</td>
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<tr>
<td>25</td>
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<td>14.0 (200)</td>
<td>Upright/pendent</td>
<td>14.0</td>
<td>Pendent</td>
<td>50 3.4</td>
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</tr>
<tr>
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<td></td>
<td>16.8 (240)</td>
<td>Upright/pendent</td>
<td>16.8</td>
<td>Pendent</td>
<td>50 3.4</td>
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</tr>
<tr>
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<td>22.4 (320)</td>
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<td>22.4</td>
<td>Pendent</td>
<td>25 1.7</td>
<td>No</td>
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</table>
### Table 16.2.3.1

<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Commodity</th>
<th>Maximum Storage Height ft</th>
<th>Maximum Ceiling/Ro of Height ft</th>
<th>Nominal K-Factor</th>
<th>Orientation</th>
<th>Minimum Operating Pressure psi</th>
<th>In-Rack Sprinkler Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<tr>
<td>32</td>
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<td>25.2 (360)</td>
<td>Pendent</td>
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<td>1.0</td>
<td>No</td>
<td></td>
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<tr>
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<td></td>
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<td>4.1</td>
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<td>2.9</td>
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<td>Upright/pendent</td>
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<td>3.6</td>
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</tr>
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<td>2.4</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>25.2 (360)</td>
<td>Pendent</td>
<td>20</td>
<td>1.4</td>
<td>No</td>
<td></td>
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<tr>
<td>40</td>
<td></td>
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<td>Pendent</td>
<td>52</td>
<td>3.6</td>
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<td></td>
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<td>Pendent</td>
<td>40</td>
<td>2.8</td>
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</tr>
<tr>
<td></td>
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<td>25.2 (360)</td>
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<td>1.7</td>
<td>No</td>
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<tr>
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<td></td>
<td>14.0 (200)</td>
<td>Pendent</td>
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<td>6.2</td>
<td>Yes</td>
<td></td>
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<td>Pendent</td>
<td>63</td>
<td>4.3</td>
<td>Yes</td>
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<tr>
<td></td>
<td></td>
<td>22.4 (320)</td>
<td>Pendent</td>
<td>40</td>
<td>2.8</td>
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<td></td>
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<td>Pendent</td>
<td>40</td>
<td>2.8</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

16.2.3.4 ESFR sprinkler systems shall be designed such that the minimum operating pressure is not less than that indicated in Table 16.2.3.1 for type of storage, commodity, storage height, and building height involved.

16.2.3.5 The design area shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of three branch lines.
16.2.3.6 In-Rack Sprinkler Requirements for Rack Storage of Class I Through Class IV Commodities Stored Up to and Including 25 ft (7.6 m) in Height Where ESFR Sprinklers Are Being Used at the Ceiling.

16.2.3.6.1 Where required by Table 16.2.3.1, in-rack sprinklers shall be installed at the first tier level at or above one-half of the storage height.

16.2.3.6.2 In-rack sprinklers shall be K-8.0 (115) or K-11.2 (160) quick-response, ordinary-temperature sprinklers.

16.2.3.6.3 The minimum of 6 in. (150 mm) vertical clear space shall be maintained between the sprinkler deflectors and the top of a tier of storage.

(A) Sprinkler discharge shall not be obstructed by horizontal rack members.

16.2.3.6.4 The maximum horizontal distance between in-rack sprinklers shall be 5 ft (1.5 m).

16.2.3.6.5* In-rack sprinklers shall be located at an intersection of transverse and longitudinal flues while not exceeding the maximum spacing rules.

16.2.3.6.6 Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

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

16.2.3.6.8 The water demand for sprinklers installed in racks shall be based on simultaneous operation of the most hydraulically remote eight sprinklers.

16.2.3.6.9 Each of the in-rack sprinklers described in 16.2.3.6.8 shall discharge at a minimum of 60 gpm (230 L/min).

16.3 Protection Criteria for Rack Storage of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height.

A.16.3.1.1

Table 16.3.1.1 Single- or Double-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height with Aisles 4 ft (1.2 m) or More in Width
<table>
<thead>
<tr>
<th>Commodity-Class</th>
<th>Longitudinal-Flue Face</th>
<th>Figure</th>
<th>Maximum Storage Height</th>
<th>Ceiling Sprinkler Operating Area</th>
<th>Ceiling Sprinkler Density Clearance to Ceiling Up to 10 ft (3 m)</th>
<th>Ordinary Temperature</th>
<th>High Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>I, III</td>
<td>Vertical 20 ft (6.1 m)</td>
<td></td>
<td>30 ft (9.1 m)</td>
<td>16.3.1.3.1.1(A)(a)</td>
<td>No</td>
<td>200 ft^2</td>
<td>10.2 0.35 14.2</td>
</tr>
<tr>
<td></td>
<td>Under horizontal barriers</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Vertical 20 ft (6.1 m)</td>
<td></td>
<td>30 ft (9.1 m)</td>
<td>16.3.1.3.1.1(A)(b)</td>
<td>Yes</td>
<td>0.25 10.2 0.35 14.2</td>
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<tr>
<td></td>
<td>Horizontal 10 ft (3.0 m)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>I</td>
<td>Vertical 10 ft (3.0 m)</td>
<td></td>
<td>30 ft (9.1 m)</td>
<td>16.3.1.3.1.1(A)(c)</td>
<td>Yes</td>
<td>0.3 12.2 0.4 16.3</td>
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</tr>
<tr>
<td></td>
<td>or at 15 ft (4.6 m) and 25 ft (7.6 m)</td>
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<td></td>
<td></td>
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<td>I, II, III</td>
<td>Vertical 10 ft (3.0 m)</td>
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<td>30 ft (9.1 m)</td>
<td>16.3.1.3.1.1(A)(d)</td>
<td>Yes</td>
<td>0.3 12.2 0.4 16.3</td>
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<tr>
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<td>Horizontal 10 ft (3.0 m)</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Vertical 20 ft (6.1 m)</td>
<td></td>
<td>30 ft (9.1 m)</td>
<td>16.3.1.3.1.1(A)(e)</td>
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<td>0.3 12.2 0.4 16.3</td>
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<tr>
<td>Commodity Class</td>
<td>Longitudinal Flue&lt;sup&gt;d&lt;/sup&gt;</td>
<td>Figure</td>
<td>Maximum Storage Height</td>
<td>Stagger</td>
<td>Ceiling Sprinkler Operating Area</td>
<td>Ceiling Sprinkler Density Clearance to Ceiling Up to 10 ft (3-m)&lt;sup&gt;g&lt;/sup&gt;</td>
<td></td>
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<td>--------------------------------</td>
<td></td>
</tr>
<tr>
<td>I, II, III, IV</td>
<td>Vertical 15 ft (4.6 m)</td>
<td>Vertical 20 ft (6.1 m)</td>
<td>16.3.1.3.1.1(A)(h)</td>
<td>Higher than 25 ft (7.6 m)</td>
<td>Yes</td>
<td>0.35</td>
<td>14.3</td>
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<tr>
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<td>Horizontal 10 ft (3.1 m)</td>
<td>Horizontal 10 ft (3.0 m)</td>
<td>16.3.1.3.1.1(A)(h)</td>
<td>Higher than 25 ft (7.6 m)</td>
<td>Yes</td>
<td>0.35</td>
<td>14.3</td>
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<tr>
<td></td>
<td>Vertical 20 ft (6.1 m)</td>
<td>Vertical 20 ft (6.1 m)</td>
<td>16.3.1.3.1.1(A)(i)</td>
<td>No</td>
<td>0.35</td>
<td>14.2</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>Horizontal barriers at 20 ft (6.1 m)</td>
<td>Vertical intervals — two lines of sprinklers under barriers — maximum horizontal spacing 10 ft (3.0 m), staggered</td>
<td>16.3.1.3.1.1(A)(g)</td>
<td>Yes</td>
<td>0.3</td>
<td>12.2</td>
<td>0.4</td>
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<td></td>
<td>Vertical 25 ft (7.6 m)</td>
<td>Vertical 25 ft (7.6 m)</td>
<td>16.3.1.3.1.1(A)(f)</td>
<td>No</td>
<td>0.3</td>
<td>12.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Commodity Class</td>
<td>In-Rack Sprinklers Approximate Vertical Spacing at Tier Nearest the Vertical Distance and Maximum Horizontal Spacing&lt;sup&gt;a,b,c&lt;/sup&gt;</td>
<td>Figure</td>
<td>Maximum Storage Height</td>
<td>Staggered</td>
<td>Ceiling Sprinkler Operating Area</td>
<td>Ceiling Sprinkler Density Clearance to Ceiling Up to 10 ft (3 m)&lt;sup&gt;#&lt;/sup&gt;</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>gpm/ft&lt;sup&gt;2&lt;/sup&gt;</td>
<td>mm/m</td>
</tr>
<tr>
<td></td>
<td>Horizontal barriers at 15 ft (4.6 m) Vertical intervals — two lines of sprinklers under barriers — maximum horizontal spacing 10 ft (3.0 m); staggered</td>
<td>16.3.1.3.1.1(A)(j)</td>
<td>Yes</td>
<td>0.35</td>
<td>14.2</td>
<td>0.45</td>
<td>18.3</td>
</tr>
</tbody>
</table>

<sup>a</sup>Minimum in-rack sprinkler discharge, 30 gpm (114 L/min).
<sup>b</sup>Water shields required.
<sup>c</sup>All in-rack sprinkler spacing dimensions start from the floor.
<sup>d</sup>Install sprinklers at least 3 in. (75 mm) from uprights.
<sup>e</sup>Face sprinklers shall not be required for a Class I commodity consisting of none combustible products on wood pallets (without combustible containers), except for arrays shown in Figure 16.3.1.3.1.1(A)(g) and Figure 16.3.1.3.1.1(A)(j).
<sup>f</sup>In Figure 16.3.1.3.1.1(A)(a) through Figure 16.3.1.3.1.1(A)(j), each square represents a storage cube that measures 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there can be one load to six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
<sup>#</sup>For encapsulated commodity, increase density 25 percent.
<table>
<thead>
<tr>
<th>Commodity Class</th>
<th>Encapsulated</th>
<th>Maximum Vertical Spacing</th>
<th>Maximum Horizontal Spacing in A-Flue</th>
<th>Maximum Horizontal Spacing across Flue</th>
<th>Height Limit (ft)</th>
<th>Staggered</th>
<th>Maximum Spacing from Top of Storage to Highest In-Rack Sprinklers</th>
<th>Ceiling Sprinkler Operating Area</th>
<th>Ceiling Sprinklers Density/Clearance Up to 10 ft</th>
<th>165°F (74°C) Rating</th>
<th>286°F (141°C) Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>No</td>
<td>20 ft 6.1 m</td>
<td>12 ft 3.7 m</td>
<td>10 ft 3.0 m</td>
<td>10 ft 3.0 m</td>
<td>Non</td>
<td>16.3.1.3.1.3(A)(a)</td>
<td>10 ft 3.0 m</td>
<td>0.25 ft² 10.2 mm/ min</td>
<td>0.35 ft² 14.3 mm/ min</td>
<td></td>
</tr>
<tr>
<td>I, II, and III</td>
<td>Yes</td>
<td>15 ft 4.6 m</td>
<td>10 ft 3.0 m</td>
<td>10 ft 3.0 m</td>
<td>None</td>
<td>Figure 3(A)(a)</td>
<td>16.3.1.3.1.3(A)(b)</td>
<td>10 ft 3.0 m</td>
<td>0.31 ft² 12.6 mm/ min</td>
<td>0.44 ft² 17.9 mm/ min</td>
<td></td>
</tr>
<tr>
<td>I, II, III, and IV</td>
<td>Yes</td>
<td>10 ft 3.1 m</td>
<td>10 ft 3.0 m</td>
<td>10 ft 3.0 m</td>
<td>5 ft 1.5 m</td>
<td>Figure 3(A)(c)</td>
<td>16.3.1.3.1.3(A)(c)</td>
<td>5 ft 1.5 m</td>
<td>0.30 ft² 12.2 mm/ min</td>
<td>0.40 ft² 16.3 mm/ min</td>
<td></td>
</tr>
</tbody>
</table>

For SI units, °C = 5/9 (°F-32); 1 gpm/ft² = 40.746 mm/min.

a All four rack faces shall be protected by sprinklers located within the racks and no more than 18 in. (450 mm) from the faces, as indicated in Figure 16.3.1.3.1.3(A)(a) through Figure 16.3.1.3.1.3(A)(c). It shall not be required for each sprinkler level to protect all faces.
b All in-rack sprinkler spacing dimensions start from the floor.
c In Figure 16.3.1.3.1.3(A)(a) through Figure 16.3.1.3.1.3(A)(c), each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.1 m) apart vertically.

**16.3.1.3 In-Rack Sprinklers for Rack Storage of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height Protected with Control Mode Density/Area Sprinklers at Ceiling.**

**16.3.1.3.1 In-Rack Sprinkler Location for Rack Storage of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height Protected with Control Mode Density/Area Sprinklers at Ceiling.**
16.3.1.3.1.1* Double-Row Racks.

(A) In double-row racks and with a maximum of 10 ft (3.0 m) between the top of storage and the ceiling, in-rack sprinklers shall be installed in accordance with Table 16.3.1.1 and Figure 16.3.1.3.1.1(A)(a) through Figure 16.3.1.3.1.1(A)(j). The highest level of in-rack sprinklers shall be not more than 10 ft (3.1 m) below the top of storage. Where a single-row rack is mixed with double-row racks, Table 16.3.1.1 and Figure 16.3.1.3.1.1(A)(a) through Figure 16.3.1.3.1.1(A)(j) shall be used.

Figure 16.3.1.3.1.1(A)(a) In-Rack Sprinkler Arrangement, Class I Commodities, Storage Height 25 ft to Maximum 30 ft (7.6 m to Maximum 9.1 m).

![Diagram](image1)

**Elevation**

**Plan View**

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

Figure 16.3.1.3.1.1(A)(b) In-Rack Sprinkler Arrangement, Class I Commodities, Storage Height Over 25 ft (7.6 m).
Figure 16.3.1.1(A)(c) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities,
Storage Height 25 ft to Maximum 30 ft (7.6 m to Maximum 9.1 m).

Notes:
1. Sprinklers labeled 1 (the selected array from Table 16.3.1.1) shall be required where loads labeled A or B represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled C or D represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled E or F represent top of storage.
4. For storage higher than represented by loads labeled F, the cycle defined by Notes 2 and 3 is repeated, with stagger as indicated.
5. Symbol △ or x indicates sprinklers on vertical or horizontal stagger.
6. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
Figure 16.3.1.3.1.1(A)(d) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 1.

Notes:
1. Alternate location of in-rack sprinklers. Sprinklers shall be permitted to be installed above loads A and C or above loads B and D.
2. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
3. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
Notes:
1. Sprinklers labeled 1 shall be required where loads labeled A represent the top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled B or C represent top of storage.
3. Sprinklers labeled 1, 2, and 3 shall be required where loads labeled D or E represent top of storage.
4. Sprinklers labeled 1, 2, 3, and 4 shall be required where loads labeled F or G represent top of storage.
5. Sprinklers labeled 1, 2, 3, 4, and 5 shall be required where loads labeled H represent top of storage.
6. For storage higher than represented by loads labeled H, the cycle defined by Notes 3, 4, and 5 is repeated with stagger as indicated.
7. The indicated face sprinklers shall be permitted to be omitted where commodity consists of unwrapped or unpackaged metal parts on wood pallets.
8. Symbol \( \Delta \) or \( x \) indicates sprinklers on vertical or horizontal stagger.
9. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
Figure 16.3.1.3.1(A)(e) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 2.

Notes:
1. Sprinklers labeled 1 (the selected array from Table 16.3.1.1) shall be required where loads labeled A or B represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled C or D represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled E or F represent top of storage.
4. For storage higher than represented by loads labeled F, the cycle defined by Notes 2 and 3 is repeated, with stagger as indicated.
5. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
6. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 16.3.1.3.1(A)(f) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 3.
Figure 16.3.1.3.1(A)(g) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Storage Height Over 25 ft (7.6 m) — Option 4.

Notes:
1. Sprinklers labeled 1 (the selected array from Table 16.3.1.1) shall be required where loads labeled A or B represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled C or D represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled E represent top of storage.
4. Sprinklers labeled 1 and 4 shall be required where loads labeled F or G represent top of storage.
5. For storage higher than represented by loads labeled G, the cycle defined by Notes 2, 3, and 4 is repeated.
6. Symbol x indicates face and in-rack sprinklers.
7. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
Figure 16.3.1.3.1.1(A)(h) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Storage Height Over 25 ft (7.6 m) — Option 1.

Notes:
1. Sprinklers labeled 1 (the selected array from Table 16.3.1.1) shall be required where loads labeled A or B represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled C or D represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled E or F represent top of storage.
4. For storage higher than represented by loads labeled F, the cycle defined by Notes 2 and 3 is repeated.
5. Symbols o, Δ, and x indicate sprinklers on vertical or horizontal stagger.
6. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
Figure 16.3.1.3.1.1(A)(i) In Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Storage Height Over 25 ft (7.6 m) — Option 2.
Figure 16.3.1.3.1.1(A)(j) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Storage Height Over 25 ft (7.6 m) — Option 3.

Notes:
1. Sprinklers labeled 1 (the selected array from Table 16.3.1.1) shall be required where loads labeled A or B represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled C or D represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled E or F represent top of storage.
4. For storage higher than represented by loads labeled F, the cycle defined by Notes 2 and 3 is repeated.
5. Symbol x indicates face and in-rack sprinklers.
6. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
16.3.1.3.1.2* Single-Row Racks.

A.16.3.1.3.1.2

(A) In single-row racks with storage height over 25 ft (7.6 m) and a maximum of 10 ft (3.0 m) between the top of storage and the ceiling, sprinklers shall be installed in accordance with Figure 16.3.1.3.1.2(A)(a) through Figure 16.3.1.3.1.2(A)(c).
Figure 16.3.1.3.1.2(A)(a) In Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.

Notes:
1. For all storage heights, sprinklers shall be installed in every other tier and staggered as indicated.
2. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
3. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

Figure 16.3.1.3.1.2(A)(b) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.
Figure 16.3.1.3.1.2(A)(c) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2.
Elevation  

Plan View

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
Figure 16.3.1.3.1.2(A)(d) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2.

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

Figure 16.3.1.3.1.2(A)(e) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3.
In single-row racks, where figures show in-rack sprinklers in transverse flue spaces centered between the rack faces, it shall be permitted to position these in-rack sprinklers in the transverse flue at any point between the load faces.

16.3.1.3.1.3* In-Rack Sprinkler Location — Multiple-Row Racks for Rack Storage of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height Protected with Control Mode Density/Area Sprinklers at Ceiling.

(A) In multiple-row racks with a maximum of 10 ft (3.0 m) between the top of storage and the ceiling, protection shall be in accordance with Table 16.3.1.2 and in-rack sprinklers...
shall be installed as indicated in Figure 16.3.1.3.1.3(A)(a) through Figure 16.3.1.3.1.3(A)(e).

Figure 16.3.1.3.1.3(A)(a) In-Rack Sprinkler Arrangement, Class I Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m).
Notes:
1. Sprinklers labeled 1 shall be required if loads labeled A represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required if loads labeled B or C represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required if loads labeled D or E represent top of storage.
4. For storage higher than represented by loads labeled E, the cycle defined by Notes 2 and 3 is repeated, with stagger as indicated.
5. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
6. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
Figure 16.3.1.3.1.3(A)(b) In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m).
Notes:
1. Sprinklers labeled 1 and 2 shall be required if loads labeled A represent top of storage.
2. Sprinklers labeled 1 and 3 shall be required if loads labeled B or C represent top of storage.
3. For storage higher than represented by loads labeled C, the cycle defined by Notes 2 and 3 is repeated, with stagger as indicated.
4. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
5. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
Figure 16.3.1.3.1.3(A)(c) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m).
Notes:
1. Sprinklers labeled 1, 2, and 3 shall be required if loads labeled A represent top of storage.
2. Sprinklers labeled 1, 2, and 4 shall be required if loads labeled B represent top of storage.
3. For storage higher than represented by loads labeled B, the cycle defined by Notes 1 and 2 is repeated, with stagger as indicated.
4. Symbol Δ or x indicates sprinklers on vertical or horizontal stagger.
5. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
The highest level of in-rack sprinklers shall be not more than 10 ft (3.0 m) below maximum storage height for Class I, Class II, or Class III commodities or 5 ft (1.5 m) below the top of storage for Class IV commodities.

16.3.1.3.2 In-Rack Sprinkler Spacing for Rack Storage of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height Protected with Control Mode Density/Area Sprinklers at Ceiling.

16.3.1.3.2.1 In-Rack Sprinkler Spacing. In-rack sprinklers shall be staggered horizontally and vertically where installed in accordance with Table 16.3.1.1, Figure 16.3.1.3.1.1(A)(a) through Figure 16.3.1.3.1.1(A)(j), and Figure 16.3.1.3.1.2(A)(a) through Figure 16.3.1.3.1.2(A)(e).

16.3.1.3.2.2 In-rack sprinklers for storage higher than 25 ft (7.6 m) in double-row racks shall be spaced horizontally and located in the horizontal space nearest the vertical intervals specified in Table 16.3.1.1 and Figure 16.3.1.3.1.1(A)(a) through Figure 16.3.1.3.1.1(A)(j).

16.3.1.3.2.3 In-Rack Sprinkler Spacing. Maximum horizontal spacing of sprinklers in multiple-row racks with storage higher than 25 ft (7.6 m) shall be in accordance with Figure 16.3.1.3.1.3(A)(a) through Figure 16.3.1.3.1.3(A)(c).

16.3.1.3.2.4 In-rack sprinklers shall be located at an intersection of transverse and longitudinal flues while not exceeding the maximum spacing rules.

(A) Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

(B) Where no transverse flues exist, in-rack sprinklers shall not exceed the maximum spacing rules.

16.3.1.3.2.5 The minimum of 6 in. (150 mm) vertical clear space shall be maintained between the sprinkler deflectors and the top of a tier of storage.

(A) Sprinkler discharge shall not be obstructed by horizontal rack members.

16.3.1.3.2.6 In-rack sprinklers shall be a minimum of 3 in. (75 mm) radially from the side of the rack uprights.

16.3.1.3.2.7 Face sprinklers in such racks shall be located within the rack a minimum of 3 in. (75 mm) from rack uprights and no more than 18 in. (450 mm) from the aisle face of storage.

16.3.1.3.3 In-Rack Sprinkler Water Demand for Rack Storage of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height Protected with Control Mode Density/Area Sprinklers at the Ceiling.
The water demand for sprinklers installed in racks shall be based on simultaneous operation of the most hydraulically remote sprinklers as follows:

1. Six sprinklers where only one level is installed in racks with Class I, Class II, or Class III commodities
2. Eight sprinklers where only one level is installed in racks with Class IV commodities
3. Ten sprinklers (five on each two top levels) where more than one level is installed in racks with Class I, Class II, or Class III commodities
4. Fourteen sprinklers (seven on each two top levels) where more than one level is installed in racks with Class IV commodities

16.3.1.3.3.1 In-Rack Sprinkler Discharge for Rack Storage of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height Protected with Control Mode Density/Area Sprinklers at the Ceiling. Sprinklers in racks shall discharge at a rate not less than 30 gpm (115 L/min) for all classes of commodities.

16.3.2 CMSA Sprinklers for Rack Storage of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height.

16.3.2.1 Protection of single-, double-, and multiple-row rack storage Class I through Class IV commodities shall be in accordance with Table 16.3.2.1.

Table 16.3.2.1 CMSA Sprinkler Design Criteria for Rack Storage of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height (Encapsulated and Nonencapsulated)

<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Commodity Class</th>
<th>Maximum Storage Height</th>
<th>Maximum Ceiling/roof Height</th>
<th>K-Factor/Orientation</th>
<th>Type of System</th>
<th>Number of Design Sprinklers</th>
<th>Minimum Operating Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class I or II</td>
<td>30 ft 9.1 m</td>
<td>35 ft 10.7 m</td>
<td>11.2 (160) Upright</td>
<td>Wet</td>
<td>20 + 1 level of in-rack</td>
<td>25 psi 1.7 bar</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
<td></td>
<td>30 + 1 level of in-rack</td>
<td>25 psi 1.7 bar</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Wet</td>
<td>16.8 (240) Upright</td>
<td>20 + 1 level of in-rack</td>
<td>15 psi 1.0 bar</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
<td></td>
<td>30 + 1 level of in-rack</td>
<td>15 psi 1.0 bar</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Wet</td>
<td>19.6 (280) Pendent</td>
<td>15</td>
<td>25 psi 1.7 bar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>35 ft 10.7 m</td>
<td>40 ft 12.2 m</td>
<td>Dry*</td>
<td>11.2 (160) Upright</td>
<td>36</td>
<td>55 psi 3.8 bar</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry*</td>
<td>16.8 (240) Upright</td>
<td>36</td>
<td>22 psi 1.5 bar</td>
</tr>
<tr>
<td>Storage Arrangement</td>
<td>Commodity Class</td>
<td>Maximum Storage Height</td>
<td>Maximum Ceiling/Height</td>
<td>K-Factor/Orientation</td>
<td>Type of System</td>
<td>Number of Design Sprinklers</td>
<td>Minimum Operating Pressure</td>
</tr>
<tr>
<td>---------------------</td>
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<td>---------------------------</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>ft   m</td>
<td>ft   m</td>
<td></td>
<td></td>
<td></td>
<td>psi  bar</td>
</tr>
<tr>
<td>Class III or IV</td>
<td></td>
<td>30  9.1</td>
<td>35  10.7</td>
<td>19.6 (280)</td>
<td>Wet</td>
<td>15</td>
<td>30  2.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>35  10.7</td>
<td>40  12.2</td>
<td>19.6 (280)</td>
<td>Wet</td>
<td>15</td>
<td>30  2.1</td>
</tr>
</tbody>
</table>

*High temperature-rated sprinklers shall be used. Dry system water delivery shall be determined in accordance with 7.2.3.6 with a maximum time of water delivery of 30 seconds with four sprinklers initially open.*

**16.3.2.2** Where in-rack sprinklers are required by Table 16.3.2.1, in-rack sprinkler spacing, design pressure, and hydraulic calculation criteria shall be in accordance with the requirements of 16.3.2.7 as applicable for the commodity.

**16.3.2.3** Protection shall be provided as specified in Table 16.3.2.1 or appropriate NFPA standards in terms of minimum operating pressure and the number of sprinklers to be included in the design area.

**16.3.2.4 Open Wood Joist Construction.**

**16.3.2.4.1** Where CMSA sprinklers are installed under open wood joist construction, their minimum operating pressure shall be 50 psi (3.4 bar) for a K-11.2 (160) sprinkler or 22 psi (1.5 bar) for a K-16.8 (240) sprinkler.

**16.3.2.4.2** Where each joist channel of open wood joist construction is fully firestopped to its full depth at intervals not exceeding 20 ft (6.1 m), the lower pressures specified in Table 16.3.2.1 shall be permitted to be used.

**16.3.2.5 Preaction Systems.** For the purpose of using Table 16.3.2.1, preaction systems shall be classified as dry pipe systems.

**16.3.2.6** Building steel shall not require special protection where Table 16.3.2.1 are applied as appropriate for the storage configuration.

**16.3.2.7 In-Rack Sprinklers for Rack Storage of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height Protected with CMSA Sprinklers at the Ceiling.**

**16.3.2.7.1** Where in-rack sprinklers are required by Table 16.3.2.1 in-rack sprinklers shall be installed at the first tier level at or above one-half of the storage height.

**16.3.2.7.2** The minimum of 6 in. (150 mm) vertical clear space shall be maintained between the sprinkler deflectors and the top of a tier of storage.
(A) Sprinkler discharge shall not be obstructed by horizontal rack members.

16.3.2.7.3 In-rack sprinklers shall be a minimum of 3 in. (75 mm) radially from the side of the rack uprights.

16.3.2.7.4 Face sprinklers in such racks shall be located within the rack a minimum of 3 in. (76 mm) from rack uprights and no more than 18 in. (460 mm) from the aisle face of storage.

16.3.2.7.5 In-rack sprinklers shall be located at an intersection of transverse and longitudinal flues.

16.3.2.7.6 The maximum horizontal distance between in-rack sprinklers shall be 5 ft (1.5 m).

16.3.2.7.7 Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

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

16.3.2.7.9 In-Rack Sprinkler Water Demand. The water demand for sprinklers installed in racks shall be based on simultaneous operation of the most hydraulically remote eight sprinklers.

16.3.2.7.10 In-Rack Sprinkler Discharge Pressure. Sprinklers in racks shall discharge at not less than 15 psi (1.0 bar) for all classes of commodities. (See Section C.19.)

16.3.3* Early Suppression Fast-Response (ESFR) Sprinklers for Rack Storage of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height.

16.3.3.1 Protection of single-, double-, and multiple-row rack storage of Class I through Class IV commodities shall be in accordance with Table 16.3.3.1.

Table 16.3.3.1 ESFR Sprinkler Protection of Rack Storage of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height

<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Commodity</th>
<th>Maximum Storage Height</th>
<th>Maximum Ceiling/ Roof Height</th>
<th>Nominal K-Factor</th>
<th>Orientation</th>
<th>Minimum Operating Pressure</th>
<th>In-Rack Sprinkler Requirements</th>
<th>Hose Stream Supply</th>
<th>Water Supply Duration (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single, double, triple</td>
<td>Class I, II, III, or IV</td>
<td>30 ft, 9.1 m</td>
<td>35 ft, 10.7 m</td>
<td>140 (200)</td>
<td>Upright/pendant</td>
<td>75 psi, 5.2 bar</td>
<td>No</td>
<td>250 gp</td>
<td>946 L/m</td>
</tr>
<tr>
<td>Storage Arrangement and multiple-row rack (no-open-top containers)</td>
<td>Commodity Encapsulated or nonencapsulated</td>
<td>Maximum Storage Height ft</td>
<td>Maximum Ceiling/Roof Height m</td>
<td>Nominal K-Factor</td>
<td>Orientation Upright/Pendent</td>
<td>Minimum Operating Pressure psi bar</td>
<td>In-Rack Sprinkler Requirements</td>
<td>Hose Stream Allowance gp/ft² m</td>
<td>Water Supply Duration (hours)</td>
</tr>
<tr>
<td>---</td>
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<td>---</td>
<td>---</td>
</tr>
<tr>
<td>40</td>
<td>12.2</td>
<td>16.8 (240)</td>
<td>52</td>
<td>3.6</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.4 (320)</td>
<td>Pendent</td>
<td>35</td>
<td>2.4</td>
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</tr>
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<td></td>
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</tr>
<tr>
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<td>Pendent</td>
<td>90</td>
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<td>16.8 (240)</td>
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<tr>
<td>22.4 (320)</td>
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<td>No</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>25.2 (360)</td>
<td>Pendent</td>
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<td>2.8</td>
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<td>3.6</td>
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<td>2.8</td>
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<tr>
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<td>Pendent</td>
<td>90</td>
<td>6.2</td>
<td>Yes</td>
<td></td>
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<td>63</td>
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<td>Pendent</td>
<td>63</td>
<td>4.3</td>
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### Storage Arrangement

<table>
<thead>
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<th>Maximum Ceiling Height</th>
<th>Nominal K-Factor</th>
<th>Orientation</th>
<th>Minimum Operating Pressure</th>
<th>In-Rack Sprinkler Requirements</th>
<th>Hose Stream Allowance</th>
<th>Water Supply Duration (hours)</th>
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</thead>
<tbody>
<tr>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>psi</td>
<td>bar</td>
<td>gp</td>
<td>L/m</td>
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<td>45</td>
<td>13.7</td>
<td>22.4</td>
<td>2.8</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
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</tr>
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<td>(360)</td>
<td></td>
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</tr>
</tbody>
</table>

#### 16.3.3.2
ESFR protection as defined shall not apply to the following:
1. Rack storage involving solid shelves, except for situations complying with 16.3.3.2.1
2. Rack storage involving open-top cartons or containers

#### 16.3.3.2.1
ESFR sprinklers shall not be permitted to protect storage on solid shelf racks unless the solid shelf racks are protected with in-rack sprinklers in accordance with 16.1.6.

#### 16.3.3.2.1.1
Where solid shelves are used, in-rack sprinklers shall be installed in every level below the highest solid shelf.

#### 16.3.3.3
ESFR sprinkler systems shall be designed such that the minimum operating pressure is not less than that indicated in Table 16.3.3.1 for type of storage, commodity, storage height, and building height involved.

#### 16.3.3.4
The design area shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of three branch lines.

#### 16.3.3.5
Where required by Table 16.3.3.1, one level of K-8.0 (115) or K-11.2 (160) quick-response, ordinary-temperature in-rack sprinklers shall be installed at the tier level closest to but not exceeding one-half of the maximum storage height.

#### 16.3.3.5.1
In-rack sprinkler hydraulic design criteria shall be the most hydraulically remote eight sprinklers at 60 gpm (230 L/min).

#### 16.3.3.5.2
In-rack sprinklers shall be located at the intersection of the longitudinal and transverse flue space.

#### 16.3.3.5.3
Horizontal spacing shall not be permitted to exceed 5 ft (1.5 m) intervals.

#### 16.3.3.5.4
The minimum of 6 in. (150 mm) vertical clear space shall be maintained between the sprinkler deflectors and the top of a tier of storage.
(A) Sprinkler discharge shall not be obstructed by horizontal rack members.

16.3.3.5.5 In-rack sprinklers shall be located at an intersection of transverse and longitudinal flues while not exceeding the maximum spacing rules.

16.3.3.5.6 Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

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

16.3.3.5.8 In-rack sprinklers shall be a minimum of 3 in. (76 mm) radially from the side of the rack uprights.

16.3.3.5.9 Face sprinklers in such racks shall be located within the rack a minimum of 3 in. (76 mm) from rack uprights and no more than 18 in. (460 mm) from the aisle face of storage.

16.3.4 Special Design for Rack Storage of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height.

16.3.4.1 Where high-expansion foam systems are used for storage over 25 ft (7.6 m) high up to and including 35 ft (11 m) high, they shall be used in combination with ceiling sprinklers.

16.3.4.2 The maximum submergence time for the high-expansion foam shall be 5 minutes for Class I, Class II, or Class III commodities and 4 minutes for Class IV commodities.
First Revision No. 862-NFPA 13-2016 [ Global Input ]

See attached word doc

Supplemental Information

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Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Wed Aug 31 09:01:47 EDT 2016

Committee Statement

Committee Statement: Deletes text that was previously moving to Chapter 25.
Response Message:
Chapter 17—Protection of Rack Storage of Plastic and Rubber Commodities

17.1—General.

17.1.1—This chapter shall apply to storage of plastic and rubber commodities stored in racks. The requirements of Chapter 12 shall apply unless modified by this chapter. (See Section C.9.)

17.1.1.1—This chapter also shall be used to determine protection for commodities that are not entirely Group A plastics but contain such quantities and arrangements of Group A plastics that they are deemed more hazardous than Class IV commodities.

17.1.2—Sprinkler Protection Criteria.

17.1.2.2—The design criteria of Chapter 17 for single- and double-row rack storage of Group A plastic commodities shall be applicable where aisles are 3.5 ft (1.1 m) or greater in width.

17.1.2.3—Storage with aisles less than 3.5 ft (1.1 m) shall be protected as multiple-row rack storage.

17.1.2.6—Sprinkler protection criteria for the storage of Group A plastic commodities on racks shall be in accordance with Section 17.2 for storage up to 25 ft (7.6 m) and Section 17.3 for storage over 25 ft (7.6 m).

17.1.2.8*—The ceiling design criteria for single-, double-, and multiple-row racks in Chapter 17 shall be based on open rack configurations as defined in 3.9.3.7.4.

17.1.2.9—Alternative Protection. The protection of Group A plastic commodities requiring a greater level of protection than is available from the overhead sprinkler system shall be permitted to be protected in accordance with 17.1.2.9.1 through 17.1.2.9.7.

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

(1)—Extend the protection prescribed by 17.1.2.9 horizontally one pallet load in all directions beyond the commodity storage area requiring the higher level of protection.

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

17.1.2.9.2—Commodities that can be protected by the ceiling-level sprinkler system shall be permitted to be stored vertically above and horizontally adjacent to the portions of the storage rack equipped as prescribed by 17.1.2.9.

17.1.2.9.3—Horizontal Barriers. Horizontal barriers shall be installed at every tier level of the dedicated storage rack where the rack is equipped with solid shelves.
17.1.2.9.3.1 Where the dedicated storage rack is open frame, horizontal barriers shall be installed at vertical increments not exceeding 12 ft (3.6 m).

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

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

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

(A) The barrier shall be constructed of minimum 22 gauge (0.7 mm) sheet metal or of minimum 3/8 in. (10 mm) plywood.

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

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

17.1.2.9.4 In-Rack Sprinklers. Minimum K-8.0 (K-115) quick-response sprinklers (ceiling-level or in-rack) shall be installed beneath each horizontal barrier. The deflector of the sprinkler shall be located as close to the underside of the horizontal barrier as possible.

17.1.2.9.4.1 Single-Row Racks.

(A) For single-row racks, sprinklers shall be installed at each rack upright and at each rack mid-bay as shown in Figure 17.1.2.9.4.1(A).

Figure 17.1.2.9.4.1(A) Alternative Protection Single-Row Racks.
(B) The maximum linear spacing between sprinklers shall not exceed 5 ft (1.5 m).

17.1.2.9.4.2 Double-Row Racks.

(A) For double-row racks, sprinklers shall be installed at each rack upright within the longitudinal flue space and at the face of the rack and at the mid-bay face of each rack bay as shown in Figure 17.1.2.9.4.2(A).

Figure 17.1.2.9.4.2(A) Alternative Protection Double-Row Racks.
(B) The maximum linear spacing between sprinklers shall not exceed 5 ft (1.5 m) at the rack face and 10 ft (3.0 m) within the longitudinal flue space.

17.1.2.9.4.3 Multiple-Row Racks.

(A) For multiple-row racks, an alternating sprinkler arrangement shall be installed within adjacent transverse flue spaces, as shown in Figure 17.1.2.9.4.3(A), with sprinklers at the face of each flue space.

Figure 17.1.2.9.4.3(A) Alternative Protection Multiple-Row Racks.
Plan View

- 5 ft (1.5 m) max
- Horizontal barrier

Elevation View

- 3 in. (75 mm) max gap at rack upright
- 12 ft (3.7 m) max
(B) The maximum linear spacing between sprinklers at the face and each alternating bay shall not exceed 5 ft (1.5 m) and shall not exceed 10 ft (3.0 m) between sprinklers at every other bay.

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

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

17.1.2.9.7 Ceiling Sprinkler System. The ceiling-level sprinkler system shall be designed based on the highest commodity hazard not protected by the criteria prescribed by 17.1.2.9.

17.1.3 Movable Racks. Rack storage in movable racks shall be protected in the same manner as multiple-row racks.

17.1.4 Fire Protection of Steel Columns — Columns Within Storage Racks. See Section C.10.

17.1.4.1* Where fireproofing of building columns is not provided and storage heights are in excess of 15 ft (4.6 m), protection of building columns located wholly or partially within the rack footprint inclusive of flue space or within 12 in. (305 mm) of the footprint shall be protected in accordance with one of the following:

(1) In-rack sprinklers
(2) Sidewall sprinklers at the 15 ft (4.6 m) elevation, pointed toward one side of the steel column
(3) Provision of ceiling sprinkler density for a minimum of 2000 ft² (186 m²) with ordinary temperature—or high temperature-rated sprinklers as shown in Table 17.1.4.1 for storage heights above 15 ft (4.6 m) up to and including 20 ft (6.1 m)
(4) Provision of CMSA or ESFR ceiling sprinkler protection

| Table 17.1.4.1 Ceiling Sprinkler Densities for Protection of Steel Building Columns |
|---------------------------------|-------------------------------|-------------------------------|
| **Commodity Classification**    | **Aisle Width**               | **4 ft (1.2 m)** | **8 ft (2.4 m)** |
|                                 |                               | gpm/ft² | (L/min)/m² | gpm/ft² | (L/min)/m² |
| Group A plastics                |                               | 0.68    | 27.7       | 0.57    | 23.2       |

17.1.4.2 Where storage heights are in excess of 15 ft (4.6 m) and vertical rack members support the building structure, the vertical rack members shall be protected in accordance with one of the options in 17.1.4.1.

17.1.4.3 The flow from a column sprinkler(s) shall be permitted to be omitted from the sprinkler system hydraulic calculations.
17.1.5 Solid Shelving.

17.1.5.1 Where solid shelving in single-, double-, and multiple-row racks exceeds 20 ft² (1.9 m²) but does not exceed 64 ft² (5.9 m²) in area, sprinklers shall not be required below every shelf, but shall be installed at the ceiling and below shelves at intermediate levels not more than 6 ft (1.8 m) apart vertically. (See Section C.11.)

17.1.5.2 Where solid shelving in single-, double-, and multiple-row racks exceeds 64 ft² (5.9 m²) in area or where the levels of storage exceed 6 ft (1.8 m), sprinklers shall be installed at the ceiling and below each level of shelving.

17.1.5.3 Where multiple-row racks of any height have no longitudinal flue or where double-row racks with storage up to 25 ft (7.6 m) in height have no longitudinal flue, the situation shall not be considered solid shelves where transverse flues exist at maximum 5 ft (1.5 m) intervals and additional in-rack sprinklers shall not be required in accordance with 17.1.5.1 and 17.1.5.2.

17.1.5.4 The maximum horizontal spacing between in-rack sprinklers shall be 5 ft (1.5 m).

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

17.1.5.6 Where the criteria in 17.1.5.7 are not met, the water demand for the in-rack sprinklers shall be based on a minimum flow of 30 gpm (115 L/min) discharging from the following number of sprinklers balanced to the ceiling sprinkler demand in accordance with Section 23.8:
   (1) Eight sprinklers where only one level of in-rack sprinklers is installed
   (2) Fourteen sprinklers (seven on each of the top two levels) when more than one level of in-rack sprinklers is installed

17.1.5.7 The water demand for in-rack sprinklers shall not be required to be balanced to the ceiling sprinkler demand where additional face sprinklers are installed under each solid shelf at rack uprights and the in-rack sprinklers are calculated to discharge at least 60 gpm (230 L/min) from eight sprinklers.

17.1.5.8 Where solid shelves obstruct only a portion of the rack, in-rack sprinklers shall be installed horizontally, within the flue a minimum of 4 ft (1.2 m) beyond the end of the solid shelf, and vertically as follows:
   (1) In accordance with 17.1.5.1 and 17.1.5.2 for CMDA sprinklers
   (2) Beneath all tiers under the highest solid shelf for CMSA and ESFR sprinklers

17.1.6 Open-Top Containers. The protection of open-top containers is outside the scope of Chapter 17. (See Section C.12.)

17.1.7 In-Rack Sprinklers.
17.1.7.1 The number of sprinklers and the pipe sizing on a line of sprinklers in racks shall be restricted only by hydraulic calculations and not by any piping schedule.

17.1.7.2 When in-rack sprinklers are necessary to protect a higher hazard commodity that occupies only a portion of the length of a rack, in-rack sprinklers shall be extended a minimum of 8 ft (2.4 m) or one bay, whichever is greater, in each direction along the rack on either side of the higher hazard.

17.1.7.2.1 The in-rack sprinklers protecting the higher hazard shall not be required to be extended across the aisle.

17.1.7.3 Where a storage rack, due to its length, requires less than the number of in-rack sprinklers specified, only those in-rack sprinklers in a single rack need to be included in the calculation.

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

17.1.7.4.1 Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

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

17.1.7.4.3 For storage over 25 ft in height, in-rack sprinklers in longitudinal flues shall be installed with the deflector located at or below the bottom of horizontal load beams or above or below other adjacent horizontal rack members, and such in-rack sprinklers shall be a minimum of 3 in. (76 mm) radially from the side of the rack uprights.

17.1.8* Horizontal Barriers and In-Rack Sprinklers.

17.1.8.1 Horizontal barriers used in conjunction with in-rack sprinklers to impede vertical fire development shall be constructed of sheet metal, wood, or similar material and shall extend the full length and depth of the rack.

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

17.1.9 Flue Space Requirements for Storage Up to and Including 25 ft (7.6 m).
See Section C.13.

17.1.9.1 In double- and multiple-row open racks, a longitudinal (back-to-back clearance between loads) flue space shall not be required.
17.1.9.2 Nominal 6 in. (150 mm) transverse flue spaces between loads and at rack uprights shall be maintained in single-, double-, and multiple-row racks.

17.1.9.3 Random variations in the width of flue spaces or in their vertical alignment shall be permitted.

17.1.10 Flue Space Requirements for Storage Over 25 ft (7.6 m).

17.1.10.1 Nominal 6 in. (150 mm) longitudinal flue spaces shall be provided in double-row racks.

17.1.10.1.1 Nominal 6 in. (150 mm) transverse flue spaces between loads and at rack uprights shall be maintained in single-, double-, and multiple-row racks.

17.1.10.1.2 Random variations in the width of the flue spaces or in their vertical alignment shall be permitted.

17.2 Protection Criteria for Rack Storage of Group A Plastic Commodities Stored Up to and Including 25 ft (7.6 m) in Height.

17.2.1.1 Storage 5 ft (1.5 m) or Less in Height. For the storage of Group A plastics stored 5 ft (1.5 m) or less in height, the sprinkler design criteria for miscellaneous storage specified in Chapter 13 shall be used.

17.2.1.1.1 For storage 5 ft (1.5 m) or less in height that does not meet the definition of Miscellaneous Storage that is on solid shelf racks, in-rack sprinklers shall be provided in accordance with 17.1.5, and ceiling sprinkler protection shall be provided in accordance with Chapter 13.

17.2.1.2 Ceiling Sprinkler Water Demand. See Section C.22.

17.2.1.5 In-Rack Sprinkler Requirements Where Control Mode Density/Area Sprinklers Are Being Used at Ceiling.

17.2.1.5.1 In-Rack Sprinkler Clearance. The minimum of 6 in. (150 mm) vertical clear space shall be maintained between the sprinkler deflectors and the top of a tier of storage.

(A) Sprinkler discharge shall not be obstructed by horizontal rack members.

17.2.1.5.2 The spacing of in-rack sprinklers shall be in accordance with Figure 17.2.1.2.1(a) through Figure 17.2.1.2.1(f).

17.2.1.5.3 In-rack sprinklers shall be located at an intersection of transverse and longitudinal flues while not exceeding the maximum spacing rules.
17.2.1.5.4 Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

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

17.2.1.5.6 In-Rack Sprinkler Water Demand. The water demand for sprinklers installed in racks shall be based on simultaneous operation of the most hydraulically remote sprinklers as follows:
(1) Eight sprinklers where only one level is installed in racks
(2) Fourteen sprinklers (seven on each top two levels) where more than one level is installed in racks

17.2.1.5.7 In-Rack Sprinkler Discharge Pressure. Sprinklers in racks shall discharge at not less than 15 psi (1.0 bar) for all classes of commodities. (See Section C.19.)

17.2.2 CMSA Sprinklers for Rack Storage of Group A Plastic Commodities Stored Up to and Including 25 ft (7.6 m) in Height.

17.2.2.1.1 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 17.1.5.

17.2.2.1.1.1 Where solid shelves are used, in-rack sprinklers shall be installed in every level below the highest solid shelf.

17.2.2.2 Protection shall be provided as specified in Table 17.2.2.1 or appropriate NFPA standards in terms of minimum operating pressure and the number of sprinklers to be included in the design area.

17.2.2.3 Open Wood Joist Construction.

17.2.2.3.1 Where CMSA sprinklers are installed under open wood joist construction, firestopping in accordance with 17.2.2.3.2 shall be provided or the minimum operating pressure of the sprinklers shall be 50 psi (3.4 bar) for a K-11.2 (160) sprinkler or 22 psi (1.5 bar) for a K-16.8 (240) sprinkler.

17.2.2.3.2 Where each joist channel of open wood joist construction is fully firestopped to its full depth at intervals not exceeding 20 ft (6.1 m), the lower pressures specified in Table 17.2.2.1 shall be permitted to be used.

17.2.2.4 Preaction Systems. For the purpose of using Table 17.2.2.1, preaction systems shall be classified as dry pipe systems.
17.2.2.5 Building steel shall not require special protection where Table 17.2.2.1 is applied as appropriate for the storage configuration.

17.2.2.6 In-Rack Sprinkler Requirements Where CMSA Sprinklers Are Used at Ceiling.

17.2.2.6.1 In-rack sprinklers shall be installed at the first tier level at or above one-half of the storage height.

17.2.2.6.2 The minimum of 6 in. (150 mm) vertical clear space shall be maintained between the sprinkler deflectors and the top of a tier of storage.

   (A) Sprinkler discharge shall not be obstructed by horizontal rack members.

17.2.2.6.3* In-rack sprinklers shall be located at an intersection of transverse and longitudinal flues.

17.2.2.6.4 The maximum horizontal distance between in-rack sprinklers shall be 5 ft (1.5 m).

17.2.2.6.5 Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

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

17.2.2.6.7 In-Rack Sprinkler Water Demand. The water demand for sprinklers installed in racks shall be based on simultaneous operation of the most hydraulically remote eight sprinklers.

17.2.2.6.8 In-Rack Sprinkler Discharge Pressure. Sprinklers in racks shall discharge at not less than 15 psi (1.0 bar) for all classes of commodities. (See Section C.19.)

17.2.3.1.1 ESFR protection as defined shall not apply to the following:

(1) Rack storage involving solid shelves, except as permitted by 17.2.3.1.2

(2) Rack storage involving open-top cartons or containers

17.2.3.1.2 ESFR sprinklers shall not be permitted to protect storage on solid shelf racks unless the solid shelf racks are protected with in-rack sprinklers in accordance with 17.1.5.

17.2.3.1.2.1 Where solid shelves are used, in-rack sprinklers shall be installed in every level below the highest solid shelf.

17.2.3.2 ESFR sprinkler systems shall be designed such that the minimum operating pressure is not less than that indicated in Table 17.2.3.1 for type of storage, commodity, storage height, and building height involved.
17.2.3.3 The design area shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of three branch lines.

17.2.3.4 In-Rack Sprinkler Requirements Where ESFR Sprinklers Are Used at Ceiling.

17.2.3.4.1 Where required by Table 17.2.3.1, in-rack sprinklers shall be installed at the first-tier level at or above one-half of the storage height.

17.2.3.4.2 In-rack sprinklers shall be K-8.0 (115) or K-11.2 (160) quick-response, ordinary-temperature sprinklers.

17.2.3.4.3 The minimum of 6 in. (150 mm) vertical clear space shall be maintained between the sprinkler deflectors and the top of a tier of storage.

(A) Sprinkler discharge shall not be obstructed by horizontal rack members.

17.2.3.4.4 The maximum horizontal distance between in-rack sprinklers shall be 5 ft (1.5 m).

17.2.3.4.5* In-rack sprinklers shall be located at an intersection of transverse and longitudinal flues while not exceeding the maximum spacing rules.

17.2.3.4.6 Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

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

17.2.3.4.8 The water demand for sprinklers installed in racks shall be based on simultaneous operation of the most hydraulically remote eight sprinklers.

17.2.3.4.9 Each of the in-rack sprinklers described in 17.2.3.4.8 shall discharge at a minimum of 60 gpm (227 L/min).

17.2.4 Special Design for Rack Storage of Plastics Commodities Stored Up to and Including 25 ft (7.6 m) in Height.

17.2.4.1 Slatted Shelves.

17.2.4.1.1* Slatted rack shelves shall be considered equivalent to solid rack shelves where the shelving is not considered open rack shelving or where the requirements of 17.2.4.1 are not met. (See Section C.20.)
17.2.4.1.2 A wet pipe system that is designed to provide a minimum of 0.6 gpm/ft² (24.4 mm/min) density over a minimum area of 2000 ft² (186 m²) or K-14.0 (200) ESFR sprinklers operating at a minimum of 50 psi (3.4 bar), K-16.8 (240) sprinklers operating at a minimum of 32 psi (2.2 bar), or K-25.2 (360) ESFR sprinklers operating at a minimum of 15 psi (1.0 bar) shall be permitted to protect single- and double-row racks with slatted rack shelving racks where all of the following conditions are met:

1. Sprinklers shall be K-11.2 (160), K-14.0 (200), or K-16.8 (240) orifice spray sprinklers with a temperature rating of ordinary, intermediate, or high and shall be listed for storage occupancies or shall be K-14.0 (200), K-16.8 (240), or K-25.2 (360) ESFR.

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

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

4. Where K-11.2 (160), K-14.0 (200), or K-16.8 (240) orifice sprinklers are used, there shall be no slatted shelf levels in the rack above 12 ft (3.7 m). Open rack shelving using wire mesh shall be permitted for shelf levels above 12 ft (3.7 m).

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

6. Longitudinal flue spaces at least 6 in. (150 mm) wide shall be provided for double-row racks. Longitudinal flue spaces shall not be required when ESFR sprinklers are used.

7. The aisle widths shall be at least 7 1⁄2 ft (2.3 m).

8. The maximum roof height shall be 27 ft (8.2 m) or 30 ft (9.1 m) where ESFR sprinklers are used.

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

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

17.3 Protection Criteria for Rack Storage of Group A Plastic Commodities Stored Over 25 ft (7.6 m) in Height.

17.3.1.4 For protection of cartoned storage of Group A plastics, expanded or unexpanded, whether encapsulated or nonencapsulated, on single-row racks, in-rack sprinklers shall be arranged in accordance with one of the options in Figure 17.3.1.4(a) through Figure 17.3.1.4(c) or Figure 17.3.1.7. The highest level of in-rack sprinklers shall be not more than 10 ft (3.0 m) below the top of storage.

Figure 17.3.1.4(a) In-Rack Sprinkler Arrangement, Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.
Figure 17.3.1.4(b) In-Rack Sprinkler Arrangement, Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2.

Elevation View
Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
Figure 17.3.1.4(c) In-Rack Sprinkler Arrangement, Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3.

Elevation View

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
For protection of cartoned storage of Group A plastics, expanded or unexpanded, whether encapsulated or nonencapsulated, on double-row racks, in-rack sprinklers shall be arranged in accordance with one of the double-row rack options in Figure 17.3.1.5(a), Figure 17.3.1.5(b), or Figure 17.3.1.7. The highest level of in-rack sprinklers shall be not more than 10 ft (3.0 m) below the top of storage.

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
Figure 17.3.1.5(a) In-Rack Sprinkler Arrangement, Group A Plastic Commodities, Storage Height Over 25 ft (7.6 m) — Option 1.

**Notes:**
1. Sprinklers and barriers labeled 1 shall be required where loads labeled A or B represent top of storage.
2. Sprinklers labeled 1 and 2 and barriers labeled 1 shall be required where loads labeled C represent top of storage.
3. Sprinklers and barriers labeled 1 and 3 shall be required where loads labeled D or E represent top of storage.
4. For storage higher than represented by loads labeled E, the cycle defined by Notes 2 and 3 is repeated.
5. Symbol Δ or x indicates face sprinklers on vertical or horizontal stagger.
6. Symbol o indicates longitudinal flue space sprinklers.
7. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
17.3.1.5(b) In-Rack Sprinkler Arrangement, Group A Plastic Commodities, Storage Height Over 25 ft (7.6 m) — Option 2.

Figure 17.3.1.5(b) In-Rack Sprinkler Arrangement, Group A Plastic Commodities, Storage Height Over 25 ft (7.6 m) — Option 2.

Notes:
1. Sprinklers labeled 1 shall be required where loads labeled A or B represent top of storage.
2. Sprinklers labeled 1 and 2 shall be required where loads labeled C represent top of storage.
3. Sprinklers labeled 1 and 3 shall be required where loads labeled D or E represent top of storage.
4. For storage higher than loads labeled F, the cycle defined by Notes 2 and 3 is repeated.
5. Symbol x indicates face and in-rack sprinklers.
6. Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.

17.3.1.6 Where a single-row rack of cartoned Group A plastic storage is mixed with double-row racks of cartoned Group A plastic storage, either Figure 17.3.1.5(a) or Figure 17.3.1.5(b) shall be permitted to be used in accordance with the corresponding storage height. The highest level of in-rack sprinklers shall be not more than 10 ft (3.0 m) below the top of storage.
17.3.1.7 For protection of storage of exposed unexpanded Group A plastics, whether encapsulated or nonencapsulated, on single racks or double row racks, in-rack sprinklers shall be arranged in accordance with Figure 17.3.1.7. The highest level of in-rack sprinklers shall be not more than 10 ft (3.0 m) below the top of storage. Where this figure is used, aisles shall be at least 4 ft (1.2 m) wide and the ceiling sprinklers shall be designed for a minimum discharge density of 0.45 gpm/ft² over 2000 ft² (18.3 mm/min over 186 m²).

Figure 17.3.1.7 In-Rack Sprinkler Arrangement, Cartoned Expanded and Nonexpanded Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Single- and Double-Row Racks, Storage Height Over 25 ft (7.6 m).

17.3.1.8 For protection of storage of exposed unexpanded Group A plastics, whether encapsulated or nonencapsulated, or cartoned Group A plastics, expanded or unexpanded, whether encapsulated or nonencapsulated, on multiple-row racks, in-rack sprinklers shall be arranged in accordance with one of the options in Figure 17.3.1.8(a) through Figure 17.3.1.8(f).
The highest level of in-rack sprinklers shall be not more than 10 ft (3.0 m) below the top of storage.

Figure 17.3.1.8(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m)—Option 1 [10 ft (3.0 m) Maximum Spacing].

Figure 17.3.1.8(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m)—Option 2 [10 ft (3.0 m) Maximum Spacing].
Figure 17.3.1.8(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic, Multiple Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1 [5 ft (1.5 m) Maximum Spacing].

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

Elevation View

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
Figure 17.3.1.8(d) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Uncartonned Unexpanded Group A Plastic, Multiple-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 2 [5 ft (1.5 m) Maximum Spacing].

Plan View

Elevation View

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
Figure 17.3.1.8(e) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic, Multiple Row Racks, Storage Height Over 25 ft (7.6 m) — Option 3 [5 ft (1.5 m) Maximum Spacing].

Figure 17.3.1.8(f) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic and Exposed Nonexpanded Group A Plastic, Multiple Row Racks, Storage Height Over 25 ft (7.6 m) — Option 4 [5 ft (1.5 m) Maximum Spacing].

Note: Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. (450 mm) up to 10 ft (3.0 m). Therefore, there could be as few as one load or as many as six or seven loads between in-rack sprinklers that are spaced 10 ft (3.0 m) apart vertically.
17.3.1.9 The minimum of 6 in. (150 mm) vertical clear space shall be maintained between the in-rack sprinkler deflectors and the top of a tier of storage.

(A) Sprinkler discharge shall not be obstructed by horizontal rack members.
17.3.1.10 In-rack sprinklers shall be located at an intersection of transverse and longitudinal flues while not exceeding the maximum spacing rules.

17.3.1.11 Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

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

17.3.1.13 In-rack sprinklers shall be a minimum of 3 in. (76 mm) radially from the side of the rack uprights.

17.3.1.14 Face sprinklers in such racks shall be located within the rack a minimum of 3 in. (75 mm) from rack uprights and no more than 18 in. (450 mm) from the aisle face of storage.

17.3.1.15 In-Rack Sprinkler Water Demand. The water demand for sprinklers installed in racks shall be based on simultaneous operation of the most hydraulically remote sprinklers as follows:
(1) Eight sprinklers where only one level is installed in racks
(2) Fourteen sprinklers (seven on each top two levels) where more than one level is installed in racks

17.3.1.16 In-Rack Sprinkler Discharge Pressure. Sprinklers in racks shall discharge at not less than 30 gpm (115 L/min).

17.3.1.17 [move to 21.5.4.4] The minimum water supply requirements for a hydraulically designed occupancy hazard fire control sprinkler system shall be determined by adding the hose stream allowance from Table 17.3.1.17 to the water supply for sprinklers determined in Section 17.3.

Table 17.3.1.17 Hose Stream Allowance and Water Supply Duration Requirements for Rack Storage of Group A Plastic Commodities Stored Over 25 ft (7.6 m) in Height

<table>
<thead>
<tr>
<th>Commodity Classification</th>
<th>Storage Height</th>
<th>Inside-Hose</th>
<th>Total Combined Inside and Outside-Hose</th>
<th>Duration (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ft</td>
<td>m</td>
<td>gpm</td>
<td>L/min</td>
</tr>
<tr>
<td>Plastic</td>
<td>&gt;25</td>
<td>&gt;7.6</td>
<td>0,50</td>
<td>or 100</td>
</tr>
</tbody>
</table>

17.3.2 CMSA Sprinklers for Rack Storage of Plastic Commodities Stored Over 25 ft (7.6 m) in Height.

17.3.2.1 Protection of single-, double-, and multiple-row rack storage for cartoned, unexpanded Group A plastic commodities shall be in accordance with Table 17.3.2.1.
Table 17.3.2.1 CMSA Sprinkler Design Criteria for Single-, Double-, and Multiple-Row Racks of Group A Plastic Commodities Stored Over 25 ft (7.6 m) in Height

<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Commodity Class</th>
<th>Maximum Storage Height ft</th>
<th>Maximum Ceiling/ Roof Height ft</th>
<th>K-Factor/ Orientation</th>
<th>Type of System</th>
<th>Number of Design Sprinklers</th>
<th>Minimum Operating Pressure psi</th>
<th>Minimum Operating Pressure bar</th>
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</thead>
<tbody>
<tr>
<td>Single-, double-, and multiple-row racks (no open-top containers)</td>
<td>Cartoned, unexpanded plastics</td>
<td>30</td>
<td>9.1</td>
<td>35</td>
<td>11</td>
<td>Wet</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>35</td>
<td>11</td>
<td>40</td>
<td>12</td>
<td>19.6 (280) Pendent</td>
<td>15</td>
<td>30</td>
</tr>
</tbody>
</table>

17.3.2.1.1 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 17.1.5.

17.3.2.1.1.1 Where solid shelves are used, in-rack sprinklers shall be installed in every level below the highest solid shelf.

17.3.2.2 Protection shall be provided as specified in Table 17.3.2.1 or appropriate NFPA standards in terms of minimum operating pressure and the number of sprinklers to be included in the design area.

17.3.2.3 [move to 22.1.4.1] The design area shall be a rectangular area having a dimension parallel to the branch lines at least 1.2 times the square root of the area protected by the number of sprinklers to be included in the design area. Any fractional sprinkler shall be included in the design area.

17.3.2.4 Building steel shall not require special protection where Table 17.3.2.1 is applied as appropriate for the storage configuration.

17.3.2.5* In-Rack Sprinklers. (Reserved)

17.3.3* Early Suppression Fast-Response (ESFR) Sprinklers for Rack Storage of Group A Plastic Commodities Stored Over 25 ft (7.6 m) in Height.

17.3.3.1 Protection of single-, double-, and multiple-row rack storage of cartoned or exposed, unexpanded Group A plastic shall be in accordance with Table 17.3.3.1.

Table 17.3.3.1 ESFR Protection of Rack Storage of Group A Plastic Commodities Stored Over 25 ft (7.6 m) in Height
<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Commodity</th>
<th>Maximum Storage Height</th>
<th>Maximum Ceiling/Roof Height</th>
<th>Nominal K-Factor</th>
<th>Orientation</th>
<th>Minimum Operating Pressure psi</th>
<th>In-Rack Sprinkler Requirement</th>
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</thead>
<tbody>
<tr>
<td>Single-, double-, and multiple-row racks (no open-top containers)</td>
<td>Cartoned unexpanded</td>
<td>30 9.1</td>
<td>40 12</td>
<td>35 11</td>
<td>14.0 (200)</td>
<td>Upright/pendent</td>
<td>75 5.2</td>
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<tr>
<td></td>
<td></td>
<td>40 12</td>
<td>45 14</td>
<td>45 14</td>
<td>16.8 (240)</td>
<td>Pendent</td>
<td>52 3.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22.4 (320)</td>
<td>Pendent</td>
<td>35 2.4</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25.2 (360)</td>
<td>Pendent</td>
<td>20 1.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>35 11</td>
<td>45 14</td>
<td>45 14</td>
<td>16.8 (240)</td>
<td>Pendent</td>
<td>52 3.6</td>
</tr>
<tr>
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<td></td>
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<td>40 2.7</td>
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<td>63 4.3</td>
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<td>Maximum Ceiling/Roof Height</td>
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<td>Orientation</td>
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<td>In-Rack Sprinkler Requirements</td>
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<td>Exposed unexpanded</td>
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<td>63 4.3</td>
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17.3.3.1.1 ESFR sprinklers shall not be permitted to protect storage on solid shelf racks unless the solid shelf racks are protected with in-rack sprinklers in accordance with 17.1.5.

17.3.3.1.1.1 Where solid shelves are used, in-rack sprinklers shall be installed in every level below the highest solid shelf.
17.3.3.1.2 ESFR sprinklers shall not be permitted to protect storage with open-top containers.

17.3.3.2 ESFR sprinkler systems shall be designed such that the minimum operating pressure is not less than that indicated in Table 17.3.3.1 for type of storage, commodity, storage height, and building height involved.

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

17.3.3.4 Where required by Table 17.3.3.1, one level of K-8.0 (115) or K-11.2 (160) quick-response, ordinary-temperature in-rack sprinklers shall be installed at the tier level closest to but not exceeding one-half of the maximum storage height.

17.3.3.4.1 In-rack sprinkler hydraulic design criteria shall be the most hydraulically remote eight sprinklers at 60 gpm (230 L/min).

17.3.3.4.2 In-rack sprinklers shall be located at the intersection of the longitudinal and transverse flue space.

17.3.3.4.3 Horizontal spacing shall not be permitted to exceed 5 ft (1.5 m) intervals.

17.3.3.4.4 The minimum of 6 in. (150 mm) vertical clear space shall be maintained between the sprinkler deflectors and the top of a tier of storage.

(A) Sprinkler discharge shall not be obstructed by horizontal rack members.

17.3.3.4.5 In-rack sprinklers shall be located at an intersection of transverse and longitudinal flues while not exceeding the maximum spacing rules.

17.3.3.4.6 Where distances between transverse flues exceed the maximum allowable distances, sprinklers shall be installed at the intersection of the transverse and longitudinal flues, and additional sprinklers shall be installed between transverse flues to meet the maximum distance rules.

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

17.3.3.4.8 In-rack sprinklers shall be a minimum of 3 in. (75 mm) radially from the side of the rack uprights.

17.3.3.4.9 Face sprinklers in such racks shall be located within the rack a minimum of 3 in. (75 mm) from rack uprights and no more than 18 in. (450 mm) from the aisle face of storage.

17.3.3.5* Protection of Exposed Expanded Group A Plastics.
17.3.3.5.1 Protection of single-, double-, and multiple row rack storage of exposed expanded Group A plastics shall be permitted to be in accordance with 17.3.3.5.2 through 17.3.3.5.8.

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

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

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

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

17.3.3.5.6 The minimum operating pressure shall be 60 psi (4.1 bar).

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

17.3.3.5.8 The rack shall have a solid vertical barrier of 3/8 in. (9.5 mm) plywood or particleboard, 22-gauge sheet metal, or equivalent, from face of rack to face of rack, spaced at a maximum 16.5 ft (5.0 m) interval.

17.3.3.5.8.1 The vertical barrier shall extend from a maximum of 4 in. (102 mm) above the floor to the maximum storage height.

17.3.3.5.8.2 The plan area of storage between vertical barriers and aisles shall not exceed 124 ft² (11.52 m²).

17.3.3.5.8.3 The vertical barrier shall extend across the longitudinal flue.

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

Supplemental Information

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Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Wed Aug 31 09:02:53 EDT 2016

Committee Statement

Committee Statement: Deletes text that was previously moving to Chapter 25.
Response Message:
Chapter 18—Protection of Rubber-Tire Storage

18.1 General. The requirements of Chapter 12 shall apply unless modified by this chapter.

18.5 In-Rack Sprinkler System Requirements for Protection of Rubber Tires. In-rack sprinklers, where provided, shall be installed in accordance with Chapter 17, except as modified by 18.5.2 through 18.5.4.

18.5.2 The maximum horizontal spacing of sprinklers in racks shall be 8 ft (2.4 m).

18.5.3 Water demand for sprinklers installed in racks shall be based on simultaneous operation of the most hydraulically remote 12 sprinklers where only one level is installed in racks.

18.5.4 Sprinklers in racks shall discharge at not less than 30 psi (2.1 bar).
Supplemental Information

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</table>

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Wed Aug 31 09:03:50 EDT 2016

Committee Statement

Committee Statement: Deletes text that was previously moving to Chapter 25.
Response Message:
Chapter 23—Plans and Calculations

23.4.5.2 Water demand of sprinklers installed in racks shall be added to ceiling sprinkler water demand over the same protected area at the point of connection.

23.4.5.3 The demand shall be balanced to the higher pressure.
Add new Chapter 25 In-Rack Sprinkler Requirements. See attached word doc

Supplemental Information

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Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 31 09:05:19 EDT 2016

Committee Statement

Committee Statement: Based on the recommendation of the NFPA 13 Discharge Committee, the Chapters 24 and 25 Task Group put together a draft version of Chapter 25 with ceiling-level sprinkler designs included in the chapter so that flipping between Chapter 25 and other chapters could be minimized. The draft version of Chapter 25 was developed based on this concept and arranged so that there were no technical changes incorporated to the content of the chapter. However, the wording of many individual sections has been modified from its original language in an effort to create a common style of presenting the guidance. As a result, a majority of the wording from the 2016 edition has been modified, but only in the way the wording is presented, not in the technical guidance the wording provides.

Response Message:

Public Input No. 359-NFPA 13-2016 [Sections 16.1.6.1, 16.1.6.2]
Task Group 25 Draft Version of Chapter 25

25 Protection of Rack Storage Using In-Rack Sprinklers

25.1 General Requirements of In-Rack Sprinklers

25.1.1 Scope. This section shall apply where rack storage of Class I through Class IV commodities, Group A plastic commodities, or rubber tires will be protected with in-rack sprinklers.

25.1.2 Open-Frame Storage Racks

25.1.2.1 The in-rack sprinkler arrangements as well as the ceiling and in-rack sprinkler design criteria for rack storage in this chapter shall be based on open-frame rack configurations as defined in 3.3.139 unless indicated otherwise.

25.1.2.2 Where Group A commodities are being stored in racks with aisles less than 3.5 ft (1.1 m) wide, in-rack sprinkler protection shall be in accordance with the guidelines for multiple-row racks.

25.1.2.3 Where open-frame double-row racks with storage up 25 ft (7.6 m) in height have no longitudinal flue, but have transverse flues at maximum 5 ft (1.5 m) intervals, the double-row rack storage arrangement shall be considered open-frame.

25.1.2.4 Where multiple-row racks of any height have no longitudinal flue, but have transverse flues at maximum 5 ft (1.5 m) intervals, the multiple-row rack storage arrangement shall be considered open-frame.

25.1.3 In-Rack Sprinkler System

25.1.3.1 In-Rack Sprinkler System Size

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

25.1.3.1.2 An in-rack sprinkler system shall be permitted to be supplied from the overhead ceiling sprinkler system where the area of the racks protected by the in-rack sprinklers, including the adjacent aisles, do not exceed 8,000 ft² (740 m²).

25.1.3.2* In-Rack Sprinkler System Control Valves

A.25.1.3.2 In-rack sprinklers and ceiling sprinklers selected for protection should be controlled by at least two separate indicating valves and drains. In higher rack arrangements, consideration should be given to providing more than one in-rack control valve in order to limit the extent of any single impairment.

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

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

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

25.1.3.3* Sprinkler Waterflow Alarm for In-Rack Sprinklers. See Section C.4.

A.25.1.3.3 Central station, auxiliary, remote station, or proprietary protective signaling systems are a highly desirable supplement to local alarms, especially from a safety to life standpoint. (See 16.11.10.) Approved identification signs, as shown in Figure A.25.1.3.3, should be provided for outside alarm devices. The sign should be located near the device in a conspicuous position and should be worded as follows:
25.1.4 Flue Space Requirements for Racks Protected by In-Rack Sprinklers.

25.1.4.1 Where in-rack sprinklers are protecting rack storage, nominal 6 in. (150 mm) transverse flue spaces between loads and at rack uprights shall be maintained.

25.1.4.2 Where in-rack sprinklers are protecting rack storage, random variations in the width of flue spaces or in their vertical alignment shall be permitted.

25.1.4.3 Where in-rack sprinklers are protecting double- and multiple-row rack storage up to and including 25 ft (7.6 m) in height, a longitudinal (back-to-back clearance between loads) flue space shall not be required.

25.1.4.4 Where in-rack sprinklers are protecting double-row racks over 25 ft (7.6 m) in height, nominal 6 in. (150 mm) longitudinal flue spaces shall be provided.

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

25.1.6 Movable Racks. Rack storage in movable racks shall be protected in the same manner as multiple-row racks.

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

25.2.1 General.

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

A.25.2.1.1 The fire protection system design should consider the maximum storage height. For new sprinkler installations, maximum storage height is the usable height at which commodities can be stored above the floor while the minimum required unobstructed space below sprinklers is maintained. Where evaluating existing situations, maximum storage height is the maximum existing storage height if space between the sprinklers and storage is equal to or greater than that required.

25.2.1.2* Ceiling-level sprinkler design criteria for single-, double-, and multiple-row racks in 25.2 shall be based on open rack configurations as defined in 3.3.139.

A.25.2.1.2 Solid shelf racks as defined in 3.3.198 or obstructions resulting in solid shelf requirements could require additional in-rack sprinklers that could affect the ceiling design requirements.

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

A.25.2.1.3 Information for the protection of Classes I, II, III, and IV commodities was extrapolated from full-scale fire tests that were performed at different times than the tests that were used to develop the protection for plastic commodities. It is possible that, by selecting certain points from the tables (and after applying the appropriate modifications), the protection specified by 25.2.3.2.4 for Class I through Class IV commodities exceeds the requirements for Group A plastic commodities. In such situations, the protection specified for plastics, although less than that required by the tables, can adequately protect Class I, II, III, and IV commodities. This section also allows storage areas that are designed to protect plastic commodities to store Class I, II, III, and IV commodities without a re-evaluation of fire protection systems.

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

25.2.1.5 Ceiling-level sprinkler design criteria for rack storage of Group A plastic commodities shall be protected as multiple-row racks where aisles are less than 3.5 ft (1.1 m) in width.
25.2.1.6 The minimum water supply requirements for a hydraulically designed occupancy hazard automatic ceiling-level sprinkler system shall be determined by adding the hose stream allowance from Table 20.12.2.6 to the water supply for in-rack sprinklers determined in Section 25.12, unless indicated otherwise.

25.2.2 Miscellaneous and Low-Piled Storage.

25.2.2.1 Miscellaneous Storage.

25.2.2.1.1 This section shall apply to any of the following situations:

25.2.2.1.1(1) Miscellaneous storage of Class I through Class IV commodities up to and including 12 ft (3.7 m) in height.

25.2.2.1.1(2) Miscellaneous storage of Group A plastic commodities up to and including 12 ft (3.7 m) in height.

25.2.2.1.1(3) Miscellaneous storage of rubber tires up to and including 12 ft (3.7 m) in height.

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

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

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

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

25.2.2.2 Low-Piled Storage.

25.2.2.2.1 This section shall apply to any of the following situations:

25.2.2.2.1(1) Storage of Class I through Class IV commodities up to 12 ft and including (3.7 m) in height.

25.2.2.2.1(2)* Storage of Group A plastic commodities up to and including 5 ft (1.5 m) in height.

A.25.2.2.2.1(2) All rack fire tests of plastic commodities were run with an approximate 10 ft (3.0 m) maximum clearance to ceiling.

25.2.2.2.2 For low-piled rack storage with solid shelves of Class I through Class-IV commodities up to and including 12 ft (3.7 m) in height, in-rack sprinklers shall be provided in accordance with Section 25.6, and the ceiling-level sprinkler design shall be in accordance with Figure 25.2.2.1.2.

25.2.2.2.3 For low-piled rack storage with solid shelves of Group A plastic commodities up to and including 5 ft (1.5 m) in height, in-rack sprinklers shall be provided in accordance with 25.6, and the ceiling-level sprinkler design shall be in accordance with Figure 25.2.2.1.2.

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

25.2.3.1 General.

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

25.2.3.1.2 Ceiling-level sprinkler design criteria for the rack storage of Group A plastic commodities shall be in accordance with Section 25.2.3.4 for storage over 5 ft (1.5 m) and up to and including 25 ft (7.6 m) in height and Section 25.2.3.5 for storage over 25 ft (7.6 m) in height.
25.2.3.1.3 This chapter also shall be used to determine protection for commodities that are not entirely Group A plastic commodities but contain such quantities and arrangements of Group A plastic commodities that they are deemed more hazardous than Class IV commodities.

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

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

A.25.2.3.2.1 Bulkheads are not a substitute for sprinklers in racks. Their installation does not justify reduction in sprinkler densities or design operating areas as specified in the design curves.

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

<table>
<thead>
<tr>
<th>Height</th>
<th>Commodity Class</th>
<th>Encapsulated</th>
<th>Aisles</th>
<th>In-Rack Sprinklers Mandatory</th>
<th>Appropriate Figure and Curves</th>
<th>Apply Figure 25.2.3.2.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 12 ft (3.7 m) and up to and including 20 ft (6.1 m)</td>
<td>I</td>
<td>No</td>
<td>4</td>
<td>1.2</td>
<td>No</td>
<td>25.2.3.2.3(a)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>2.4</td>
<td>No</td>
<td>25.2.3.2.3(b)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>4</td>
<td>1.2</td>
<td>No</td>
<td>25.2.3.2.3(e)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>2.4</td>
<td>No</td>
<td>25.2.3.2.3(d)</td>
</tr>
<tr>
<td>Over 20 ft (6.1 m) and up to and including 22 ft (6.7 m)</td>
<td>I</td>
<td>No</td>
<td>4</td>
<td>1.2</td>
<td>No</td>
<td>25.2.3.2.3(a)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>2.4</td>
<td>No</td>
<td>25.2.3.2.3(b)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>4</td>
<td>1.2</td>
<td>No</td>
<td>25.2.3.2.3(e)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>2.4</td>
<td>No</td>
<td>25.2.3.2.3(d)</td>
</tr>
<tr>
<td>Over 22 ft (6.7 m) and up to and including 25 ft (7.6 m)</td>
<td>I</td>
<td>No</td>
<td>4</td>
<td>1.2</td>
<td>No</td>
<td>25.2.3.2.3(a)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>2.4</td>
<td>No</td>
<td>25.2.3.2.3(b)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>4</td>
<td>1.2</td>
<td>No</td>
<td>25.2.3.2.3(e)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>2.4</td>
<td>No</td>
<td>25.2.3.2.3(d)</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Height</th>
<th>Commodity Class</th>
<th>Encapsulated</th>
<th>In-Rack Sprinklers Manditory</th>
<th>Appropriate Figure and Curves</th>
<th>Apply Figure 25.2.3.2.1</th>
<th>1.25 x Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 12 ft (3.7 m) and up to and including 15 ft (4.6 m)</td>
<td>I</td>
<td>No</td>
<td>No</td>
<td>25.2.3.2.2.1 (a) Cand D</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>No</td>
<td>25.2.3.2.2.1 (c) Cand D</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Over 15 ft (4.6 m) and up to and including 20 ft (6.1 m)</td>
<td>I</td>
<td>No</td>
<td>No</td>
<td>25.2.3.2.2.1 (a) Cand D</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>No</td>
<td>25.2.3.2.2.1 (b) Cand D</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>No</td>
<td>No</td>
<td>25.2.3.2.2.1 (b) Cand D</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>No</td>
<td>25.2.3.2.2.1 (c) Cand D</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>No</td>
<td>No</td>
<td>25.2.3.2.2.1 (c) Cand D</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>1 Level</td>
<td>25.2.3.2.2.1 (d) A and B</td>
<td>Yes</td>
<td>1.5 x Density</td>
</tr>
<tr>
<td>Over 20 ft (6.1 m) and up to and including 25 ft (7.6 m)</td>
<td>I</td>
<td>No</td>
<td>No</td>
<td>25.2.3.2.2.1 (a) Cand D</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>1 Level</td>
<td>25.2.3.2.2.1 (d) A and B</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>No</td>
<td>1 Level</td>
<td>25.2.3.2.2.1 (d) A and B</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>1 Level</td>
<td>25.2.3.2.2.1 (d) A and B</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>No</td>
<td>1 Level</td>
<td>25.2.3.2.2.1 (c) Cand D</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>1 Level</td>
<td>25.2.3.2.2.1 (c) Cand D</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>No</td>
<td>2 Levels</td>
<td>25.2.3.2.2.1 (d) A and B</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>2 Levels</td>
<td>25.2.3.2.2.1 (d) A and B</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

25.2.3.2.2.2 For multiple-row racks, having a rack depth up to and including 16 ft (4.9 m) with aisles 8 ft (2.4 m) or wider, storing Class I through Class IV commodities, encapsulated or nonencapsulated, over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, Table 25.2.3.2.2.2 shall be used to determine the appropriate figure for determining ceiling-level sprinkler design criteria with the provision of one level of in-rack sprinklers.
### TABLE 25.2.3.2.2 Determining Appropriate Ceiling-Level Protection Criteria Figure for Multiple-Row Racks of Class I through Class IV Commodities — Rack Depth Over 16 ft (4.9 m) or Aisles Narrower Than 8 ft (2.4 m), Storage Height Over 12 ft (3.7 m) Up to and Including 25 ft (7.6 m)

<table>
<thead>
<tr>
<th>Height</th>
<th>Commodity Class</th>
<th>Encapsulated</th>
<th>In-Rack Sprinklers Mandatory</th>
<th>Appropriate Figure and Curves</th>
<th>Apply Figure 25.2.3.2.3</th>
<th>1.25 x Density</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>No</td>
<td>No</td>
<td>Figure 25.2.3.2.2.2</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Over 12 ft (3.7 m) and up to and including 25 ft (4.6 m)</td>
<td>II</td>
<td>No</td>
<td>No</td>
<td>Figure 25.2.3.2.3(b)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>No</td>
<td>No</td>
<td>Figure 25.2.3.2.3(c)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>No</td>
<td>No</td>
<td>Figure 25.2.3.2.3(d)</td>
<td>1 Level</td>
<td>1.5 x Density</td>
</tr>
<tr>
<td>Over 15 ft (4.6 m) and up to and including 20 ft (6.1 m)</td>
<td>II</td>
<td>No</td>
<td>No</td>
<td>Figure 25.2.3.2.3(b)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>No</td>
<td>No</td>
<td>Figure 25.2.3.2.3(c)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>No</td>
<td>No</td>
<td>Figure 25.2.3.2.3(d)</td>
<td>1 Level</td>
<td>1.5 x Density</td>
</tr>
<tr>
<td>Over 20 ft (6.1 m) and up to and including 25 ft (7.6 m)</td>
<td>II</td>
<td>No</td>
<td>No</td>
<td>Figure 25.2.3.2.3(b)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>No</td>
<td>No</td>
<td>Figure 25.2.3.2.3(c)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>No</td>
<td>No</td>
<td>Figure 25.2.3.2.3(d)</td>
<td>2 Levels</td>
<td>1.5 x Density</td>
</tr>
</tbody>
</table>

### 25.2.3.2.3 Ceiling-Level Protection Criteria Figures.

25.2.3.2.3.1* The ceiling-level sprinkler design criteria in terms of density [gpm/ft² (mm/min)] and area of sprinkler operation [ft² (m²)] of ceiling or roof] obtained from the appropriate density/area curves of Figure 25.2.3.2.3(a) through Figure 25.2.3.2.3(g) shall be modified as appropriate by 16.2.1.3.4 25.2.3.2.4. These requirements shall apply to portable racks arranged in the same manner as single-, double- or multiple-row racks. (See Section C.14.)

A.25.2.3.2.3.1 Data indicate that the sprinkler protection criteria in Figure 25.2.3.2.3(a) through Figure 25.2.3.2.3(g) are ineffective, by themselves, for rack storage with solid shelves, if the required flue spaces are not maintained. Use of Figure 25.2.3.2.3(a) through Figure 25.2.3.2.3(g), along with the additional provisions that are required by this standard, can provide acceptable protection.
25.2.3.2.3* Design densities obtained from Figure 25.2.3.2.3(a) through Figure 25.2.3.2.3(g) for single- and double-row racks shall be selected to correspond to aisle width. (See Section C.15.)

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

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

25.2.3.2.3.2(C) The density given for 4 ft (1.2 m) wide aisles shall be applied to aisles more narrow than 4 ft (1.2 m) down to 3-1/2 ft (1.1 m).

25.2.3.2.3.2(D) Where aisles are more narrow than 3-1/2 ft (1.1 m), racks shall be considered to be multiple-row racks.

A.25.2.3.2.3 The aisle width and the depth of racks are determined by material-handling methods. The widths of aisles should be considered in the design of the protection system. Storage in aisles can render protection ineffective and should be discouraged.

FIGURE 25.2.3.2.3(a) CMDA Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class I Nonencapsulated Commodities — Conventional Pallets.

FIGURE 25.2.3.2.3(a)(A) Single- or double-row racks with 8 ft (2.4 m) aisles with high-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(a)(B) Single- or double-row racks with 8 ft (2.4 m) aisles with ordinary-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(a)(C) Single- or double-row racks with 4 ft (1.2 m) aisles or multiple-row racks with high-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(a)(D) Single- or double-row racks with 4 ft (1.2 m) aisles or multiple-row racks with ordinary-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(b) CMDA Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class II Nonencapsulated Commodities — Conventional Pallets.

FIGURE 25.2.3.2.3(b)(A) Single- or double-row racks with 8 ft (2.4 m) aisles with high-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(b)(B) Single- or double-row racks with 8 ft (2.4 m) aisles with ordinary-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(b)(C) Single- or double-row racks with 4 ft (1.2 m) aisles or multiple-row racks with high-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(b)(D) Single- or double-row racks with 4 ft (1.2 m) aisles or multiple-row racks with ordinary-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(c) CMDA Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class III Nonencapsulated Commodities — Conventional Pallets.

FIGURE 25.2.3.2.3(c)(A) Single- or double-row racks with 8 ft (2.4 m) aisles with high-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(c)(B) Single- or double-row racks with 8 ft (2.4 m) aisles with ordinary-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(c)(C) Single- or double-row racks with 4 ft (1.2 m) aisles or multiple-row racks with high-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(c)(D) Single- or double-row racks with 4 ft (1.2 m) aisles or multiple-row racks with ordinary-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers
FIGURE 25.2.3.2.3(d) CMDA Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class IV Nonencapsulated Commodities — Conventional Pallets.

FIGURE 25.2.3.2.3(d)(A) Single- or double-row racks with 8 ft (2.4 m) aisles with high-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(d)(B) Single- or double-row racks with 8 ft (2.4 m) aisles with ordinary-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(d)(C) Single- or double-row racks with 4 ft (1.2 m) aisles or multiple-row racks with high-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(d)(D) Single- or double-row racks with 4 ft (1.2 m) aisles or multiple-row racks with ordinary-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(e) CMDA Sprinkler System Design Curves — Single- or Double-Row Racks — 20 ft (6.1 m) High Rack Storage — Class I and Class II Encapsulated Commodities — Conventional Pallets.

FIGURE 25.2.3.2.3(e)(A) 8 ft (2.4 m) aisles with high-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(e)(B) 8 ft (2.4 m) aisles with ordinary-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(e)(C) 4 ft (1.2 m) aisles with high-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(e)(D) 4 ft (1.2 m) aisles with ordinary-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(f) CMDA Sprinkler System Design Curves — Single- or Double-Row Racks — 20 ft (6.1 m) High Rack Storage — Class III Encapsulated Commodities — Conventional Pallets.

FIGURE 25.2.3.2.3(f)(A) 8 ft (2.4 m) aisles with high-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(f)(B) 8 ft (2.4 m) aisles with ordinary-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(f)(C) 4 ft (1.2 m) aisles with high-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(f)(D) 4 ft (1.2 m) aisles with ordinary-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(g) CMDA Sprinkler System Design Curves — Single- or Double-Row Racks — 20 ft (6.1 m) High Rack Storage — Class IV Encapsulated Commodities — Conventional Pallets.

FIGURE 25.2.3.2.3(g)(A) 8 ft (2.4 m) aisles with high-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(g)(B) 8 ft (2.4 m) aisles with ordinary-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(g)(C) 4 ft (1.2 m) aisles with high-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

FIGURE 25.2.3.2.3(g)(D) 4 ft (1.2 m) aisles with ordinary-temperature ceiling sprinklers and ordinary-temperature in-rack sprinklers

25.2.3.2.4* Ceiling Sprinkler Density Adjustments.
A.25.2.3.2.4 The adjustments in 25.2.3.2.4 apply to solid shelves where the minimum required level of in-rack sprinklers from an open rack option is exceeded.

25.2.3.2.4.1 Where Class I, Class II, and Class III commodities are encapsulated in multiple-row racks over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, the ceiling sprinkler density obtained from the applicable figure in 25.2.3.2.3 shall be increased by 25 percent over that required for nonencapsulated commodities.

25.2.3.2.4.2 Where Class IV commodities are encapsulated in multiple-row racks over 12 ft (3.7 m) and up to and including 25 ft (7.6 m) in height, the ceiling sprinkler density obtained from the applicable figure in 25.2.3.2.3 shall be increased by 50 percent over that required for nonencapsulated commodities.

25.2.3.2.4.3 Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 12 ft (3.7 m) up to and including 20 ft (6.1 m) protected with CMDA sprinklers at ceiling level along with the minimum number of required in-rack sprinkler levels, densities obtained from design curves shall be adjusted in accordance with Figure 25.2.3.2.4.3.

FIGURE 25.2.3.2.4.3 Adjustment to Ceiling-Level Sprinkler Density Due to Storage Height.

25.2.3.2.4.4 Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 12 ft (3.7 m) and up to and including 20 ft (6.1 m) in height protected with CMDA sprinklers at ceiling level along with more than one level of in-rack sprinklers, but not in every tier, densities obtained from design curves and adjusted in accordance with Figure 25.2.3.2.4.3 shall be permitted to be reduced an additional 20 percent, as indicated in Table 25.2.3.2.4.4.

TABLE 25.2.3.2.4.4 Adjustment to Ceiling-Level Sprinkler Density Due to Storage Height and In-Rack Sprinklers.

<table>
<thead>
<tr>
<th>Storage Height</th>
<th>In-Rack Sprinklers</th>
<th>Apply Figure 25.2.3.2.4.3</th>
<th>Permitted Ceiling-Level Sprinkler Density Adjustment Due to In-Rack Sprinklers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 12 ft (3.7 m) and up to and including 20 ft (6.1 m)</td>
<td>Minimum required</td>
<td>Yes</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>More than required but not in every tier</td>
<td>Yes</td>
<td>Reduce density 20% from that for minimum in-rack sprinklers</td>
</tr>
<tr>
<td></td>
<td>Every tier level</td>
<td>Yes</td>
<td>Reduce density 40% from that for minimum in-rack sprinklers</td>
</tr>
<tr>
<td>Over 20 ft (6.1 m) and up to and including 25 ft (7.6 m)</td>
<td>Minimum required</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>More than required but not in every tier</td>
<td>No</td>
<td>Reduce density 20% from that for minimum in-rack sprinklers</td>
</tr>
<tr>
<td></td>
<td>Every tier level</td>
<td>No</td>
<td>Reduce density 40% from that for minimum in-rack sprinklers</td>
</tr>
</tbody>
</table>

25.2.3.2.4.5* Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 12 ft (3.7 m) and up to and including 20 ft (6.1 m) in height protected with CMDA sprinklers at ceiling level along with in-rack sprinklers at each tier level, densities obtained from design curves and adjusted in accordance with Figure 25.2.3.2.4.3 shall be permitted to be reduced an additional 40 percent, as indicated in Table 25.2.3.2.4.4.

A.25.2.3.2.4.5 It is not the intent that an in-rack sprinkler be installed above the top-tier of storage when utilizing “in-rack sprinklers at each tier level.”

25.2.3.2.4.6 Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) in height protected with CMDA sprinklers at ceiling level along...
with the minimum number of required in-rack sprinkler levels, densities obtained from design curves shall be used. Densities shall not be adjusted in accordance with Figure 25.2.3.2.4.3.

25.2.3.2.4.7 Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) in height protected with CMDA sprinklers at ceiling level along with more than the minimum required level of in-rack sprinklers, but not in every tier, densities obtained from design curves shall be permitted to be reduced 20 percent, as indicated in Table 25.2.3.2.4.4. Densities shall not be adjusted in accordance with Figure 25.2.3.2.4.3 for storage height.

25.2.3.2.4.8 Where in-rack sprinklers are being installed within racks of Class I through Class IV commodities stored over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) in height protected with CMDA sprinklers at ceiling level along with in-rack sprinklers at each tier level, except above the top tier, densities obtained from design curves shall be permitted to be reduced 40 percent, as indicated in Table 25.2.3.2.4.4. Densities shall not be adjusted in accordance with Figure 25.2.3.2.4.3 for storage height.

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

25.2.3.3.1 Single- and Double-Row Racks.

25.2.3.3.1.1* Where in-rack sprinklers are being installed within single- and double-row racks separated by aisles at least 4 ft (1.2 m) wide and with a clearance to ceiling up to and including 10 ft (3.0 m) of nonencapsulated Class I through Class IV commodities stored over 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level, the ceiling sprinkler designs shall be in accordance with Table 25.2.3.3.1.1.

A.25.2.3.3.1.1 Water demand for storage height over 25 ft (7.6 m) on racks separated by aisles at least 4 ft (1.2 m) wide and with more than 10 ft (3.0 m) between the top of storage and the sprinklers should be based on sprinklers in a 2000 ft² (186 m²) operating area for double-row racks and a 3000 ft² (279 m²) operating area for multiple-row racks discharging a minimum of 0.18 gpm/ft² (7.3 mm/min) for Class I commodities, 0.21 gpm/ft² (8.5 mm/min) for Class II and Class III commodities, and 0.25 gpm/ft² (10.2 mm/min) for Class IV commodities for ordinary temperature-rated sprinklers or a minimum of 0.25 gpm/ft² (10.2 mm/min) for Class I commodities, 0.28 gpm/ft² (11.4 mm/min) for Class II and Class III commodities, and 0.32 gpm/ft² (13 mm/min) for Class IV commodities for high temperature-rated sprinklers. (See A.25.9.2.3.1.) Where such storage is encapsulated, ceiling sprinkler density should be 25 percent greater than for nonencapsulated storage. Data indicate that the sprinkler protection criteria in 25.2.3.3.1.1 are ineffective, by themselves, for rack storage with solid shelves if the required flue spaces are not maintained. Use of 25.2.3.3.1.1, along with the additional provisions that are required by this standard, can provide acceptable protection.

**TABLE 25.2.3.3.1.1 CMDA Ceiling-Level Sprinkler Design Criteria for Single- or Double-Row Racks of Nonencapsulated Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height with Aisles 4 ft (1.2 m) or More in Width, Clearance to Ceiling Up to and Including 10 ft (3.0 m) Supplemented With In-Rack Sprinklers**

<table>
<thead>
<tr>
<th>Commodity Class</th>
<th>Encapsulated</th>
<th>Ceiling Sprinkler Density, Clearance to Ceiling up to 10 ft (3.0 m)</th>
<th>Ceiling Sprinkler Operating Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ordinary Temperature</td>
<td>High Temperature</td>
</tr>
<tr>
<td>I, II, III</td>
<td>No</td>
<td>0.30</td>
<td>12.0</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>0.33</td>
<td>12.0</td>
</tr>
<tr>
<td>I, II, III</td>
<td>No</td>
<td>0.37</td>
<td>15.3</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>0.35</td>
<td>14.2</td>
</tr>
<tr>
<td>I, II, III, IV</td>
<td>No</td>
<td>0.44</td>
<td>17.8</td>
</tr>
</tbody>
</table>

25.2.3.3.1.2 Where storage as described in 25.2.3.3.1.1 is encapsulated, the ceiling sprinkler density obtained from Table 25.2.3.3.1.1 shall be increased by 25 percent over that required for nonencapsulated commodities.

25.2.3.3.2 Multiple-Row Racks.
25.2.3.3.2.1 Where in-rack sprinkler are being installed within multiple-row racks separated by aisles at least 4 ft (1.2 m) wide and with a clearance to ceiling up to and including 10 ft (3.0 m) of nonencapsulated Class I through Class IV commodities stored over 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level, the ceiling sprinkler designs shall be in accordance with Table 25.2.3.3.2.1.

**TABLE 25.2.3.3.2.1 CMDA Ceiling-Level Sprinkler Design Criteria for Multiple-Row Racks of Nonencapsulated Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height, Clearance to Ceiling Up to and Including 10 ft (3.0 m) Supplemented With In-Rack Sprinklers**

<table>
<thead>
<tr>
<th>Commodity Class</th>
<th>Encapsulated</th>
<th>Maximum Allowable Storage Height Above Top In-Rack Sprinkler Level</th>
<th>Ceiling Sprinkler Density, Clearance to Ceiling up to 30 ft (9.1 m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>m</td>
<td>Ordinary Temperature (gpm/ft²)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.45 mm/min</td>
</tr>
<tr>
<td>I, II, III</td>
<td>No</td>
<td>10</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>10</td>
<td>0.30</td>
</tr>
<tr>
<td>I, II, III, IV</td>
<td>No</td>
<td>10</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>10</td>
<td>0.30</td>
</tr>
<tr>
<td>I, II, III, IV</td>
<td>No</td>
<td>5</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>5</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.44</td>
</tr>
</tbody>
</table>

25.2.3.3.2.2 Where storage as described in 25.2.3.3.2.1 is encapsulated, the ceiling sprinkler density obtained from Table 25.2.3.3.2.1 shall be increased by 25 percent over that required for nonencapsulated commodities.

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

25.2.3.4.1 Cartoned Group A Plastic Commodities.

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

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

25.2.3.4.1.3 No interpolation between clearance to ceiling shall be permitted.

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

25.2.3.4.2(1) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.2(a), the ceiling-level sprinkler design shall be a minimum 0.45 gpm/ft² (18.3 mm/min) density over a 2000 ft² (186 m²) demand area.

25.2.3.4.2(2) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.2(b), the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft² (12.2 mm/min) density over a 2000 ft² (186 m²) demand area.

25.2.3.4.2(3) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.2(c), the ceiling-level sprinkler design shall be a minimum 0.45 gpm/ft² (18.3 mm/min) density over a 2000 ft² (186 m²) demand area.

25.2.3.4.2(4) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.2(d), the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft² (12.2 mm/min) density over a 2000 ft² (186 m²) demand area.

25.2.3.4.2(5) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.2(e), the ceiling-level sprinkler design shall be a minimum 0.6 gpm/ft² (24.4 mm/min) density over a 2000 ft² (186 m²) demand area.
25.2.3.4.2(6) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.2(f), the ceiling-level sprinkler design shall be a minimum 0.45 gpm/ft² (18.3 mm/min) density over a 2000 ft² (186 m²) demand area.

25.2.3.4.2(7) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.2(g), the ceiling-level sprinkler design shall be a minimum 0.8 gpm/ft² (32.6 mm/min) density over a 1500 ft² (139 m²) demand area.

25.2.3.4.2(8) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.2(h), the ceiling-level sprinkler design shall be a minimum 0.6 gpm/ft² (24.4 mm/min) density over a 1500 ft² (139 m²) demand area.

25.2.3.4.2(9) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.2(i), the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft² (12.2 mm/min) density over a 2000 ft² (186 m²) demand area.

25.2.3.4.2(10) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.2(j), the ceiling-level sprinkler design shall be a minimum 0.8 gpm/ft² (32.6 mm/min) density over a 1500 ft² (139 m²) demand area.

25.2.3.4.2(11) Where in-rack sprinklers are installed in accordance with Figure 25.9.3.2(k), the ceiling-level sprinkler design shall be a minimum 0.30 gpm/ft² (12.2 mm/min) density over a 2000 ft² (186 m²) demand area.

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

A.25.2.3.5 In this application ordinary-, intermediate-, or high-temperature ceiling-level sprinklers can be used. There are no data to support temperature rating restrictions for this section.

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

<table>
<thead>
<tr>
<th>Storage Height Above Top Level of In-Rack Sprinklers</th>
<th>Ceiling-Level Sprinkler Design Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>Up to and including 5 ft</td>
<td>Up to and including 1.5 m</td>
</tr>
<tr>
<td>Over 5 ft and up to and including 10 ft</td>
<td>Over 1.5 m and up to and including 3.0 m</td>
</tr>
</tbody>
</table>

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

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

25.2.3.6.2* Ceiling Systems. Where rack storage of rubber tires, either on-side or on-tread, over 5 ft (1.5 m) and up to and including 20 ft (6.1 m) in height protected by CMDA sprinklers at ceiling-level with a maximum clearance to ceiling of 10 ft (3.0 m) along with one level of in-rack sprinklers, the ceiling-level sprinkler system design density and area of application shall be a minimum 0.40 gpm/ft² (16.3 mm/min) density over a 3000 ft² (279 m²) demand area.

A.25.2.3.6.2 See A.21.6.

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

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

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

25.2.4.1 General.

25.2.4.1.1 **Open Wood Joist Construction with CMSA Sprinklers at Ceiling-Level.**

25.2.4.1.1.2 Where CMSA sprinklers are installed under open wood joist construction, fire-stopping in accordance with 25.2.4.1.1.3 shall be provided or the minimum operating pressure of the sprinklers shall be 50 psi (3.4 bar) for a K-11.2 (160) sprinkler or 22 psi (1.5 bar) for a K-16.8 (240) sprinkler.

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

25.2.4.1.2 **Preaction Systems for CMSA Sprinklers.** For the purpose of using Table 25.2.4.2.1, preaction systems shall be classified as dry pipe systems.

25.2.4.2 Rack Storage of Class I Through Class IV Commodities.

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

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

<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Commodity Class</th>
<th>Maximum Storage Height</th>
<th>Maximum Ceiling / Roof Height</th>
<th>K-Factor / Orientation</th>
<th>Type of System</th>
<th>Number of Design Sprinklers</th>
<th>Minimum Operating Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td></td>
<td>psi</td>
</tr>
<tr>
<td></td>
<td>I or II</td>
<td>30</td>
<td>9.1</td>
<td>35</td>
<td>10.7</td>
<td></td>
<td>11.2 (160) Upright Wet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
</tr>
<tr>
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<td>Wet</td>
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<td></td>
<td>Dry</td>
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<tr>
<td></td>
<td></td>
<td>30</td>
<td>9.1</td>
<td>25</td>
<td>7.6</td>
<td></td>
<td>11.2 (160) Upright Wet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td>Dry</td>
</tr>
<tr>
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<td>Wet</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>25</td>
<td>7.6</td>
<td>30</td>
<td>9.1</td>
<td></td>
<td>11.2 (160) Upright Wet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Wet</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Wet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
</tr>
</tbody>
</table>

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

25.2.4.3 Rack Storage of Group A Plastic Commodities.
25.2.4.3.1 Where-rack storage of unexpanded, cartoned and uncartoned, Group A plastic commodities is protected by CMSA sprinklers at ceiling level along with one level of in-rack sprinklers, the ceiling-level sprinkler system design criteria shall be in accordance with Table 25.2.4.3.1.

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

<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Commodity Class</th>
<th>Maximum Storage Height ft</th>
<th>Maximum Ceiling / Roof Height ft</th>
<th>K Factor / Orientation</th>
<th>Type of System</th>
<th>Number of Design Sprinklers</th>
<th>Minimum Operating Pressure psi</th>
<th>Minimum Operating Pressure bar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single, double-, and multiple-row racks (no open-top containers) Cartoned unexpanded, plastics and exposed unexpanded plastics</td>
<td>25</td>
<td>9.1</td>
<td>35</td>
<td>10.7</td>
<td>13.2 (100) Upright</td>
<td>Wet</td>
<td>13 + 1 level of in-racks</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16.8 (140) Upright</td>
<td>Wet</td>
<td>20 + 1 level of in-racks</td>
<td>35</td>
</tr>
</tbody>
</table>

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

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

25.2.5.1 Rack Storage of Class I Through Class IV Commodities.

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

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

<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Commodity Class</th>
<th>Maximum Storage Height ft</th>
<th>Maximum Ceiling / Roof Height ft</th>
<th>K Factor / Orientation</th>
<th>Type of System</th>
<th>Number of Design Sprinklers</th>
<th>Minimum Operating Pressure psi</th>
<th>Minimum Operating Pressure bar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single, double-, and multiple-row racks (no open-top containers) Class I, II, III or IV, encapsulated or nonencapsulated</td>
<td>20</td>
<td>6.1</td>
<td>45</td>
<td>18.9</td>
<td>14.0 (200)</td>
<td>Pendant</td>
<td>12 + 1 level of in-racks</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16.8 (240)</td>
<td>Pendant</td>
<td>12 + 1 level of in-racks</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>7.6</td>
<td>45</td>
<td>18.9</td>
<td>14.0 (200)</td>
<td>Pendant</td>
<td>12 + 1 level of in-racks</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16.8 (240)</td>
<td>Pendant</td>
<td>12 + 1 level of in-racks</td>
<td>63</td>
</tr>
</tbody>
</table>

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

25.2.5.1.3 The design area applicable to the ceiling-level design options listed in Table 25.xx shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of three branch lines.

25.2.5.2 Rack Storage of Group A Plastic Commodities.

25.2.5.2.1 Where rack storage of cartoned or exposed unexpanded Group A plastic and cartoned expanded Group A plastic commodity is protected by ESFR sprinklers at ceiling level along with one level of in-rack sprinklers, the ceiling-level sprinkler design criteria shall be in accordance with Table 25.2.5.2.1.

TABLE 25.2.5.2.1 ESFR Ceiling-Level Sprinkler Design Criteria for Rack Storage of Group A Plastic Commodities Supplemented with In-Rack Sprinklers
25.2.5.2.2 ESFR sprinkler systems, when supplemented with in-rack sprinklers, shall be designed such that the minimum operating pressure is not less than that indicated in Table 25.2.5.2.1 for type of storage, commodity, storage height, and building height involved.

25.2.5.2.3 The design area applicable to the ceiling-level design options listed in Table 25.2.5.2.1 shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of three branch lines.

25.3 In-Rack Sprinkler Characteristics

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

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

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

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

25.3.5 In-Rack Sprinkler Water Shields.

25.3.5.1 In-Rack Sprinkler Water Shields for Storage of Class I Through Class IV Commodities. Water shields shall be provided directly above in-rack sprinklers, or listed intermediate level/rack storage sprinklers shall be used where there is more than one level, if not shielded by horizontal barriers. (See Section C.3.)

25.3.5.2 In-Rack Sprinkler Water Shields for Plastic Storage. Where in-rack sprinklers are not shielded by horizontal barriers, water shields shall be provided above the sprinklers, or listed intermediate level/rack storage sprinklers shall be used.

25.4 Vertical Spacing and Location of In-Rack Sprinklers

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

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

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

A25.4.3* Where possible, it is recommended that in-rack sprinkler deflectors be located at least 6 in. (150 mm) vertically above the top of storage located below them.

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

25.4.5* Where one level of in-rack sprinklers are required by the guidelines of this chapter, in-rack sprinklers shall be installed at the first tier level at or above one-half of the highest expected storage height.
A.25.4.5 Where one level of in-rack sprinklers are required by the guidelines in Chapter 25, in-rack sprinklers for multiple-row rack storage up to and including 25 ft (7.6 m) of Class I through Class IV commodities should be installed at the first tier level nearest one-half to two-thirds of the highest expected storage height.

25.4.6 Where two levels of in-rack sprinklers are required by the guidelines of this chapter for rack storage of Class I through Class IV commodities up to and including 25 ft (7.6 m) in height, in-rack sprinklers shall be installed at the first tier level at or above one-third and two-thirds of the highest expected storage height.

25.4.7 Maximum Storage Height Above Top In-Rack Sprinkler Level.

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

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

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

25.4.8 Where single- and double-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, in-rack sprinklers shall be staggered vertically where installed in accordance with Table 25.9.2.1.1, Figure 25.9.2.2(A)(a) through Figure 25.9.2.2(A)(j), and Figure 25.9.2.1.1(A)(a) through Figure 25.9.2.1.1(A)(e).

25.4.9 Where multiple-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, in-rack sprinklers shall be staggered vertically where installed in accordance with Table 25.9.2.1.1, Figure 25.9.2.2(A)(a) through Figure 25.9.2.2(A)(j), and Figure 25.9.2.1.1(A)(a) through Figure 25.9.2.1.1(A)(e).

25.5 Horizontal Spacing and Location of In-Rack Sprinklers

25.5.1 Horizontal Spacing of In-Rack Sprinklers

25.5.1.1 General.

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

25.5.1.1.2 For miscellaneous and low piled rack storage, the maximum allowable horizontal spacing of in-rack sprinklers shall be 8 ft (2.4 m).

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

25.5.1.2 CMDA Sprinklers Installed at Ceiling Level.

25.5.1.2.1* Where single- and double-row rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Table 25.5.1.2.1.

A.25.5.1.2.1 Spacing of sprinklers on branch lines in racks in the various tests demonstrates that maximum spacing as specified is proper.

TABLE 25.5.1.2.1 In-Rack Sprinkler Horizontal Spacing for Class I, II, III, and IV Commodities Stored in Single- or Double-Row Racks Up to 25 ft (7.6 m) in Height Protected by Control Mode Density/Area Sprinklers at Ceiling Level
25.5.1.2.2 Where multiple-row rack storage of Class I through Class IV commodities is up to and including 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Table 25.5.1.2.2.

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

25.5.1.2.2(B) The aisles shall not be included in area calculations.

**TABLE 25.5.1.2.2 In-Rack Sprinkler Horizontal Spacing for Class I, II, III, and IV Commodities Stored in Multiple-Row Racks Up to 25 ft (7.6 m) in Height Protected by Control Mode Density/Area Sprinklers at Ceiling Level**

<table>
<thead>
<tr>
<th>Commodity Class</th>
<th>Aisle Width</th>
<th>Encapsulated</th>
<th>Maximum Allowable Linear Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ft</td>
<td>m</td>
<td>Yes</td>
</tr>
<tr>
<td>I, II</td>
<td>8</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>III</td>
<td>8</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>IV</td>
<td>8</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
</tbody>
</table>

25.5.1.2.3 Where rack storage of plastic commodities is up to and including 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Figure 25.9.3.1(a) through Figure 25.9.3.1(e).

25.5.1.2.4 Where single- and double-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Table 25.9.2.1.1 and Figure 25.9.2.2(a) through Figure 25.9.2.2(j).

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

25.5.1.2.6 Where single-row rack storage of cartoned Group A plastic commodities, expanded or unexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the
maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Figure 25.9.4.1.1(a) through Figure 25.9.4.1.1(d) or Figure 25.9.4.2.2.

25.5.1.2.7 Where double-row rack storage of cartoned Group A plastic commodities, expanded or unexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Figure 25.9.4.2.1(a) through Figure 25.9.4.2.1(c).

25.5.1.2.8 Where single- and double-row rack storage of exposed unexpanded Group A plastic commodities, whether encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Figure 25.9.4.2.2.

25.5.1.2.9* Where multiple-row rack storage of exposed unexpanded Group A plastic commodities, whether encapsulated or nonencapsulated, or cartoned Group A plastic commodities, expanded or unexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, the maximum allowable horizontal spacing of in-rack sprinklers shall be in accordance with Figure 25.9.4.3.1(a) through Figure 25.9.4.3.1(f).

A.25.5.1.2.9 The protection area per sprinkler under barriers should be no greater than 80 ft² (7.4 m²) in Figure 25.9.4.3.1(a) and Figure 25.9.4.3.1(b). The protection area per sprinkler under barriers should be no greater than 50 ft² (4.6 m²) in Figure 25.9.4.3.1(c) through Figure 25.9.4.3.1(f).

25.5.1.3 CMSA Sprinklers Installed at Ceiling Level.

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

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

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

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

25.5.2 Horizontal Location of In-Rack Sprinklers

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

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

A.25.5.2.2 In-rack sprinklers have proven to be the most effective way to fight fires in rack storage. To accomplish this, however, in-rack sprinklers must be located where they will operate early in a fire as well as direct water where it will do the most good. Simply maintaining a minimum horizontal spacing between sprinklers does not achieve this goal. This is because fires in rack storage develop and grow in transverse and longitudinal flues, and in-rack sprinklers do not operate until flames actually impinge on them. To assure early operation and effective discharge, in-rack sprinklers in the longitudinal flue of open-frame racks must be located at transverse flue intersections.

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

25.5.2.4 Where no transverse flues exist, horizontal spacing of in-rack sprinklers shall not exceed the maximum allowable spacing rules.
25.5.2.5 Where in-rack sprinklers are installed to protect a higher-hazard commodity that occupies only a portion of the length of a rack, in-rack sprinklers shall be extended a minimum of 8 ft (2.4 m) or one bay, whichever is greater, in each direction along the rack on either side of the higher hazard. The in-rack sprinklers protecting the higher hazard shall not be required to extend across the aisle.

25.5.2.6 The in-rack sprinkler arrangement protecting the higher hazard outlined in 25.5.2.5 shall not be required to be extended across the aisle.

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

A.25.5.2.7 Where rack storage is up to and including 25 ft (7.6 m) in height, in-rack sprinklers should be a minimum 3 in. (75 mm) radially from the side of rack uprights.

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

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

25.5.2.10 Where single- and double-row rack storage of Class I through Class IV commodities is over 25 ft (7.6 m) in height and protected by CMDA sprinklers at ceiling level, in-rack sprinklers shall be staggered horizontally where installed in accordance with Table 25.9.2.1.1, Figure 25.9.2.2(a) through Figure 25.9.2.2(j), and Figure 25.9.2.1.1(a) through Figure 25.9.2.1.1(e).

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

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

25.5.2.13 Where miscellaneous and low piled single- and double-row rack storage does not have a longitudinal flue, in-rack sprinklers shall be located within 12 in. (300 mm) of the center of the rack while not exceeding the maximum allowable horizontal in-rack sprinkler spacing.

25.6 Protection of Racks with Solid Shelves.

25.6.1 General. The requirements of 25.6 shall apply to racks with solid shelves except as modified in this section.

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

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

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

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

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

25.6.3.4 Where ESFR sprinklers are at ceiling level and protect racks with solid shelving, in-rack sprinklers shall be installed beneath all tiers under the highest solid shelf.
25.6.3.5 Where racks with solid shelves obstruct only a portion of an open-frame rack, in-rack sprinklers shall be installed vertically as follows:

25.6.3.5(1) In accordance with 25.6.3.1 and 25.6.3.2 where CMDA sprinklers are installed at ceiling level

25.6.3.5(2) In accordance with 25.6.3.3 where CMSA sprinklers are installed at ceiling level

25.6.3.5(3) In accordance with 25.6.3.4 where ESFR sprinklers are installed at ceiling level

25.6.3.6 Where CMDA sprinklers are at ceiling level and protecting single- or double-row racks with solid shelves of Class I through Class IV commodities stored up to and including 25 ft (7.6 m) in height, a minimum 6 in. (150 mm) vertical clear space shall be maintained between in-rack sprinkler deflectors and the top of storage located below them.

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

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

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

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

25.7 Horizontal Barriers in Combination with In-Rack Sprinklers.

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

A.25.7.1 Barriers should be of sufficient strength to avoid sagging that interferes with loading and unloading operations.

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

25.8 In-Rack Sprinkler Arrangements and Designs, Independent of Ceiling-Level Sprinklers.

25.8.1 Alternative In-Rack Sprinkler Protection Option 1.

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

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

25.8.1.2(1) Extend the protection outlined in this section horizontally one pallet load in all directions beyond the commodity storage area that is being protected by the alternative in-rack sprinkler arrangement.

25.8.1.2(2) Install a vertical barrier to segregate the commodities that are being protected by the alternative in-rack sprinkler arrangement.

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

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

25.8.1.4.1 The barrier shall be constructed of minimum 22 gauge (0.7 mm) sheet metal or of minimum 3/8 in. (10 mm) plywood.
25.8.1.4.2 The barrier shall span horizontally to both aisle faces of the rack, covering up all flue spaces of the rack bays in which they are installed.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

25.8.2 Alternative In-Rack Sprinkler Protection Option 2.

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

25.8.2.2 For open-frame storage racks, install horizontal barriers as outlined in 25.7 as well as in-rack sprinklers a maximum of every 6 ft (1.8 m) vertically.
25.8.2.3 For storage racks having solid shelves with shelf areas that exceed 20 ft² (1.9 m²) but not 64 ft² (5.9 m²) and CMDA sprinklers are installed at ceiling level, in-rack sprinklers shall be installed below shelves at intermediate levels not more than 6 ft (1.8 m) apart vertically.

25.8.2.4 For storage racks having solid shelves with shelf areas that exceed 20 ft² (1.9 m²) but not 64 ft² (5.9 m²) and CMSA or ESFR sprinklers are installed at ceiling level, in-rack sprinklers shall be installed below each level of shelving.

25.8.2.5 For storage racks having solid shelves with shelf areas that exceed 64 ft² (5.9 m²), in-rack sprinklers shall be installed below each level of shelving.

25.8.2.6 Where CMDA sprinklers are at ceiling level and protecting single- or double-row racks with solid shelves of Class I through Class IV commodities stored up to and including 25 ft (7.6 m) in height, a minimum 6 in. (150 mm) vertical clear space shall be maintained between in-rack sprinkler deflectors and the top of storage located below them.

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

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

25.8.2.9 Face sprinklers shall be installed under each solid shelf or horizontal barrier at rack uprights.

25.8.2.10 In-Rack Sprinkler System Design. The in-rack sprinkler design for the in-rack sprinkler arrangement outlined in this section shall be based on a minimum flow of 60 gpm (230 L/min) from the most remote eight in-rack sprinklers.

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

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

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

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

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

25.9.1 Rack Storage of Class I through Class IV Commodities Up to and Including 25 ft (7.6 m) in Height. The in-rack arrangements for rack storage up to and including 25 ft (7.6 m) in height shall be in accordance with the guidelines outlined in Section 25.4 through 25.7 as applicable.

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

25.9.2.1 Single-Row Racks.

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

A.25.9.2.1.1 In single-row racks with more than 10 ft (3.0 m) between the top of storage and the ceiling, a horizontal barrier should be installed above storage with one line of sprinklers under the barrier.

TABLE 25.9.2.1.1 Single-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height with Aisles 4 ft (1.2 m) or More in Width Protected by CMDA Sprinklers at Ceiling Level
25.9.2.1.1 In-Rack Sprinkler Arrangement, Class I, II, or III Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) — Option 1.

25.9.2.1.2 Where a single-row rack is located against a wall, the in-rack sprinkler arrangement shall be permitted to be in accordance with Figure 25.9.2.2(a) through Figure 25.9.2.2(j).

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

25.9.2.2 Double-Row Racks.

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

A.25.9.2.2.1 Where storage tiers are not the same size on each side of the longitudinal flue, one side of the flue should be protected with sprinklers at the proper elevation above the load. The next level of sprinklers should protect the other side of the flue with the sprinklers at the proper elevation above that load as indicated in Figure A.25.9.2.2.1. The vertical spacing requirements for in-rack sprinklers specified in Table 25.9.2.2.1 and Section 25.4 for plastic commodities should be followed.

FIGURE A.25.9.2.2.1 Placement of In-Rack Sprinklers Where Rack Levels Have Varying Heights.
TABLE 25.9.2.2.1 Double-Row Racks of Class I Through Class IV Commodities Stored Over 25 ft (7.6 m) in Height with Aisles 4 ft (1.2 m) or More in Width Protected by CMDA Sprinklers at Ceiling Level

<table>
<thead>
<tr>
<th>Commodity Class</th>
<th>Longitudinal Flue (^t)</th>
<th>Face (^{a,b,c})</th>
<th>Figure</th>
<th>Maximum Storage Height</th>
<th>Stagger</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m) under horizontal barriers</td>
<td>None</td>
<td>25.9.2.2.1(a)</td>
<td>30 ft (9.1 m)</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m)</td>
<td>Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m)</td>
<td>25.9.2.2.1(b)</td>
<td>Higher than 25 ft (7.6 m)</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Vertical at 10 ft (3.0 m) or at 15 ft (4.6 m) and at 25 ft (7.6 m)</td>
<td>None</td>
<td>25.9.2.2.1(c)</td>
<td>30 ft (9.1 m)</td>
<td>Yes</td>
</tr>
<tr>
<td>I, II, III</td>
<td>Vertical 10 ft (3.0 m), Horizontal 10 ft (3.0 m)</td>
<td>Vertical 30 ft (9.1 m), Horizontal 10 ft (3.0 m)</td>
<td>25.9.2.2.1(d)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vertical 20 ft (6.1 m), Horizontal 5 ft (1.5 m)</td>
<td>Vertical 20 ft (6.1 m), Horizontal 5 ft (1.5 m)</td>
<td>25.9.2.2.1(e)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vertical 25 ft (7.6 m), Horizontal 5 ft (1.5 m)</td>
<td>Vertical 25 ft (7.6 m), Horizontal 5 ft (1.5 m)</td>
<td>25.9.2.2.1(f)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m) under horizontal barriers with two lines of staggered in-rack sprinklers</td>
<td>Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m) under horizontal barriers with two lines of staggered in-rack sprinklers</td>
<td>25.9.2.2.1(g)</td>
<td>Higher than 25 ft (7.6 m)</td>
<td>Yes</td>
</tr>
<tr>
<td>I, II, III, IV</td>
<td>Vertical 15 ft (4.6 m), Horizontal 5 ft (1.5 m)</td>
<td>Vertical 20 ft (6.1 m), Horizontal 5 ft (1.5 m)</td>
<td>25.9.2.2.1(h)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vertical 20 ft (6.1 m), Horizontal 5 ft (1.5 m)</td>
<td>Vertical 20 ft (6.1 m), Horizontal 5 ft (1.5 m)</td>
<td>25.9.2.2.1(i)</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vertical 15 ft (4.6 m), Horizontal 10 ft (3.0 m) under horizontal barriers with two lines of staggered in-rack sprinklers</td>
<td>Vertical 20 ft (6.1 m), Horizontal 10 ft (3.0 m) under horizontal barriers with two lines of staggered in-rack sprinklers</td>
<td>25.9.2.2.1(j)</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)Water shields required.
\(^b\)All in-rack sprinkler spacing dimensions start from the floor.
\(^c\)Install sprinklers at least 3 in. (75 mm) from uprights
\(^t\)Face sprinklers shall not be required for a Class I commodity consisting of noncombustible products on wood pallets (without combustible containers), except for arrays shown in Figure 25.9.2.2.1(a) and Figure 25.9.2.2.1(f).

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

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

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

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

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

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

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

FIGURE 25.9.2.2.1(h) In-Rack Sprinkler Arrangement, Class I, II, III, or IV Commodities, Storage Height Over 25 ft (7.6 m) — Option 1.
25.9.2.3.1 In multiple-row racks with a maximum of 10 ft (3.0 m) between the top of storage and the ceiling, in-rack sprinklers shall be in accordance with Table 25.9.2.3.1 and Figure 25.9.1.3.1(a) through Figure 25.9.2.3.1(c).

A.25.9.2.3.1 In multiple-row racks with more than 10 ft (3.0 m) between the maximum height of storage and ceiling, a horizontal barrier should be installed above storage with a level of sprinklers, spaced as stipulated for in-rack sprinklers, installed directly beneath the barrier. In-rack sprinklers should be installed as indicated in Figure 25.9.2.3.1(a) through Figure 25.9.2.3.1(c). Data indicate that the sprinkler protection criteria in 25.9.2.3 are ineffective, by themselves, for rack storage with solid shelves if the required flue spaces are not maintained. Use of Table 25.9.2.3.1, along with the additional provisions that are required by this standard, can provide acceptable protection.

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

<table>
<thead>
<tr>
<th>Commodity Class</th>
<th>Maximum Vertical Spacing</th>
<th>Maximum Horizontal Spacing in a Flue</th>
<th>Maximum Horizontal Spacing across Flue</th>
<th>Stagger Between adjacent flues</th>
<th>Maximum Allowable Storage Height Above Top In-Rack Sprinkler Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>I, II, III, IV</td>
<td>20 ft</td>
<td>6.1 ft</td>
<td>3.7 ft</td>
<td>3.0 ft</td>
<td>2.0 ft</td>
</tr>
<tr>
<td>I, II</td>
<td>15 ft</td>
<td>4.6 ft</td>
<td>3.0 ft</td>
<td>10 ft</td>
<td>10 ft</td>
</tr>
<tr>
<td>I</td>
<td>10 ft</td>
<td>3.0 ft</td>
<td>3.0 ft</td>
<td>10 ft</td>
<td>15 ft</td>
</tr>
</tbody>
</table>

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

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

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

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

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

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

FIGURE 25.9.3.1(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to Storage 20 ft (6.1 m) in Height with 5 ft to 10 ft (1.5 m to 3.0 m) Clearance to Ceiling.
FIGURE 25.9.3.1(d) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to Storage 25 ft (7.6 m) in Height with <5 ft (1.5 m) Clearance to Ceiling. (See Note 2.)

FIGURE 25.9.3.1(e) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Storage Up to Storage 25 ft (7.6 m) in Height with 5 ft to 10 ft (1.5 m to 3.0 m) Clearance to Ceiling. (See Note 2.)

25.9.3.2 Notes in each figure shall be permitted to clarify options or to present additional options not shown in the figures.

A25.9.3.2 In most of Figure 25.9.3.1(a) through Figure 25.9.3.1(e), the designer is presented with multiple options from which to choose. The single column of boxes in the elevation view represents single-row rack storage. The double column of boxes in the elevation view represents double-row rack storage, and the options with three or four columns of boxes represent different arrangements of multiple-row rack storage. The “o” and “x” characters in the elevation and plan views represent different rows of in-rack sprinklers. The “o” and “x” characters in the elevation view show the vertical spacing of in-rack sprinklers while the characters in the plan view show the horizontal spacing of in-rack sprinklers. Different symbols are used so that the upper and lower levels of in-rack sprinklers can be determined when looking at the plan view.

25.9.3.2* Where rack storage of exposed unexpanded Group A plastic commodities, encapsulated or nonencapsulated, require in-rack sprinklers, in-rack sprinkler arrangements shall be selected from Figure 25.9.3.2(a) through Figure 25.9.3.2(k).

A25.9.3.2 Each of the figures in 25.3.4.2 shows a variety of different potential rack arrangements. The first single-row rack (SRR) to the left in each figure shows a rack against a wall. The second SRR shows a single-row rack with aisles on each side. The double-row rack (DRR) is in the center of the figure. The first multiple-row rack (MRR) shows the in-rack sprinkler position for racks up to 15 ft (4.6 m) long in the dimension parallel to the transverse flue. The second MRR shows longer rack structures where the in-rack sprinkler pattern would repeat.

FIGURE 25.9.3.2(a) In-Rack Sprinkler Arrangement, Exposed Unexpanded Group A Plastic Commodities Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building - Option 1.

FIGURE 25.9.3.2(b) In-Rack Sprinkler Arrangement, Exposed Unexpanded Group A Plastic Commodities Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building - Option 2.

FIGURE 25.9.3.2(c) In-Rack Sprinkler Arrangement, Exposed Unexpanded Group A Plastic Commodities Up to 15 ft (4.6 m) in Height in Up to a 25 ft (7.6 m) High Building - Option 1.

FIGURE 25.9.3.2(d) In-Rack Sprinkler Arrangement, Exposed Unexpanded Group A Plastic Commodities Up to 15 ft (4.6 m) in Height in Up to a 25 ft (7.6 m) High Building - Option 2.

FIGURE 25.9.3.2(e) In-Rack Sprinkler Arrangement, Exposed Unexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 25 ft (7.6 m) High Building - Option 1.

FIGURE 25.9.3.2(f) In-Rack Sprinkler Arrangement, Exposed Unexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 25 ft (7.6 m) High Building - Option 2.

FIGURE 25.9.3.2(g) In-Rack Sprinkler Arrangement, Exposed Unexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building - Option 1.

FIGURE 25.9.3.2(h) In-Rack Sprinkler Arrangement, Exposed Unexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building - Option 2.

FIGURE 25.9.3.2(i) In-Rack Sprinkler Arrangement, Exposed Unexpanded Group A Plastic Commodities Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building - Option 3.

FIGURE 25.9.3.2(j) In-Rack Sprinkler Arrangement, Exposed Unexpanded Group A Plastic Commodities Up to 25 ft (7.6 m) in Height in Up to a 35 ft (10.7 m) High Building - Option 1.

FIGURE 25.9.3.2(k) In-Rack Sprinkler Arrangement, Exposed Unexpanded Group A Plastic Commodities Up to 25 ft (7.6 m) in Height in Up to a 35 ft (10.7 m) High Building - Option 2.
25.9.4 Rack Storage of Group A Commodities Over 25 ft (7.6 m) in Height.

25.9.4.1 Single-Row Racks.

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

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

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

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

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

25.9.4.1.2 Where a single-row rack of cartoned Group A plastic commodities is located against a wall, the in-rack sprinkler arrangement shall be permitted to be in accordance with Figure 25.9.4.2(a) or Figure 25.9.4.2(b).

25.9.4.2 Double-Row Racks.

25.9.4.2.1 Where double-row rack storage of cartoned Group A plastic commodities, expanded or unexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height, in-rack sprinklers shall be arranged in accordance with one of the options in Figure 25.3.5.2.1(a) through Figure 25.3.5.2.1(c).

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

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

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

25.9.4.2.2* Where double-row rack storage of exposed unexpanded Group A plastic commodities, whether encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height and has minimum 4 ft (1.2 m) wide aisles, in-rack sprinklers shall be arranged in accordance with Figure 25.9.4.2.2.

A.25.9.4.2.2 All arrangements of exposed unexpanded plastic commodities cannot be protected with all types of sprinklers. Only certain combinations of ceiling sprinklers and in-rack sprinklers have been found to provide acceptable protection.

FIGURE 25.9.4.2.2 In-Rack Sprinkler Arrangement, Exposed Unexpanded Group A Plastic Commodities, Double-Row Racks, Storage Height Over 25 ft (7.6 m).

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

25.9.4.3 Multiple-Row Racks.

25.9.4.3.1* Where multiple-row rack storage of exposed unexpanded Group A plastic commodities, encapsulated or nonencapsulated, or cartoned Group A plastic commodities, expanded or unexpanded, encapsulated or nonencapsulated, is over 25 ft (7.6 m) in height, in-rack sprinklers shall be arranged in accordance with one of the options in Figure 25.9.4.3.1(a) through Figure 25.9.4.3.1(f).
A.25.9.4.3.1* All arrangements of exposed unexpanded plastic commodities cannot be protected with all types of sprinklers. Only certain combinations of ceiling sprinklers and in-rack sprinklers have been found to provide acceptable protection.

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

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

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

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

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

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

25.9.5 In-Rack Sprinkler Arrangements Due to Excessive Clearance.

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

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

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

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

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

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

25.1 In-Rack Sprinkler Arrangements in Combination with CMSA Sprinklers at Ceiling-Level.
25.10.1* **Rack Storage of Class I Through Class IV and Group A Plastic Commodities.** The in-rack arrangements for rack storage of Class I through Class IV and Group A plastic commodities protected by CMSA sprinklers at ceiling level shall be in accordance with the guidelines outlined in Section 25.4 through 25.7 as applicable.

A.25.10.1 There are currently no situations where in-rack sprinklers are required to be used to protect Group A plastic commodities stored over 25 ft (7.6 m) in height where CMSA sprinklers are used at the ceiling.

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

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

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

25.12.1 General.

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

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

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

25.12.1.4 Where in-rack sprinkler arrangements have been installed in accordance with Section 25.10, Section 25.11 or Section 25.12, the flow and pressure requirements of both the ceiling and in-rack sprinkler systems over the same protected area shall be hydraulically balanced together to the higher sprinkler system pressure requirement at their point of connection.

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

25.12.2 Number of Operating In-Rack Sprinklers.

25.12.2.1 **In-Rack Design Based on 4 In-Rack Sprinklers.** Where in-rack sprinklers have been installed to protect miscellaneous storage, the number of in-rack sprinklers to account for in the design shall be based on the simultaneous operation of the most hydraulically remote four in-rack sprinklers.

25.12.2.2 In-Rack Design Based on 6 In-Rack Sprinklers.

25.12.2.2.1 Where in-rack sprinklers have been installed on one level to protect the following commodities and storage arrangements, the number of in-rack sprinklers to account for in the design shall be based on the simultaneous operation of the most hydraulically remote six in-rack sprinklers:

25.12.2.2.1(1) Class I through Class III commodities stored in racks with solid shelves.

25.12.2.2.1(2) Class I through Class III commodities stored in racks protected by CMDA sprinklers at ceiling level.

25.12.2.3 In-Rack Design Based on 8 In-Rack Sprinklers.

25.12.2.3.1 Where in-rack sprinklers have been installed on one level to protect the following commodities and storage arrangements, the number of in-rack sprinklers to account for in the design shall be based on the simultaneous operation of the most hydraulically remote eight in-rack sprinklers:

25.12.2.3.1(1) Class IV and Group A plastic commodities stored in racks with solid shelves.

25.12.2.3.1(2) Class IV and Group A plastic commodities stored in racks protected by CMDA sprinklers at ceiling level.
25.12.2.3.1(3) Class I through Class IV commodities stored in racks protected by CMSA sprinklers at ceiling level.

25.12.2.3.1(4) Group A plastic commodities stored in racks up to and including 25 ft (7.6 m) in height protected by CMSA sprinklers at ceiling level.

25.12.2.3.1(5) Class I through Class IV commodities stored in racks protected by ESFR sprinklers at ceiling level.

25.12.2.4 In-Rack Design Based on 10 In-Rack Sprinklers.

25.12.2.4.1 Where in-rack sprinklers have been installed on more than one level to protect the following commodities and storage arrangements, the number of in-rack sprinklers to account for in the design shall be based on the simultaneous operation of the most hydraulically remote ten in-rack sprinklers (five on each of the top two levels):

25.12.2.4.1(1) Class I through Class III commodities stored in racks with solid shelves.

25.12.2.4.1(2) Class I through Class III commodities stored in racks over 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level.

25.12.2.4.1(3) Class IV commodities stored in racks up to and including 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level.

25.12.2.5 In-Rack Design Based on 12 In-Rack Sprinklers. Where in-rack sprinklers have been installed on one level to protect rack storage of rubber tires, the number of in-rack sprinklers to account for in the design shall be based on the simultaneous operation of the most hydraulically remote twelve in-rack sprinklers.

25.12.2.6 In-Rack Design Based on 14 In-Rack Sprinklers.

25.12.2.6.1 Where in-rack sprinklers have been installed on more than one level to protect the following commodities and storage arrangements, the number of in-rack sprinklers to account for in the design shall be based on the simultaneous operation of the most hydraulically remote fourteen in-rack sprinklers (seven on each of the top two levels):

25.12.2.6.1(1) Class IV and Group A plastic commodities stored in racks with solid shelves.

25.12.2.6.1(2) Class IV and Group A plastic commodities stored in racks protected by CMDA sprinklers at ceiling level.

25.12.3 In-Rack Sprinkler Flow/Pressure

25.12.3.1 In-Rack Design Based on 15 psi (1.0 bar)

25.12.3.1.1 Where in-rack sprinklers have been installed to protect the following commodities and storage arrangements, the minimum allowable design pressure at the hydraulically most remote in-rack sprinkler shall be 15 psi (1.0 bar). (See Section C.19.)

25.12.3.1.1(1) Miscellaneous storage.

25.12.3.1.1(2) Class I through Class IV commodities stored in racks up to and including 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level.

25.12.3.1.1(3) Class I through Class IV commodities stored in racks protected by CMSA sprinklers at ceiling level.

25.12.3.1.1(4) Group A plastic commodities stored in racks up to and including 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level.

25.12.3.1.1(5) Group A plastic commodities stored in racks up to and including 25 ft (7.6 m) in height protected by CMSA sprinklers at ceiling level.

25.12.3.2 In-Rack Design Based on 30 psi (2.1 bar). Where in-rack sprinklers have been installed to protect rack storage of rubber tires, the minimum allowable design pressure at the hydraulically most remote in-rack sprinkler shall 30 psi (2.1 bar).

25.12.3.3 In-Rack Design Based on 30 gpm (115 L/min).
25.12.3.3.1 Where in-rack sprinklers have been installed to protect rack storage of the following commodities and storage arrangements, the minimum allowable design pressure at the hydraulically most remote in-rack sprinkler shall be 30 gpm (115 L/min).

25.12.3.3.1(1) Class I through Class IV and Group A plastic commodities stored in racks with solid shelves.

25.12.3.3.1(2) Class I through Class IV and Group A plastic commodities stored in racks over 25 ft (7.6 m) in height protected by CMDA sprinklers at ceiling level.

25.12.3.4 In-Rack Design Based on 60 gpm (230 L/min). Where in-rack sprinklers have been installed to protect rack storage protected by ESFR sprinklers at ceiling level, the minimum allowable design pressure at the hydraulically most remote in-rack sprinkler shall be 60 gpm (230 L/min).
First Revision No. 900-NFPA 13-2016 [ Global Input ]

See attached file for changes to new Chapter 21.

Supplemental Information

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State: 
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Committee Statement

Committee Statement: Chapter 21 consolidates all of the Control Mode Density Area (CMDA) sprinkler criteria into one Chapter. A benefit of this is to have all of the charts, curves and tables relative to CMDA in one spot and not intermixed with other sprinkler technologies.

Response Message:
Table 21.5.3 Protection of Group A plastics between 5 ft and 12 ft (1.5 m and 3.7 m) in height

Table 21.5.1.1 Control Mode Density/Area Sprinkler Protection Criteria for Single-, Double-, and Multiple-Row Racks for Group A Plastic Commodities Stored Up to and Including 25 ft (7.6 m) in Height

21.1 General

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

21.1.10.4 12.7.7.3 The minimum design density for any sprinkler system installed in a storage occupancy shall be not less than 0.15 gpm/ft² (6.1 mm/min) after all adjustments are made.

21.4.16.2.1 Control Mode Density/Area Sprinkler Protection Criteria for Rack Storage of Class I Through Class IV Commodities Stored Up to and Including 25 ft (7.6 m) in Height.

21.4.116.2.1.3 Protection Criteria for Rack Storage of Class I Through Class IV Commodities Stored Over 12 ft (3.7 m) up to and Including 25 ft (7.6 m) in Height.

21.5* Plastic commodities shall be protected in accordance with Figure 17.1.2.1. (See Section C.21.)

Figure 21.5 Decision Tree.

21.5.1.117.2.1.2.1 For Group A plastic commodities in cartons, encapsulated or nonencapsulated in single-, double-, and multiple-row racks and with a clearance to ceiling up to and including 10 ft (3.1 m), ceiling sprinkler water demand in terms of density [gpm/ft² (mm/min)] and area of operation [ft² (m²)] shall be selected from Figure 17.2.1.2.1(a) through Figure 17.2.1.2.1(f)Table 21.5.1.1

Figure 17.2.1.2.1(a) Storage 5 ft to 10 ft (1.5 m to 3.1 m) in Height with Up to 10 ft (3.1 m) Clearance to Ceiling.

21.5.1.4*17.2.1.2.4* An option shall be selected from the appropriate Figure 17.2.1.2.1(a) through Figure 17.2.1.2.1(f)Table 25.1.1 given the storage height and clearance being protected. The density/area criteria at the top of each option shall be applied to the ceiling sprinklers and the in-rack sprinklers shown in the option (if any) shall be provided. Options that do not show multiple-row racks in the figures shall not be permitted to protect multiple-row rack storage. Notes in each figure shall be permitted to clarify options or to present additional options not shown in the figures.

21.5.3*17.2.1.4* Exposed unexpanded Group A plastics protected with control mode density/area sprinklers shall be protected in accordance with one of the following: Table 21.5.3

21.5.4.3*17.3.1.3* Ceiling Sprinkler Water Demand. For Group A plastic commodities, encapsulated or nonencapsulated, ceiling sprinkler water demand in terms of density [gpm/ft² (mm/min)] and area of operation [ft² (m²)] shall be selected from Table 21.5.4.3 17.3.1.3 when in-rack sprinklers are installed per 25.

21.6*18.4* Ceiling Systems. Control Mode Density/Area Sprinkler Protection Criteria for Rack Storage Rubber Tires Sprinkler discharge and area of application shall be in accordance with one of the following:

21.6.1 Protection of rubber tire storage shall be selected from Table 21.6.1(a) or 21.6.1(b).

21.9 16.2.4 Special Design for Rack Storage of Class I Through Class IV Commodities and Group A plastics Stored Up to and Including 25 ft (7.6 m) in Height.
21.9.1.216.2.4.1.2  A wet pipe system that is designed to provide a minimum of 0.6 gpm/ft² (24.5 mm/min) density over a minimum area of 2000 ft² (186 m²), or K-14.0 (200) ESFR sprinklers operating at a minimum of 50 psi (3.4 bar), K-16.8 (240) sprinklers operating at a minimum of 32 psi (2.2 bar), K-22.4 (320) ESFR sprinklers operating at a minimum of 25 psi (1.7 bar), or K-25.2 (360) ESFR sprinklers operating at a minimum of 15 psi (1 bar) shall be permitted to protect single-row and double-row racks with slatted rack shelving where all of the following conditions are met:

(1) Sprinklers shall be K-11.2 (160), K-14.0 (200), or K-16.8 (240) orifice spray sprinklers with a temperature rating of ordinary, intermediate, or high and shall be listed for storage occupancies or shall be K-14.0 (200), K-16.8 (240), K-22.4 (320) ESFR, or K-25.2 (360) ESFR.

(6) Longitudinal flue spaces at least 6 in. (152 mm) wide shall be provided for double-row racks. Longitudinal flue spaces shall not be required where ESFR sprinklers are used.

(8) The maximum roof height shall be 27 ft (8.2 m) or 30 ft (9.1 m) where ESFR sprinklers are used.

21.1220.5 Control Mode Density/Area Sprinkler Protection Criteria for Sprinkler Protection of Carton Records Storage with Catwalk Access.

21.1320.6 Control Mode Density/Area Sprinkler Protection Criteria for Compact Storage of Commodities Consisting of Paper Files, Magazines, Books, and Similar Documents in Folders and Miscellaneous Supplies with No More Than 5 Percent Plastics Up to 8 ft (2.44 m) High.
First Revision No. 901-NFPA 13-2016 [ Global Input ]

See attached files for changes for new Chapter 22

Supplemental Information

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Committee Statement

Committee Statement: Chapter 22 consolidates all of the Control Mode Specific Application (CMSA) sprinkler criteria into one Chapter. A benefit of this is to have all of the charts, curves and tables relative to CMSA in one spot and not intermixed with other sprinkler technologies.

Response Message:
22.1 General. The criteria in Chapter 20 shall apply to storage protected with CMSA sprinklers.

22.1.1 22.6.7.2 Quick-response CMSA sprinklers designed to meet any criteria in Chapter 12 or Chapter 14 through Chapter 20 shall be permitted to protect any of the following:

1. Light hazard occupancies
2. Ordinary hazard occupancies
3. Any storage arrangement in Chapter 13 referencing OH1, OH2, EH1, and EH2 design criteria

22.1.2 22.6.7.3 Standard-response CMSA sprinklers designed to meet any criteria in Chapter 12 or Chapter 14 through Chapter 20 shall be permitted to protect any of the following:

1. Ordinary hazard occupancies
2. Any storage arrangement in Chapter 13 referencing OH1, OH2, EH1, and EH2 design criteria

Table 22.4 16.2.2.1 CMSA Sprinkler Design Criteria for Rack Storage of Class I Through Class IV Commodities (Encapsulated and Nonencapsulated). Stored Up to and Including 25 ft (7.6 m) in Height (Combine with over 25 ft)

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

22.7 19.1.2.2 CMSA Sprinklers for Protection of Roll Paper Storage with CMSA sprinklers shall be in accordance with Table 22.7. Where automatic sprinkler system protection utilizes CMSA sprinklers, hydraulic design criteria shall be as specified in Table 19.1.2.2.
See attached file for changes to new Chapter 23

Supplemental Information

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Committee Statement

Committee Statement: Chapter 23 consolidates all of the Early Suppression Fast Response (ESFR) sprinkler criteria into one Chapter. A benefit of this is to have all of the charts, curves and tables relative to ESFR in one spot and not intermixed with other sprinkler technologies.
Chapter 23 Protection of High Piled Storage Using Early Suppression Fast Response (ESFR) Sprinklers

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

23.1.12.6.7.1 ESFR sprinklers designed to meet any criteria in Chapter 12 or Chapter 14 through Chapter 20 this chapter shall be permitted to protect any of the following:

1. Light hazard occupancies
2. Ordinary hazard occupancies
3. Any storage arrangement in Chapter 13 referencing OH1, OH2, EH1, and EH2 design criteria

23.1.3 Draft Curtains.

23.1.3.18.4.6.4.1 Where ESFR sprinkler systems are installed adjacent to sprinkler systems with standard-response sprinklers, a draft curtain of noncombustible construction and at least 2 ft (600 mm) in depth shall be required to separate the two areas.

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

23.1.3.38.4.6.5 Temperature Ratings. Sprinkler temperature ratings for ESFR sprinklers shall be ordinary unless 8.3.2 requires intermediate- or high-temperature ratings.

23.1.5* The ceiling design criteria for single-, double-, and multiple-row racks in Chapter 16-23 shall be based on open rack configurations as defined in 3.9.3.7.4.

23.1.5.116.2.3.2 ESFR sprinklers shall not be permitted to protect storage on solid shelf racks unless the solid shelf racks are protected with in-rack sprinklers in accordance with 16.1.6 Chapter 25.

23.2 ESFR design criteria shall be selected from Section 23.3 to Section 23.13

23.4.1* 15.1.4 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:

1. Pile height
2. Clearance to ceiling
3. Pile stability
4. Array

A 15.1.1 23.4.1 An evaluation for each field situation should be made to determine the worst applicable height–clearance to ceiling relationship that can be expected to appear in a particular case. Fire tests have shown that considerably greater demands occur where the clearance to ceiling is 10 ft (3.0 m) as compared to 3 ft (900 mm) and where a pile is stable as compared to an unstable pile. Since a system is designed for a particular clearance to ceiling, the system could be inadequate when significant areas do not have piling to the design height and larger clearances to ceiling. This can also be true where the packaging or arrangement is changed so that stable piling is created where unstable piling existed.
Recognition of these conditions is essential to avoid installation of protection that is inadequate or becomes inadequate because of changes.

No tests were conducted simulating a peaked roof configuration. However, it is expected that the principles of Chapter 12 still apply. The worst applicable height–clearance to ceiling relationship that can be expected to occur should be found, and protection should be designed for it. If storage is all at the same height, the worst height–clearance to ceiling relationship creating the greatest water demand would occur under the peak. If commodities are stored higher under the peak, the various height–clearance to ceiling relationships should be tried and the one creating the greatest water demand used for designing protection.

23.5*16.2.3* Early Suppression Fast-Response (ESFR) Sprinklers for Rack Storage of Class I Through Class IV Commodities Stored Up to and Including 25 ft (7.6 m) in Height.

Table 23.5.16.2.3.1 ESFR Sprinkler Protection of Rack Storage of Class I Through Class IV Commodities Stored Up to and Including 25 ft (7.6 m) in Height (combine with above 25 ft)

23.6*17.2.3* Early Suppression Fast-Response (ESFR) Sprinklers for Rack Storage of Group A Plastic Commodities Stored Up to and Including 25 ft (7.6 m) in Height.

Table 23.6.17.2.3.1 ESFR Protection of Rack Storage of Group A Plastic Commodities Stored Up to and Including 25 ft (7.6 m) in Height (combine with over 25 ft)

23.7.217.2.3.5.2 The maximum storage height shall be 25 ft (9.1 m) 35 ft (10.7 m).

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

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

b) 60 psi (4.1 bar) for storage heights up to 25 ft (7.6 m) with a maximum ceiling height of 40 ft (12.2 m).

23.8* ESFR Protection of Rack Storage of Rubber Tires Sprinkler discharge and area of application shall be in accordance with one of the following: Table 23.8

23.10* Plastic Motor Vehicle Components. Group A plastic automotive components and associated packaging material shall be permitted to be protected in accordance with Table 23.1020.2.

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

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

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

2) Solid veneered particleboard/plywood displays shall be permissible, provided that all flues are maintained and only one display is installed per bay.
(3) A single display shall be permitted to have one or two solid horizontal or slanted members, and a solid back.

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

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

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

(7) Minimum longitudinal flue spaces of 6 in. (152 mm) shall be provided for double-row racks.

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

(9) Maximum storage height shall be 22 ft (6.71 m).

(10) Aisle widths shall be a minimum of 8 ft (2.44 m).

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

(12) Minimum longitudinal flue spaces of 6 in. (152 mm) shall be provided for double-row racks.

(13) Storage in the aisle shall be permissible, provided the aisle storage is no more than 4 ft (1.22 m) high and a minimum clear aisle of 4 ft (1.22 m) is maintained.

23.13 Slatted Shelves
See attached file for any extract updates being made in current Chapter 22 [new Chapter 26]

Supplemental Information

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Committee Statement

Committee Statement: Update extracted information to latest editions. TC will consider additions and deletions during SD.

Response Message:
Chapter 22 Special Occupancy Requirements

22.1 General.

22.1.1 Application.

22.1.1.1 In addition to the requirements of Chapter 8, Chapters 11 through 22, and Chapter 23, the following special occupancy requirements shall apply.

22.1.1.1.1 All provisions of design criteria in this standard, including design area increases and reductions, shall also apply to these special occupancy requirements.

22.1.1.2 Where the requirements of the reference standard differ from the requirements of this standard, the reference standard shall take precedence.

22.1.2 Definitions.

For terms not defined in Chapter 3, the definitions of the reference standard shall apply.

22.2 Flammable and Combustible Liquids.

22.2.1 Design Requirements.

Sprinkler system discharge criteria for the protection of flammable and combustible liquids shall comply with NFPA 30.

22.2.2 Installation Requirements. (Reserved)

22.3 Aerosol Products.

22.3.1 Design Requirements.

Sprinkler system discharge criteria for the protection of aerosol products shall comply with NFPA 30B.

22.3.2 Installation Requirements. (Reserved)

22.4 Spray Application Using Flammable or Combustible Materials.

22.4.1 Design Requirements.

22.4.1.1* The automatic sprinkler system shall be a wet pipe system, a dry pipe system, a preaction system, or an open-head deluge system, whichever is most appropriate for the portion of the spray operation being protected. [33:9.4.1]

22.4.1.2 The automatic sprinkler system shall be designed for Extra Hazard (Group 2) occupancies as defined in NFPA 13.

Exception No. 1: For spray application of styrene cross-link thermoset resins, Section 17.3 of NFPA 33 shall apply.

Exception No. 2: Automatic sprinkler systems for powder coating operations shall be designed for Ordinary Hazard (Group 2), as defined in NFPA 13. [33:9.4.2]

22.4.1.3 The water supply shall be sufficient to supply all sprinklers likely to open in any one fire incident without depleting the available water for use in hose streams. [33:9.4.3]
Where sprinklers are installed to protect spray areas and mixing rooms only, water shall be permitted to be supplied from domestic water systems, provided the domestic supply can meet the design criteria of 22.4.1.2. [33:9.4.4]

22.4.1.5
The sprinkler system shall be controlled by a separate, listed indicating valve(s), operable from floor level. [33:9.4.5]

22.4.1.6
Automated liquid electrostatic spray application equipment that is unlisted shall be protected further by the following:

1. In addition to meeting the requirements in 9.8.1 of NFPA 33, the optical flame detection system shall also activate one of the following over each zone in which fire has been detected:
   1. An open head deluge system designed to discharge a minimum density of 24.4 mm/min (0.6 gpm/ft²)
   2. A carbon dioxide extinguishing system
   3. A dry chemical extinguishing system
   4. A gaseous agent extinguishing system

   [33:9.8.2(1)]

2. A wet pipe sprinkler system shall also be provided throughout the spray booth. This system shall meet all the applicable requirements of this standard for Extra Hazard (Group 2) occupancies.

   [33:9.8.2(3)]

22.4.2  Installation Requirements.

22.4.2.1*
Sprinkler systems protecting stacks or ducts shall meet all of the following requirements:

1. Sprinklers shall be spaced no more than 3.7 m (12 ft) apart.
2. If exhaust ducts are manifolded, a sprinkler shall be located in the manifold at the junction of each exhaust duct with the manifold.
3. Sprinklers shall provide a minimum flow of 114 L/min (30 gpm) per head at a minimum of 1 bar (15 psi) pressure.
4. Sprinklers shall be ordinary temperature rated, unless required to be higher due to operating temperatures measured in the ducts, in which case the operating temperature shall be at least 28°C (50°F) above the inside temperature of the duct.

   [33:9.4.6]

22.4.2.1.1
Stacks and exhaust ducts shall be provided with access openings for inspection and cleaning of sprinklers. [33:9.4.6.1]

22.4.2.1.2
Sprinkler systems protecting stacks and ducts that are subject to freezing shall be of a nonfreezing type or be a manually controlled open-head system. [33:9.4.6.2]
22.4.2.2 Sprinklers shall be protected against overspray residue, either by location or covering, so that they will operate quickly in event of fire. [33:9.4.7]  
22.4.2.2.1 Sprinklers shall be permitted to be covered only by cellophane bags having a thickness of 0.08 mm (0.003 in.) or less or by thin paper bags. These coverings shall be replaced frequently so that heavy deposits of residue do not accumulate. [33:9.4.7.1]  
22.4.2.2.2 Sprinklers that have been painted or coated by overspray or residues shall be replaced with new sprinklers. [33:9.4.7.2]  
22.5 Solvent Extraction Plants. [NFPA 36]  
22.5.1* Design Requirements.  
22.5.2 Installation Requirements. (Reserved)  
22.6 Installation and Use of Stationary Combustion Engines and Gas Turbines.  
22.6.1* Design Requirements.  
Automatic sprinkler systems shall be designed to provide for a density of 0.3 gpm/ft² (12.2 mm/min) over the most remote 2500 ft² (230 m²). [37:11.4.5.1]  
22.6.2 Installation Requirements.  
22.6.2.1 Sprinklers and spray nozzles shall be spaced at a 100 ft² (9 m²) maximum area of coverage per sprinkler or spray nozzle. [37:11.4.5.1.1]  
22.6.2.2 Sprinkler and water spray system coverage shall be provided to all areas within the enclosure located within 20 ft (6 m) of the following:  
1. The engine  
2. The lubricating oil system  
3. The fuel system  
[37:11.4.5.1.2]  
22.6.2.3 Sprinklers and water spray nozzles shall not be directed at engine components that are susceptible to thermal shock or deformation. [37:11.4.5.2]  
22.7 Nitrate Film.  
22.7.1 Design Requirements.  
22.7.1.1 Every room, except projection booths and rewinding rooms, where nitrate film is stored or handled in quantities greater than 51 lb (23 kg), or 10 standard rolls, shall be protected by an automatic sprinkler system that is installed in accordance with the requirements for Group II extra hazard occupancies. [40:5.1.2]  
22.7.1.2 Water supplies for automatic sprinklers shall be based on 20 gpm (1.26 L/sec) per sprinkler for 20 minutes for the total number of sprinklers in one vault plus 25 percent of the sprinklers in the communicating fire area. [40:5.2.2]  
22.7.1.3* Vaults Other Than Extended Term Storage Vaults.
Fire protection in vaults shall be provided by a deluge system with directional nozzles meeting the criteria in 22.7.1.4. For extended term storage vaults in accordance with Section 6.5.5 of NFPA 40, fire protection shall be provided by a deluge system with directional nozzles installed in accordance with NFPA 15 and meeting the criteria in 22.7.1.4.1 through 22.7.1.4.9.

Sprinkler systems in existing extended term storage vaults that were in compliance with the provisions of this standard at the time of installation shall be permitted to be continued in use. Sprinkler systems in existing extended term storage vaults that were in compliance with the provisions of this standard at the time of installation shall be permitted to be continued in use.

High-velocity open head nozzles each capable of providing a discharge rate of 1.26 L/sec (20 gpm) at a gauge pressure of 345 kPa (50 psi) shall be installed. The design shall be based on a discharge density of 28 mm/min (0.68 gpm/ft²) over each face of storage racks. The nozzles shall have a combined spray pattern capable of covering the face of the film storage racks. The nozzles shall be installed at the top of the storage shelf array, aimed at the opposite shelf array. Nozzles shall be installed on opposite faces of the storage shelf array in a staggered pattern such that no nozzles are directly opposite one another.

The water supply duration shall be a minimum of 20 minutes. The deluge system shall be activated by a signal from one of the following:

1. An air sampling–type smoke detection system
2. A fixed temperature heat sensitive cable

Full water flow shall be discharged from the water spray nozzles within 10 seconds of reaching the set point actuation of the detection system.

In areas or rooms where nitrate film is handled, the area that is protected per sprinkler head shall not exceed 64 ft² (6 m²) with sprinklers not being more than 8 ft (2.4 m) apart. Cabinets having a capacity of more than 34 kg (75 lb), or 15 standard rolls, of film shall be provided with at least one automatic sprinkler head.
Where cans are stored on more than one shelf, as shown in Figure 22.7.2.2.2 and as described in 6.2.6.2 or 6.2.6.3 of NFPA 40, one sprinkler shall be provided for each shelf. [40:6.2.5.2]

Figure 22.7.2.2.2 Standard Film Cabinet for Other Than Extended Term Storage Film.

[40:Figure 6.2.1]

Vent flue equivalent to No. 18 U.S. gauge riveted steel; when inside building, flue to be covered with 25 mm (1 in.) of insulating material.

22.7.2.3 Motion Picture Film Laboratories.
In all cases, sprinklers shall be arranged so that not more than two machines are protected by any one sprinkler head. [40:9.2.5.2]

22.8 Laboratories Using Chemicals.
22.8.1 Design Requirements.
Automatic sprinkler system protection shall be required for all new laboratories in accordance with the following:

1. Automatic sprinkler system protection for Class A and Class B laboratories shall be in accordance with NFPA 13 for ordinary hazard (Group 2) occupancies.
2. Automatic sprinkler system protection for Class C and Class D laboratories shall be in accordance with NFPA 13 for ordinary hazard (Group 1) occupancies.

22.8.2 Installation Requirements.
Fire sprinklers in laboratory units shall be the quick response (QR) sprinkler type installed in accordance with NFPA 13.

22.9 Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes.
22.9.1 Design Requirements.
22.9.1.1 Oxygen cylinders connected to one manifold shall be limited to a total gas capacity of 6500 ft³ (184 m³).
22.9.1.1.1 Two such manifolds with connected cylinders shall be permitted to be located in the same room, provided the building is protected throughout with an approved automatic sprinkler system designed in accordance with this standard, furnishing a sprinkler discharge density of at least 0.25 gpm/ft² (10.2 mm/min) over a minimum operating area of at least 3000 ft² (279 m²) with sprinklers located not more than 20 ft (6.1 m) above the floor where the manifolds are located.

22.9.2 Installation Requirements.
22.9.2.1 In buildings protected by an automatic sprinkler system and water supply designed in accordance with this standard for an Ordinary Hazard Group 2 or more hazardous occupancy, where the occupancy other than the cylinder storage is not more hazardous than ordinary hazard as defined in this standard, the distance between designated storage areas shall be permitted to be reduced to 15.2 m (50 ft) (15.2 m).

22.10 Acetylene Cylinder Charging Plants.
22.10.1 Design Requirements.
22.10.1.1 When sprinkler protection is provided, the area in which flammable compressed gases are stored or used shall be protected with a sprinkler system designed to be not less than that required by NFPA 13 for Extra Hazard Group 1 with a minimum design area of 2500 ft² (232.26 m²).

22.10.2 At mobile acetylene trailer systems (MATS) at mobile acetylene charging plants, a fire sprinkler system in accordance with this standard, Extra Hazard Group 1 shall be installed in the areas occupied by trailers in charging or discharging stations. [51A:11.2.1.2]

22.11 Compressed Gases and Cryogenic Fluids Code.
22.11.1 Design Criteria.
22.11.1.1 When sprinkler protection is required, the area in which compressed gases or cryogenic fluids are stored or used shall be protected with a sprinkler system designed to be not less than that required by NFPA 13 for Ordinary Hazard Group 2. [55:6.10.2.1]

22.11.1.2 When sprinkler protection is required, the area in which the flammable or pyrophoric compressed gases or cryogenic fluids are stored or used shall be protected with a sprinkler system designed to be not less than that required by NFPA 13 for Extra Hazard Group 1. [55:6.10.2.2]

22.11.2 Installation Requirements. (Reserved)

22.12 Utility LP-Gas Plants.
22.12.1 Design Requirements.
22.12.1.1 The design of fire water supply and distribution systems, where used, shall provide for the simultaneous supply of those fixed fire protection systems involved in the maximum single incident expected in the plant, including monitor nozzles, at their design flow and pressure. [59:13.4.2]

22.12.1.2 An additional supply of 1000 gal/min (63 L/sec) shall be available for hand hose streams for a period of not less than 2 hours. [59:13.4.2.1]

22.12.1.3 Manually actuated monitors shall be permitted to be used to augment hand hose streams. [59:13.4.2.2]

22.12.2 Installation Requirements. (Reserved)

22.13 Production, Storage, and Handling of Liquefied Natural Gas (LNG).
22.13.1 Design Requirements.
The fire water supply and distribution systems, if provided, shall simultaneously supply water to fixed fire protection systems, including monitor nozzles, at their design flow and pressure, involved in the maximum single incident expected in the plant plus an allowance of 1000 gpm (63 L/sec) for hand hose streams for not less than at least 2 hours. [59A:12.5.2]

22.13.2 Installation Requirements. (Reserved)

22.14 Protection of Information Technology Equipment.
22.14.1 Design Requirements. (Reserved)
22.14.2  Installation Requirements.

22.14.2.1* Information technology equipment rooms and information technology equipment areas located in a sprinklered building shall be provided with an automatic sprinkler system. [75:9.1.1]

22.14.2.2 Sprinkler systems protecting information technology equipment areas shall be valved separately from other sprinkler systems. [75:9.1.3]

22.14.2.3* An automatic sprinkler fire suppression system, as permitted by Chapter 9 of NFPA 75, or a gaseous fire extinguishing system shall be provided for the protection of the area below a raised floor in an information technology equipment room or information technology equipment area when one or more of the following exist:

1. There is a critical need to protect data in the process, reduce equipment damage, and facilitate return to service.
2. The area below the raised floor contains combustible material other than what is permitted in 9.1.1.4 of NFPA 75.

[75:9.1.1.23]

22.15  Standard on Incinerators, and Waste and Linen Handling Systems and Equipment.

22.15.1  Design Requirements. (Reserved)

22.15.2  Installation Requirements.

22.15.2.1 Automatic sprinklers shall be provided in incinerator rooms in accordance with this standard. [82:5.2.7.3]

22.15.2.2* Waste and Linen Chutes and Transport Systems.

22.15.2.2.1 Gravity Waste or Linen Chutes.

22.15.2.2.1.1 Lined metal chutes shall be protected internally by automatic sprinklers unless they are lined in accordance with 6.2.2.6.1 in NFPA 82. [82:6.2.2.6.2]

22.15.2.2.1.2 This protection requires that a sprinkler be installed at or above the top service opening of the chute. [82:6.2.6.1.2]

22.15.2.2.1.3 Chute Sprinkler Protection. Automatic sprinklers installed in gravity chute service openings shall be recessed out of the chute area through which the material travels. [82:6.2.6.1.3]

22.15.2.2.1.4 In addition, a sprinkler shall be installed within the chute at alternate floor levels in buildings over two stories in height, with a mandatory sprinkler located at the lowest service level. [82:6.2.6.1.4]

22.15.2.2.1.5 Gravity chutes shall be protected internally by automatic sprinklers unless they are lined in accordance with 6.2.2.6.1 in NFPA 82. [82:6.2.6.1.1]

22.15.2.2.1.6 Chute Room Automatic Sprinklers.
Automatic sprinklers shall be installed in chute terminal rooms. [82:6.2.6.2.1]
22.15.2.2.2 Full Pneumatic Waste and Linen Conveying Systems. [82:6.3]
22.15.2.2.2.1
Full pneumatic-type risers shall be protected internally by automatic sprinklers. [82:6.3.4.1]
22.15.2.2.2.2
A sprinkler shall be required at or above the top loading station and at alternate floor levels in buildings over two stories in height, with a mandatory sprinkler located at the lowest loading station. [82:6.3.4.2]
22.15.2.2.2.3
Sprinklers shall be recessed out of the station area through which the material travels. [82:6.3.4.3]
22.15.2.2.3 Gravity Pneumatic Trash or Linen Conveying Systems. [82:6.4]
22.15.2.2.3.1 Chute Automatic Sprinklers.
Where material is to be stored at the bottom of the chute and above the riser discharge damper (above the transport tee), automatic sprinklers shall be installed below the last service door on the chute. [82:6.4.2.3]
22.15.2.2.3.2 Automatic sprinklers shall be installed in chute discharge rooms. [82:6.4.2.4.3]
22.15.2.3 Other Waste Handling Systems. [82:7.4]
22.15.2.3.1 Automatic sprinklers shall be installed in rooms where waste handling systems and equipment are used to transport waste from interim storage areas to waste processing equipment, such as incinerators. [82:7.4.1]
22.15.2.3.2 In locations or rooms where waste handling systems and equipment are used for interim storage of waste only, the rooms shall be sprinklered in accordance with requirements specified in 22.15.2.4. [82:7.4.2]
22.15.2.4 Waste Compactors. [82:8]
22.15.2.4.1 All chute-fed compactors shall have an automatic sprinkler with a minimum 13 mm (1/2 in.) orifice installed in the hopper of the compactor. [82:8.2.1]
22.15.2.4.2 Sprinklers shall be ordinary temperature-rated sprinklers. [82:8.2.1.1]
22.15.2.4.3 Sprinklers shall be supplied by a minimum of 1 in. (25.4 mm) ferrous piping or 3/4 in. (19 mm) copper tubing line from the domestic cold water supply or by the building fire sprinkler system. [82:8.2.1.2]
22.15.2.4.4 Sprinkler water pipe shall be protected from freezing in outdoor installations. [82:8.2.1.3]
22.15.2.4.5 Hand-fed compactors located within a building and not operated in conjunction with a chute shall not require installation of an automatic sprinkler in the hopper. [82:8.2.2]
22.15.2.5
Waste and recyclables storage rooms shall be provided with automatic sprinklers in accordance with this standard. [82:9.3]

22.15.2.6

Rooms in which waste processing equipment is located shall be installed with automatic sprinklers. [82:10.4.1]

22.16 Standard for Ovens and Furnaces.

22.16.1 Design Requirements. (Reserved)

22.16.2 Installation Requirements.

22.16.2.1* Where automatic sprinklers are provided, they shall be installed in accordance with NFPA 13, unless otherwise permitted by 22.16.2.2. [86:9.2.1]

22.16.2.2 Where sprinklers that protect only ovens are installed and connection to a reliable fire protection water supply is not feasible, a domestic water supply connection shall be permitted to supply these sprinklers subject to the approval of the authority having jurisdiction. [86:9.2.2]

22.16.2.3 Where sprinklers are selected for the protection of ovens, furnaces, or related equipment, the use of closed-head sprinkler systems shall be prohibited and only deluge sprinkler systems shall be used where the following conditions exist:

1. In equipment where temperatures can exceed 625°F (329°C)
2. Where flash fire conditions can occur

[86:9.3.3]

22.16.2.4 Furnaces shall be located so as to minimize exposure to power equipment, process equipment, and sprinkler risers. [86:5.1.3.1]

22.16.2.5 Where water from a fixed protection system could come in contact with molten materials, such as molten salt or molten metal, shielding shall be provided to prevent water from contacting the molten material. [86:9.3.1]

22.16.2.6* Galvanized pipe shall not be used in sprinkler or water spray systems in ovens, furnaces, or related equipment. [86:9.3.2]

22.17 Health Care Facilities Code, Class A Hyperbaric Chambers.

22.17.1 Design Requirements.

22.17.1.1 A fixed water deluge extinguishing system shall be installed in all chamber compartments that are designed for manned operations. [99:14.2.5.2]

22.17.1.2 In chambers that consist of more than one chamber compartment (lock), the design of the deluge system shall meet the requirements of 22.17.1.1 when the chamber compartments are at different depths (pressures). [99:14.2.5.2.1]

22.17.1.3 The deluge system in different compartments (locks) shall operate independently or simultaneously. [99:14.2.5.2.2]
22.17.1.4
Fixed deluge systems shall not be required in chamber compartments that are used strictly as personnel transfer compartments (locks) and for no other purposes. [99:14.2.5.2.3]

22.17.1.5*
Manual activation and deactivation deluge controls shall be located at the operator's console and in each chamber compartment (lock) containing a deluge system. [99:14.2.5.2.4]

22.17.1.6
Controls shall be designed to prevent unintended activation. [99:14.2.5.2.4.1]

22.17.1.7
Water shall be delivered from the fixed discharge nozzles as specified in 22.17.1.9 within 3 seconds of activation of any affiliated deluge control. [99:14.2.5.2.5]

22.17.1.8*
Average spray density at floor level shall be not less than 2 gpm/ft² (81.5 L/min/m²), with no floor area larger than 10.76 ft² (1 m²) receiving less than 1 gpm/ft² (40.75 L/min/m²). [99:14.2.5.2.6]

22.17.1.9
Water shall be available in the deluge system to maintain the flow specified in 22.17.1.8 simultaneously in each chamber compartment (lock) containing the deluge system for 1 minute. [99:14.2.5.2.7]

22.17.1.10
The limit on maximum extinguishment duration shall be governed by the chamber capacity (bilge capacity also, if so equipped) or its drainage system, or both. [99:14.2.5.2.7.1]

22.17.1.11
The deluge system shall have stored pressure to operate for at least 15 seconds without electrical branch power. [99:14.2.5.2.8]

22.18  Fixed Guideway Transit and Passenger Rail Systems.

22.18.1  Design Requirements.

22.18.1.1
Other fire suppression systems, if approved, shall be permitted to be substituted for automatic sprinkler systems in the areas listed in 22.18.2.1. [130:5.7.3.45.4.4.5]

22.18.2  Installation Requirements.

22.18.2.1*
An automatic sprinkler protection system shall be provided in areas of stations used for concessions, in storage areas, in trash rooms, and in the steel truss area of all escalators and other similar areas with combustible loadings, except trainways. [130:5.7.3.45.4.4.1]

22.18.2.2
Sprinkler protection shall be permitted to be omitted in areas of open stations remotely located from public spaces. [130:5.7.3.45.4.4.2]

22.18.2.3
Installation of sprinkler systems shall comply with NFPA 13 or applicable local codes as required. [130:5.7.3.45.4.4.3]

22.18.2.4
A sprinkler system waterflow alarm and supervisory signal service shall be installed. [130:5.7.3.45.4.4.4]
22.19 Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations.
22.19.1 Design Requirements. (Reserved)
22.19.2 Installation Requirements.

The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if approved mitigation is employed. [140:4.11.1.3.1]

22.19.2.2
The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if the building sprinkler system meets the design criteria for Extra Hazard, Group 2. [140:4.11.1.3.2]

22.19.2.3
In any production location building protected by an existing automatic sprinkler system, where solid- or hard-ceiling sets or platforms are introduced and create an obstruction to sprinkler discharge, the provisions of 22.19.2.4 or 22.19.2.5 shall be met. [140:5.11.3]

22.19.2.4*
The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if approved mitigation is employed. [140:5.11.4]

22.19.2.5*
The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if the building sprinkler system meets the design criteria for Extra Hazard, Group 2. [140:5.11.5]

22.20 Animal Housing Facilities.
22.20.1 Design Requirements. (Reserved)
22.20.2 Installation Requirements. (Reserved)

Quick-response sprinklers shall be utilized in animal housing facilities. [150:9.2.3]

22.21 Water Cooling Towers.
22.21.1 Design Requirements.
22.21.1.1 Types of Systems.

Because the counterflow tower design lends itself to either closed- or open-head systems, the following systems shall be permitted to be used:

1. Wet-pipe
2. Dry-pipe
3. Preaction
4. Deluge

[214:5.2.2.1]

22.21.1.2*
The open-head deluge system shall be used in crossflow towers to maximize the water distribution and heat detection activation. [214:5.2.2.2]

22.21.1.2 Minimum Rate of Application. [214:5.2.3]
22.21.1.2.1 Under the fan decks of counterflow towers, the rate of application of water shall be 0.5 gpm/ft² (20.4 mm/min), including fan opening. \[214:5.2.3.1\]

22.21.1.2.2 Under the fan decks of crossflow towers, the rate of application of water shall be 0.33 gpm/ft² (13.45 mm/min), including fan opening. \[214:5.2.3.2\]

22.21.1.2.3 Over the fill areas of crossflow towers, the rate of application of water shall be 0.5 gpm/ft² (20.4 mm/min). \[214:5.2.3.3\]

22.21.1.3 Extended Fan Decks.
On towers having extended fan decks that completely enclose the distribution basin, the discharge outlets protecting the fill area shall be located over the basin, under the extension of the fan deck. \[214:5.2.4.3\]

22.21.1.3.1 These discharge outlets shall be open directional spray nozzles or other approved spray devices arranged to discharge 0.35 gpm/ft² (14.26 mm/min) directly on the distribution basin and 0.15 gpm/ft² (6.11 mm/min) on the underside of the fan deck extension. \[214:5.2.4.3.1\]

22.21.1.3.2 On towers having extended fan decks that do not completely enclose the hot-water basin, outlets protecting the fill shall be located under the distribution basin in accordance with 5.2.4.2.2 of NFPA 214. \[214:5.2.4.3.2\]

22.21.1.4 Combustible Fan Decks.
For deluge systems using directional spray nozzles in the pendant position, provisions shall be made to protect the underside of a combustible fan deck at a minimum of 0.15 gpm/ft² (6.11 mm/min), which shall be included as part of the application rate specified in 5.2.3 of NFPA 214. \[214:5.2.4.4\]

22.21.1.5* Water Basin Covers.
On film-filled towers that have solid, hot-water basin covers over the complete basin, the discharge outlets protecting the fill area shall be permitted to be located under the basin covers. \[214:5.2.4.5\]

22.21.1.5.1 These discharge outlets shall be open directional spray nozzles or other approved devices arranged to discharge 0.50 gpm/ft² (20.4 mm/min) into the distribution basin horizontally, with some of the spray splashing up and on the underside of the water basin covers. \[214:5.2.4.5.1\]

22.21.1.6 Exterior Protection.
[214:5.2.10]\n
22.21.1.6.1 Where any combustible exterior surfaces of a tower, including the fan deck and distribution basins, are less than 100 ft (30.5 m) from significant concentrations of combustibles such as structures or piled material, the combustible exposed surfaces of the tower shall be protected by an automatic water spray system. \[214:5.2.10.1\]

22.21.1.6.2 Systems for exterior protection shall be designed with the same attention and care as interior systems. \[214:5.2.10.2\]

22.21.1.6.2.1 Pipe sizing shall be based on hydraulic calculations. \[214:5.2.10.2.1\]
22.21.1.6.2 Water supply and discharge rate shall be based on a minimum 0.15 gpm/ft² (6.11 mm/min) for all protected surfaces. [214:5.2.10.2.2]

22.21.1.7 Sprinkler System Water Supply.
22.21.1.7.1 Deluge Systems.
22.21.1.7.1.1* Where all cells of a cooling tower are protected by a single deluge system, the water supply shall be adequate to supply all discharge outlets on that system. [214:5.6.1.1]

22.21.1.7.1.2 Where two or more deluge systems are used to protect a cooling tower and fire-resistant partitions are not provided between the deluge systems, the water supply shall be adequate to supply all discharge outlets in the two most hydraulically demanding adjacent systems. [214:5.6.1.2]

22.21.1.7.1.3* Where two or more deluge systems are separated by fire-resistant partitions, the water supply shall be adequate to supply all discharge outlets in the single most hydraulically demanding system. [214:5.6.1.3]

22.21.1.7.2 Wet, Dry, and Preaction Systems.
22.21.1.7.2.1* Where each cell of the cooling tower is separated by a fire-resistant partition, the water supply shall be adequate to supply all discharge outlets in the hydraulically most demanding single cell. [214:5.6.2.1]

22.21.1.7.2.2* Where fire-resistant partitions are not provided between each cell of a cooling tower, the water supply shall be adequate to supply all discharge outlets in the two most hydraulically demanding adjoining cells. [214:5.6.2.2]

22.21.1.7.3 Hose Streams.
Water supplies shall be sufficient to include a minimum of 500 gpm (1892.5 L/min) for hose streams in addition to the sprinkler requirements. [214:5.6.3]

22.21.1.7.4 Duration.
A water supply adequate for at least a 2-hour duration shall be provided for the combination of the water supply specified in 5.6.1 or 5.6.2 of NFPA 214, plus the hose stream demand specified in 22.21.1.7.3. [214:5.6.4]

22.21.2 Installation Requirements.
22.21.2.1* Counterflow Towers.
[214:5.2.4.1.1]

22.21.2.1.1 The discharge outlets shall be located under the fan deck and fan opening. [214:5.2.4.1.1.1]

22.21.2.1.2 Except under the fan opening, all discharge outlets shall have deflector distances installed in accordance with Section 8.5 of NFPA 13. [214:5.2.4.1.2]

22.21.2.1.3 Closed-head discharge outlets for dry-pipe and preaction systems shall be installed in the upright position only. [214:5.2.4.1.3]

22.21.2.2* Crossflow Towers. [214:5.2.4.2]
22.21.2.2.1
The discharge outlets protecting the plenum area shall be located under the fan deck and in the fan opening. [214:5.2.4.2.1]

22.21.2.2.2
Discharge outlets protecting the fill shall be located under the distribution basin on either the louver or drift eliminator side, discharging horizontally through the joist channels. [214:5.2.4.2.2]

22.21.2.2.3
Towers with an air travel dimension longer than the maximum allowable for the discharge device being used shall have discharge devices placed on both sides of the fill area in each joist channel. [214:5.2.4.2.3.1]

22.21.2.2.4
The pressure at each discharge device shall be adequate to provide protection for half of the length of the fill measured along the air travel. [214:5.2.4.2.3.2]

22.21.2.2.5
Where joist channels are wider than 2 ft (0.6 m), more than one discharge device shall be required per joist channel. [214:5.2.4.2.4.1]

22.21.2.2.6
If the discharge device being used is listed for the width of the joist channel being protected, one discharge device per joist channel shall be permitted to be used. [214:5.2.4.2.4.2]

22.21.2.3* Extended Fan Decks.
On towers having extended fan decks that completely enclose the distribution basin, the discharge outlets protecting the fill area shall be located over the basin, under the extension of the fan deck. [214:5.2.4.3]

22.21.2.4* Water Basin Covers.
On film-filled towers that have solid, hot-water basin covers over the complete basin, the discharge outlets protecting the fill area shall be permitted to be located under the basin covers. [214:5.2.4.5]

22.21.2.5  Valves.
[214:5.2.6]

22.21.2.5.1
Shutoff valves and automatically operated water control valves, if provided, shall be located as follows:

1. Outside the fire-exposed area
2. As close to the cooling tower as possible to minimize the amount of pipe to the discharge device
3. Where they will be accessible during a fire emergency

[214:5.2.6.1.2]
22.21.2.5.2  Manual Release Valve.
[214:5.2.6.2]
22.21.2.5.2.1
Remote manual release valves, where required, shall be conspicuously located and accessible during a fire emergency. [214:5.2.6.2.1]
Where remote manual release valves are not required, an inspector's test valve shall be provided for each pilot-head-operated system. [214:5.2.6.2.2]

22.21.2.6 Strainers.

Strainers shall be required for systems utilizing discharge devices with waterways of less than 3/8 in. (9.5 mm) diameter. [214:5.2.7]

22.21.2.7 Heat Detectors.

Where deluge or preaction systems are used, heat detectors shall be installed and shall be selected from either of the types in 5.2.8.1 or 5.2.8.2 of NFPA 214. [214:5.2.8]

22.21.2.7.1 In mechanical-draft towers, pilot line detectors shall be located under the fan deck at the circumference of the fan opening and under the fan opening where necessary to comply with the spacing requirements in 22.21.2.7.1.1. (For extended fan decks, see 5.2.8.2.3 in NFPA 214.) [214:5.2.8.1.2.1(A)]

22.21.2.7.2 On towers having extended fan decks that completely enclose the distribution basin, electrical heat detectors shall be located under the fan deck extension in accordance with standard, indoor-spacing rules for the type detectors used in accordance with NFPA 72. [214:5.2.8.2.3]

22.21.2.7.2.1 Where the fan deck extension is 16 ft (4.9 m) or less and this dimension is the length of the joist channel, then only one row of detectors centered on and at right angles to the joist channels shall be required. Spacing between detectors shall be in accordance with NFPA 72. [214:5.2.8.2.3.1]

22.21.2.7.2.2 On towers having extended fan decks that do not completely enclose the hot-water basin, electrical heat detectors shall not be required under the fan deck extension. [214:5.2.8.2.3.2]

22.21.2.7.3 Where electrical heat detectors are inaccessible during tower operation, an accessible test detector shall be provided for each detection zone. [214:5.2.8.3]

22.21.2.7.4 Electrical heat detector components exposed to corrosive vapors or liquids shall be protected by materials of construction or by protective coatings applied by the equipment manufacturer. [214:5.2.8.4]

22.21.2.8 Protection for Fan Drive Motor.

[214:5.2.9]

22.21.2.8.1 A sprinkler or spray nozzle shall be provided over each fan drive motor where the motor is located so that it is not within the protected area of the tower. [214:5.2.9.1]

22.21.2.8.2 Where a preaction or deluge system is used, the detection system shall be extended to cover the motor. [214:5.2.9.2]
Provision shall be made to interlock the fan motors with the fire protection system so that the cooling tower fan motors are stopped in the cell(s) for which the system is actuated.

22.21.2.8.4
Where the continued operation of the fans is vital to the process, a manual override switch shall be permitted to be provided to reactivate the fan when it is determined that there is no fire.

22.21.2.9 Corrosion Protection.

22.21.2.9.1
Piping, fittings, hangers, braces, and attachment hardware including fasteners shall be hot-dipped galvanized steel in accordance with ASTM A153A/153M, Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware, or other materials having a superior corrosion resistance.

22.21.2.9.1.1
Exposed pipe threads and bolts on fittings shall be protected against corrosion.

22.21.2.9.1.2
All other components shall be corrosion resistant or protected against corrosion by a coating.

22.21.2.9.2
Wax-type coatings shall not be used on devices without fusible elements.

22.21.2.9.3
Corrosion-resistant coatings shall not be applied to the sprinklers by anyone other than the manufacturer of the sprinklers.


22.22.1 Design Requirements.

22.22.1.1
Unless the requirements of 22.22.1.2 apply, automatic sprinkler systems shall be designed based upon the design criteria for the protection of Group A plastics.

22.22.1.2
With the approval of the authority having jurisdiction, the requirements of 22.22.1.1 shall not apply to buildings used exclusively for the handling or storage of specific cargoes and commodities that are defined as commodity classes less than Group A plastics by this standard.

22.22.1.3
Buildings consistent with 22.22.1.2 shall be protected in accordance with the design criteria for the applicable commodity as required by this standard.
22.22.1.4
Buildings used for the storage of hazardous materials shall be protected in accordance with this standard and the applicable codes and standards for the type of hazardous material being stored. [307:5.4.2.4]

22.22.2 Installation Requirements.

22.22.2.1 Piers and Wharves with Combustible Substructure.

22.22.2.1.1 Where there is danger of damage to sprinkler equipment by floating objects, physical barriers shall be provided to exclude such objects. [307:4.3.3.1.2.2]

22.22.2.1.2 The installation requirements in 22.22.2.1.1, 22.22.2.1.2.1(A), and 22.22.2.1.2.1(B) are also required.

22.22.2.1.2.1* Upward Projecting Sprinklers.
Where narrow horizontal channels or spaces are caused by caps, stringers, ties, and other structural members and where the standard upright sprinkler does not project sufficient water upward to extinguish or control fires on the underside of the pier or wharf deck, a sprinkler that projects water upward to wet the overhead shall be used. [307:4.3.3.1.3.1]

(A) Location, spacing, and deflector position shall be governed by the discharge pattern of the sprinkler and the structure being protected. [307:4.3.3.1.3.1(A)]

(B) The following design and installation guides shall apply where pendent sprinklers in the upright position or old-style sprinklers are to be utilized:

1. The maximum coverage per sprinkler head shall be limited to 80 ft² (7.5 m²).
2. Where spacing or arrangement of stringers constitutes typical open-joist construction directly supporting the deck, sprinkler branch lines shall be installed between the bents at right angles to the stringers and shall meet the following requirements:
   1. Spacing between branch lines shall not exceed 10 ft (3 m).
   2. Sprinklers on branch lines shall be staggered and spaced not to exceed 8 ft (2.5 m) on center.
3. *Where crisscross construction is involved, closer spacing of sprinklers shall be permitted as necessary to provide wetting of the entire structure.
4. The deflectors of sprinklers on lines under stringers shall be located not less than 4 in. (100 mm) nor more than 10 in. (250 mm) below the bottom plane of the stringer, and not more than 18 in. (450 mm) below the underside of the pier or wharf deck.
5. *The sprinkler system shall be hydraulically designed in accordance with the requirements of this standard and shall meet the following requirements:
   1. Sprinkler orifice shall be 1/2 in. (12.7 mm) and shall discharge at a minimum pressure of 12.5 psi (85 kPa).
   2. Design area shall be based upon the largest area between firestops plus an additional area embracing at least two branch lines on opposite sides of the firestop.
   3. Minimum design area shall be not less than 5000 ft² (465 m²).
6. The temperature rating of the sprinkler shall not exceed 165°F (74°C).
7. The maximum area to be protected by any one system shall be limited to 25,000 ft² (2325 m²).

22.23 Semiconductor Fabrication Facilities.
22.23.1 Design Requirements.
22.23.1.1* Automatic sprinklers for cleanrooms or clean zones shall be installed in accordance with this standard and shall be hydraulically designed for a density of 0.20 gpm/ft² (8.15 L/min·m²) over a design area of 3000 ft² (278.8 m²). [318:4.1.2.1]
22.23.1.2 Automatic sprinkler protection shall be designed and installed in the plenum and interstitial space above cleanrooms in accordance with this standard, for a density of 0.20 gpm/ft² (8.15 L/min·m²) over a design area of 3000 ft² (278.8 m²). [318:4.1.2.5]
22.23.1.2.1* Automatic sprinklers shall be permitted to be omitted if the construction and occupancy of these spaces are noncombustible. [318:4.1.2.5.1]
22.23.1.3* Sprinklers installed in duct systems shall be hydraulically designed to provide 0.5 gpm (1.9 L/min) over an area derived by multiplying the distance between the sprinklers in a horizontal duct by the width of the duct. [318:4.1.2.6.2]
22.23.1.3.1* Minimum discharge shall be 20 gpm (76 L/min) per sprinkler from the five hydraulically most remote sprinklers. [318:4.1.2.6.2.1]
22.23.2 Installation Requirements.
22.23.2.1* Wet pipe automatic sprinkler protection shall be provided throughout facilities containing cleanrooms and clean zones. [318:4.1.1]
22.23.2.2* Approved quick-response sprinklers shall be utilized for sprinkler installations within down-flow airstreams in cleanrooms and clean zones. [318:4.1.2.2]
22.23.2.3* Sprinklers shall be spaced a maximum of 20 ft (6.1 m) apart horizontally and 12 ft (3.7 m) apart vertically. [318:4.1.2.6.2.2]
22.23.2.4 A separate indicating control valve shall be provided for sprinklers installed in ductwork. [318:4.1.2.6.3]
22.23.2.5 The sprinklers shall be accessible for periodic inspection and maintenance. [318:4.1.2.6.6]
22.24 Aircraft Hangars.
22.24.1 Design Requirements.
Sprinkler systems installed in aircraft hangars shall comply with NFPA 409.
22.24.2 Installation Requirements.
Sprinkler systems installed in aircraft hangars shall comply with NFPA 409.
22.25 Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways.
22.25.1 Design Requirements.
22.25.1.1
Passenger-handling areas shall be classified as Ordinary Hazard Group 1 Occupancy for the purpose of sprinkler system design. [415:4.5.1.3]

22.25.1.2*
Baggage, package, and mail-handling areas shall be classified as Ordinary Hazard Group 2 Occupancy for the purpose of sprinkler system design. [415:4.5.1.4]

22.25.1.3
Other areas of the airport terminal building shall be classified in accordance with Chapter 5 of this standard. [415:4.5.1.5]

22.25.1.4 Water Supply.
Water supply from public and private sources shall be adequate to supply maximum calculated sprinkler demand plus a minimum of 500 gpm (1893 L/min) for hose streams. The supply shall be available at the rate specified for a period of at least 1 hour. [415:4.5.5]

22.25.1.4.1
Main sizes shall be hydraulically calculated based on the total domestic and fire protection requirements. Mains shall not be less than 8 in. (203 mm) in diameter except that laterals shall be permitted to be 6 in. (152 mm) in diameter if not over 200 ft (61 m) long. [415:4.5.5.1]

22.26 Aircraft Engine Test Facilities.

22.26.1 Design Requirements.

22.26.1.1* In engine test cells, the minimum design discharge density shall be 0.50 gpm/ft² (0.34 L/sec/m²) of protected area. [423:7.6.3]

22.26.1.2
In engine test cells, water supplies shall be capable of meeting the largest demand at the design rate plus hose stream demand for a period of 30 minutes. [423:7.6.4]

22.26.1.2.1
Hose stream demand shall be a minimum of 250 gpm (16 L/sec). [423:7.6.4.1]

22.26.1.2.2
The hydraulic calculation and the water supply shall be based on the assumption that all sprinklers in the test cell are operating simultaneously. [423:7.6.4.2]

22.27 Advanced Light Water Reactor Electric Generating Plants.

22.27.1 Design Requirements.

22.27.1.1* Sprinkler System Water Supply.
The fire water supply shall be calculated on the basis of the largest expected flow rate for a period of 2 hours but shall not be less than 300,000 gal (1,135,500 L), and the following criteria also shall apply:

1. The flow rate shall be based on 500 gpm (1892.5 L/min) for manual hose streams plus the largest design demand of any sprinkler or fixed water spray system as determined in accordance with this standard, with NFPA 15, or with NFPA 804.
2. The fire water supply shall be capable of delivering the design demand specified in 22.27.1.1(1) with the hydraulically least demanding portion of fire main loop out of service.
22.27.1.2 Yard Mains.
The underground yard fire main loop shall be installed to furnish anticipated water requirements, and the following criteria also shall be met:

1. The type of pipe and water treatment shall be design considerations, with tuberculation as one of the parameters.
2. Means for inspecting and flushing the systems shall be provided.

22.27.1.3 Cable Spreading Room.
The cable spreading room shall have an automatic fixed water-based suppression system, and the following criteria also shall be met:

1. The location of sprinklers or spray nozzles shall protect cable tray arrangements to ensure water coverage for areas that could present exposure fire hazards to the cable raceways.
2. Automatic sprinkler systems shall be designed for a density of 0.30 gpm/ft² (12.2 L/min·m²) over the most remote 2500 ft² (232.2 m²).

22.27.1.4 Cable Tunnels.
Automatic sprinkler systems shall be designed for a density of 0.30 gpm/ft² (12.2 L/min·m²) for the most remote 100 linear ft (30.5 m) of cable tunnel up to the most remote 2500 ft² (232.2 m²).

22.27.1.5* Beneath Turbine Generator Operating Floor.
All areas beneath the turbine generator operating floor shall be protected by an automatic sprinkler or foam-water sprinkler system meeting the following criteria:

1. The sprinkler system beneath the turbine generator shall be designed around obstructions from structural members and piping.
2. The sprinkler system shall be designed to a minimum density of 0.30 gpm/ft² (12.2 L/min·m²) over a minimum application of 5000 ft² (464.5 m²).

22.27.1.6* Turbine Generator Bearings.
Lubricating oil lines above the turbine operating floor shall be protected with an automatic sprinkler system to a minimum density of 0.30 gpm/ft² (12.2 L/min·m²) that covers those areas subject to oil accumulation, including the area within the turbine lagging (skirt). Where shaft-driven ventilation systems are used, an automatic preaction sprinkler system providing a density of 0.30 gpm/ft² (12.2 L/min·m²) over the entire area shall be provided.

Standby Emergency Diesel Generators and Combustion Turbines. The sprinkler and water spray protection systems shall be designed for a 0.25 gpm/ft² (10.19 L/min·m²) density over the entire area. If sprinkler and water spray systems are provided for fire pump houses, they shall be designed for a minimum density of 0.25 gpm/ft² (10.19 L/min·m²) over the entire fire area. Sprinkler and water spray systems shall be designed for a minimum density of 0.25 gpm/ft² (10.19 L/min·m²) over the entire area.

Installation Requirements. Yard Mains, Hydrants, and Building Standpipes. Approved visually indicating sectional control valves such as post indicator valves shall be provided to isolate portions of the main for maintenance or repair without simultaneously shutting off the supply to both primary and backup fire suppression systems. For such installations, common water supplies shall also be permitted to be utilized. For multiple-reactor sites with widely separated plants [approaching 1 mi (1.6 km) or more], separate yard fire main loops shall be used.

Sprinkler systems and manual hose station standpipes shall have connections to the plant underground water main so that a single active failure or a crack in a moderate-energy line can be isolated so as not to impair both the primary and the backup fire suppression systems unless otherwise permitted by the following:

1. Alternatively, headers fed from each end shall be permitted inside buildings to supply both sprinkler and standpipe systems, provided steel piping and fittings meeting the requirements of ASME B31.1, Code for Power Piping, are used for the headers (up to and including the first valve) supplying the sprinkler systems where such headers are part of the seismically analyzed hose standpipe system.
2. Where provided, such headers shall be considered an extension of the yard main system.
3. Each sprinkler and standpipe system shall be equipped with an outside screw and yoke (OS&Y) gate valve or other approved shutoff valve.

[804:9.4.7]
22.27.2.2 Cable Tunnels.
The location of sprinklers or spray nozzles shall protect cable tray arrangements and possible transient combustibles to ensure water coverage for areas that could present exposure fire hazards to the cable raceways. [804:10.4.2.2.3]

22.27.2.3 Deluge.
Deluge sprinkler systems or deluge spray systems shall meet the following criteria:

1. They shall be zoned to limit the area of protection to that which the drainage system can handle with any two adjacent systems actuated.
2. They shall be hydraulically designed with each zone calculated with the largest adjacent zone flowing.

[804:10.4.2.2.4]
22.27.2.4 Cable tunnels over 50 ft (15.2 m) long shall be provided with hose stations and portable fire extinguishers installed outside the tunnel. [804:10.4.2.4(3)]

22.28 Light Water Nuclear Power Plants.
22.28.1 Design Requirements.
A fire protection water supply of reliability, quantity, and duration shall be provided by one of the two following methods:

1. A fire protection water supply of not less than two separate 300,000 gal (1,135,500 L) supplies shall be provided.
2. The 2-hour fire flow rate for 2 hours shall be calculated, and the following criteria shall be met:
   1. The flow rate shall be based on 500 gpm (1892.5 L/min) for manual hose streams plus the largest design demand of any sprinkler or fixed water spray system(s) in the power block as determined in accordance with NFPA 13 or NFPA 15.
   2. The fire water supply shall be capable of delivering this design demand with the hydraulically least demanding portion of fire main loop out of service.

[805:5.5.1]
22.28.2 Installation Requirements.
22.28.2.1 Sprinkler systems and manual hose station standpipes shall be connected to the plant fire protection water main so that a single active failure or a crack to the water supply piping to these systems can be isolated so as not to impair both the primary and backup fire suppression systems. [805:5.5.12]

22.28.2.2 Each sprinkler and standpipe system shall be equipped with an outside screw and yoke (OS&Y) gate valve or other approved shutoff valve. [805:5.5.17]

22.29 Hydroelectric Generating Plants. [NFPA 851850]
22.29.1* Design Requirements.
22.29.1.1 Hydraulic Control Systems.
Fixed fire protection for this equipment, where provided, should be as follows:

1. Automatic wet pipe sprinkler systems utilizing a design density of 0.25 gpm/ft² (10.2 mm/min) for the entire hazard area.
2. Automatic foam-water sprinkler systems providing a density of 0.16 gpm/ft² (6.5 mm/min).

22.29.1.2 Cable Concentrations.
Sprinkler or water spray systems should be designed for a density of 0.30 gpm/ft² (12.2 mm/min) over 2500 ft² (232 m²). This coverage is for area protection. Individual cable tray tier coverage could be required based on the fire risk evaluation.

22.29.1.3 Cable Tunnels.
Where protection is required by the fire risk evaluation, cable tunnels should be protected by automatic water spray, automatic wet pipe sprinkler, or foam water spray systems. Automatic sprinkler systems should be designed for a density of 0.30 gpm/ft² (12.2 mm/min) over 2500 ft² (232 m²), or the most remote 100 linear ft (30.5 m) of cable tunnel up to 2500 ft² (232 m²).

22.29.1.4 Emergency Generators.
Emergency generators located within main plant structures should be protected by automatic sprinkler, water spray, foam water sprinkler, compressed air foam, or gaseous type extinguishing systems. Sprinkler and water spray protection systems should be designed for a 0.25 gpm/ft² (10.2 mm/min) density over the fire area.

22.29.1.5 Air Compressors.
Automatic sprinkler protection designed for a density of 0.25 gpm/ft² (10.2 mm/min) over the postulated oil spill or compressed air foam should be considered for air compressors containing a large quantity of oil.

22.29.1.6 Hydraulic Systems for Gate and Valve Operators.
Hydraulic control systems should use a listed fire-resistant fluid. Automatic sprinkler protection designed for a density of 0.25 gpm/ft² (10.2 mm/min) over the fire area or compressed air foam systems should be considered for hydraulic systems not using a listed fire resistant fluid.

22.29.1.7 Fire Pumps.
Rooms housing diesel driven fire pumps should be protected by automatic sprinkler, water spray, foam water sprinkler, or compressed air foam systems. If sprinkler and water spray protection systems are provided they should be designed for a density of 0.25 gpm/ft² (10.2 mm/min) over the fire area. For automatic foam water sprinkler systems, a density of 0.16 gpm/ft² (6.5 mm/min) should be provided.

22.29.2* Installation Requirements.
22.29.2.1 Hydraulic Control Systems.
Fire extinguishing systems, where installed for lube oil systems employing combustible type oil, should include protection for the reservoirs, pumps, and all oil lines, especially where unions exist on piping and beneath any shielded area where flowing oil can collect. Facilities not
provided with curbs or drains should extend coverage for a distance of 20 ft (6 m) from the oil lines, when measured from the outermost oil line. [851:7.2.7]


22.30.1 Design Requirements.


22.30.1.2* Preaction and dry pipe systems shall be designed to minimize the risk of corrosion in accordance with the requirements of 22.30.2.1 through 22.30.2.5. [909:9.12.13.5]

22.30.1.3 System Design for Museums, Libraries, and Their Collections in Compact Storage.

22.30.1.3.1* The design shall recognize the nature of the potential threat of a fire that originates in a compact mobile storage unit, where fuel loads are invariably large and fire growth is significantly different from that in other kinds of storage. [909:9.12.23.4.1.3]

22.30.1.3.2* The automatic fire suppression system, the compact storage system, and the storage compartmentalization features shall be designed to limit fire damage in accordance with the facility’s fire safety objectives. [909:9.12.23.4.1.4(A)]

22.30.1.3.3 Design calculations shall include the number and size of the storage modules, the separation provided between the modules end-to-end and back-to-back, and the type of material being stored. [909:9.12.23.4.1.4(B)]

22.30.1.3.4 Where the automatic fire suppression is provided by automatic fire sprinkler systems, the systems shall be wet pipe, single interlock pre-action, or single non-interlock pre-action systems. [909:9.12.23.4.1.4(C)]

22.30.1.3.5 Dry pipe or double-interlock pre-action systems shall not be installed in compact storage areas. [909:9.12.23.4.1.4(D)]

22.30.1.3.6 Where compact storage is installed in an existing storage area, the existing automatic fire detection and fire suppression systems shall be modified as required to accommodate the increased fire loading. [909:9.12.23.4.1.4(E)]

22.30.2 Installation Requirements.

22.30.2.1* Branch lines shall be pitched at least 1/2 in. per 10 ft (4 mm/m), and mains shall be pitched at least 1/4 in. per 10 ft (2 mm/m). [909:9.12.13.3.1]

22.30.2.2* Auxiliary drains shall be provided at all low points in accordance with NFPA 13 requirements for dry pipe systems and preaction systems subject to freezing. [909:9.12.13.3.2.1]

22.30.2.3* Where steel pipe is used in dry pipe and preaction systems, the provisions of this standard shall be applied assuming water supplies and environmental conditions that contribute to unusual corrosive properties, and a plan shall be developed to address piping corrosion. [909:9.12.13.3.3]

22.31 National Electrical Code.
22.31.1 Design Requirements. (Reserved)
22.31.2 Installation Requirements.
22.31.2.1 Dedicated Electrical Space.
   The space equal to the width and depth of the equipment and extending from the floor to a height
   of 1.8 m (6 ft) above the equipment or to the structural ceiling, whichever is lower, shall be
dedicated to the electrical installation. No piping, ducts, leak protection apparatus, or other
equipment foreign to the electrical installation shall be located in this zone.
Exception: Suspended ceilings with removable panels shall be permitted within the 1.8-m (6-ft)
zone.

22.31.2.2 Foreign Systems.
The area above the dedicated space required by 22.31.2.1 shall be permitted to contain foreign
systems, provided protection is installed to avoid damage to the electrical equipment from
condensation, leaks, or breaks in such foreign systems.

22.31.2.3* Sprinkler Protection.
Sprinkler protection shall be permitted for the dedicated space where the piping complies with
this section.

22.32 Fire Protection of Telecommunication Facilities.
22.32.1 Design Requirements. (Reserved)
22.32.2 Installation Requirements.
22.32.2.1 All piping for dry pipe and pre-action sprinkler systems shall be installed with a pitch in
accordance with NFPA 13 whether or not the piping is subjected to freezing conditions.

22.33 Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible
Particulate Solids.
22.33.1 Design Requirements.
22.33.1.1 Any portion of an exhaust system utilizing combustible components or having the potential for
combustible residue buildup on the inside, where the duct cross-sectional area is greater than or
equal to 75 in.² (480 cm²), shall be provided with an automatic extinguishing system within the
duct and at the duct intake, hood, enclosure, or canopy, or shall be constructed of material listed
for use without sprinkler protection.

22.33.1.2 When a sprinkler system is installed, means shall be provided to prevent water accumulation in
the duct or flow of water back to a process subject that could be damaged by water.

22.34 Hypobaric Facilities.
22.34.1 Design Requirements.
22.34.1.1 A fire suppression system consisting of independently supplied and operating handline and fixed
deluge-type water spray systems shall be installed.
Design of the fire suppression system shall be such that failure of components in either the handline or deluge system will not render the other system inoperative. [99B:4.5.1.6]

System design shall be such that activation of either the handline or the deluge system shall automatically cause the following:

1. Visual and audio alarm indicators shall be activated at the chamber operator's console.
2. All ungrounded electrical leads for power and lighting circuits contained inside the chamber shall be disconnected.
3. Emergency lighting and communication, where used, shall be activated.

Intrinsically safe circuits, including sound-powered communications, shall be permitted to remain connected when either the handline or deluge system is activated. [99B:4.5.1.8]

Control circuitry and other electrical equipment involved in the fire detection and suppression system shall be powered from the critical branch of the emergency electrical system and connected to the uninterruptible power supply (UPS). [99B:4.5.1.11]

In chambers that consist of more than one compartment, the deluge system shall operate independently or simultaneously even if the compartments are at different pressures (altitudes). [99B:4.5.2.2]

Fixed deluge systems shall not be required in chamber compartments that are used strictly as personnel transfer compartments and for no other purpose. [99B:4.5.2.3]

Manual activation and deactivation deluge controls shall be located at the operator's console and in each chamber compartment containing a deluge system. [99B:4.5.2.4]

Controls shall be designed to prevent unintended activation. [99B:4.5.2.4.1]

Water shall be delivered from the fixed discharge nozzles of the deluge system within 3 seconds of activation of any affiliated deluge control. [99B:4.5.2.5]

Total water demand shall be determined by multiplying the total chamber floor area by 7.5 gpm/ft² (305.6 L/min/m²). [99B:4.5.2.5.1]

The minimum operating pressure at the nozzle shall be 30 psi (206 kPa). [99B:4.5.2.5.2]

The water supply shall be constantly and fully charged. [99B:4.5.2.6]

The water supply pressure shall be constantly monitored and an interlock shall prevent chamber operation if water supply pressure has fallen 10 percent below normal operating charge pressure. [99B:4.5.2.7]
There shall be water in the deluge system to maintain the flow specified in 22.34.1.11 simultaneously in each chamber containing the deluge system for 1 minute. [99B:4.5.2.8] 22.34.1.16

The limit on maximum extinguishment duration shall be governed by the chamber capacity (bilge capacity also, if so equipped) and/or its drainage system. [99B:4.5.2.9] 22.34.1.17

The deluge system shall have stored pressure to operate for at least 15 seconds without electrical branch power. [99B:4.5.2.10]

22.34.2 Installation Requirements. (Reserved)
22.35 Coal Mines.
22.35.1 Design Requirements.
22.35.1.1 Underground Mining Operations.

Fire sprinkler systems for underground mining operations shall be designed and installed in accordance with NFPA 120.

22.35.1.2 Coal Preparation Plants and Crusher Buildings.
22.35.1.2.1 When automatic sprinkler systems are to be supplied through the standpipe system, hydraulic calculations shall be used to ensure that the piping and the water supply meet the hose and automatic sprinkler demands simultaneously. [120:6.3.2.3.2]

22.35.1.3 Underground Conveyors.
22.35.1.3.1 The application rate shall not be less than 10.2 L/min/m² (0.25 gpm/ft²) of the top surface of the top belt. [120:9.4.6.4]
22.35.1.3.2 The water supply shall be free of excessive sediment and corrosives and provide the required flow for not less than 10 minutes. A strainer with a flush-out connection and manual shutoff valve shall be provided. [120:9.4.6.6]
22.35.1.3.3 The system shall be interlocked to shut down the conveyor and provide an audible and a visual alarm. [120:9.4.6.8]
22.35.1.3.4 Fire suppression systems shall also comply with 22.35.1.1.1. [120:9.4.6.10]
22.35.1.3.5 Sprinkler systems shall meet the following requirements:

1. The sprinklers shall be installed in accordance with NFPA 13 as far as practical, and shall have components that have been listed.
2. The water supply shall be capable of supplying a constant flow of water with all heads functioning for a period of 10 minutes.
3. The sprinkler head activation temperature shall not be less than 65.6°C (150°F) or greater than 148.9°C (300°F).

[120:9.4.6.13]
22.35.2 Installation Requirements.
22.35.2.1 Underground Conveyors.
Deluge water spray systems, foam systems, closed-head sprinkler systems, or dry-chemical systems automatically actuated by rise in temperature shall be installed at main and secondary belt conveyor drives. [120:9.4.6.1]

Fire suppression systems shall extend to the drive areas of belt conveyors, including drive motor(s), reducer, head pulley, and belt storage unit (takeup), including any hydraulic power unit; its electrical controls; and the top and bottom of the first 15.2 m (50 ft) of belt from the drive on the downwind side. [120:9.4.6.2]

Piping for the deluge, foam, or closed-head sprinkler system shall be metal and listed for sprinkler applications. [120:9.4.6.3]

The discharge shall be directed at both the upper and the bottom surface of the top belt and the upper surface of the bottom belt. [120:9.4.6.5]

Maximum distance between nozzles on a branch line shall not exceed 2.4 m (8 ft). [120:9.4.6.7]

The components of the system shall be located so as to minimize the possibility of damage by roof fall or by the moving belt and its load. [120:9.4.6.9]

Deluge water spray systems shall meet the requirements of 22.35.2.1.7.1 through 22.35.2.1.7.5. [120:9.4.6.11]  
The system shall be activated by heat detectors. [120:9.4.6.11.1]

Heat detectors shall be located at the belt drive, hydraulic takeup unit (unless fire-resistive fluid is used), discharge roller, and the roof above the conveyor. [120:9.4.6.11.1.1]

Heat detectors at the roof line should be spaced 2.4 m to 3.0 m (8 ft to 10 ft) apart along the entire length of the protected area of the belt. [120:9.4.6.11.1.2]

The nozzles shall be full cone, corrosion resistant, and provided with blow-off dust covers. [120:9.4.6.11.2]

A closed sprinkler head shall be used over the electrical controls. [120:9.4.6.11.3]

Mine Surface Buildings.

If sprinklers are installed, waterflow, valve tamper, and low building temperature alarms shall be provided. [120:8.6.1.2]
When automatic sprinkler systems are supplied through the hand hose line standpipe system, hydraulic calculations shall be used to ensure that the piping and water supply will supply the hose and automatic sprinkler demands simultaneously. [122:6.2.3]

22.36.1.2

Where a fire water supply [for a surface mineral processing plant] is required by the risk assessment, capacity and availability shall provide the water demand for fire-fighting purposes, including hose and sprinkler systems, for a minimum duration of 2 hours. [122:13.7.2]

22.36.1.2*

Where provided, automatic sprinkler systems installed for the protection of flammable liquid or diesel fuel storage areas shall be of the foam-water type. [122:11.3.1]

22.36.1.3  New Solvent Extraction (SX) Facilities.

22.36.1.3.1  New Solvent Extraction (SX) Facilities.

22.36.1.3.1

Fixed fire suppression shall be provided for the following SX facility areas and equipment:

1. Buildings housing SX processes
2. Interior of all mixer-settler vessels/cells
3. Crud tanks that include treatment filters and centrifuges
4. Coalescers
5. Along launders and weirs outside of mixer-settler vessels
6. Inside pipe trenches carrying solvents
7. Inside organic solvent and diluent tanks
8. Inside dikes enclosing organic solvent storage tanks
9. Over organic solvent pumps
10. Over elevated pipe racks carrying organic solvents in plastic pipes
11. Other areas handling, processing, or exposed to flammable or combustible liquids

[122:13.19.1]

22.36.1.3.2*

Fire suppression for applications in 22.36.1.3.1 shall be water, foam, dry chemical, or water mist. [122:13.19.1.1]

22.36.1.3.2*

Design of fire suppression systems in 22.36.1.3.1 shall be based on criteria set forth in NFPA 11, NFPA 15, NFPA 16, and NFPA 17. [122:13.19.1.2]

22.36.1.3.4*

Actuation of fire suppression systems in 22.36.1.3.1 shall be automatic. [122:13.19.1.3]

22.36.1.3.5

As exposure protection, automatic water-only deluge (open-head) sprinkler systems shall be provided between mixer-settler trains if spaced closer than 15.24 m (50 ft) from each other. [122:13.19.2]

22.36.1.3.6

As exposure protection, automatic water-only deluge sprinkler systems shall be provided around the exterior perimeter of organic solvent tanks if spaced closer than 15.24 m (50 ft) from each other. [122:13.19.3]
As exposure protection, automatic fire suppression shall be provided over other critical equipment (i.e., transformers) or outside along important building walls [i.e., motor control center (MCC) rooms] that are within 15.24 m (50 ft) of a solvent fire area. [122:13.19.4]

22.36.1.3.8

Hydraulic design of automatic fire suppression systems in 22.36.1.3.1 shall include the simultaneous operation of all fire protection systems associated with a single (multi-cell) train. [122:13.19.5]

22.36.1.3.9

The total flow rate of foam application and water associated with the discharge of automatic fire extinguishing systems, fixed monitors, and hydrants shall determine the total volume of fire water required. [122:13.19.6]


22.37.1  Design Requirements.

Sprinkler system discharge criteria for the protection of hazardous materials shall comply with NFPA 400.

22.37.1.1 Requirements for Occupancies Storing Quantities of Hazardous Materials Exceeding the Maximum Allowable Quantities per Control Area for High Hazard Contents.

The design of the sprinkler system shall be not less than ordinary hazard Group 2 in accordance with NFPA 13, except as follows:

1. Where different requirements are specified in Chapters 11 through 21 of NFPA 400
2. Where the materials or storage arrangement requires a higher level of sprinkler system protection in accordance with nationally recognized standards
3. Where approved alternative automatic fire extinguishing systems are permitted [400:6.2.1.1.1]

22.37.1.2 General Requirements for Storage of Ammonium Nitrate Solids and Liquids.

Sprinkler systems shall be of the approved type and designed and installed in accordance with NFPA 13, and the following:

1. Ammonium nitrate in noncombustible or combustible containers (paper bags or noncombustible containers with removable combustible liners) shall be designated as a Class I commodity.
2. Where contained in plastic containers, ammonium nitrate shall be designated as a Class II commodity.
3. Where contained in fiber packs or noncombustible containers in combustible packaging, ammonium nitrate shall be designated as a Class III commodity. [400:11.2.6.1.3]

22.37.1.3 General Requirements for Storage of Organic Peroxide Formulations.

Where required by other provisions of this code, automatic sprinklers and water spray systems shall be designed and installed according to the requirements of NFPA 13 and NFPA 15 and shall provide the following discharge densities:
1. Class I — 0.50 gpm/ft² (20.4 L/min/m²)
2. Class II — 0.40 gpm/ft² (16.3 L/min/m²)
3. Class III — 0.30 gpm/ft² (12.2 L/min/m²)
4. Class IV — 0.25 gpm/ft² (10.2 L/min/m²)

[400:14.2.6.1]
22.37.1.3.2
The system shall be designed as follows:

1. It shall provide the required density over a 3000 ft² (280 m²) area for areas protected by a wet pipe sprinkler system or 3900 ft² (360 m²) for areas protected by a dry pipe sprinkler system.
2. The entire area of any building of less than 3000 ft² (280 m²) shall be used as the area of application.

[400:14.2.6.2]
22.37.1.3.3
Where required for detached storage buildings containing Class I organic peroxide formulations in quantities exceeding 2000 lb (907 kg), automatic sprinkler protection shall be open-head deluge-type, designed and installed in accordance with NFPA 13. [400:14.2.6.3]
22.37.1.4.1
Sprinkler protection for Class 2 oxidizers shall be designed in accordance with Table 22.37.1.4.1. [400:15.3.2.3.4.1]
Table 22.37.1.4.1 Ceiling Sprinkler Protection for Class 2 Oxidizers in Palletized or Bulk and Rack Storage Areas

<table>
<thead>
<tr>
<th>Type of Storage</th>
<th>Ceiling Sprinklers</th>
<th>Area of Application</th>
<th>In-Rack Sprinklers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Storage Height</td>
<td>Density</td>
<td></td>
</tr>
<tr>
<td>Palletized or</td>
<td>ft</td>
<td>m</td>
<td>gpm/ft² L/min/m²</td>
</tr>
<tr>
<td>bulk</td>
<td>8</td>
<td>2.4</td>
<td>0.20</td>
</tr>
<tr>
<td>Palletized or</td>
<td>12</td>
<td>3.7</td>
<td>0.35</td>
</tr>
<tr>
<td>bulk</td>
<td></td>
<td></td>
<td>0.20</td>
</tr>
<tr>
<td>Rack</td>
<td>12</td>
<td>3.7</td>
<td>0.35</td>
</tr>
<tr>
<td>Rack</td>
<td>16</td>
<td>4.9</td>
<td>0.30</td>
</tr>
</tbody>
</table>

[400: Table 15.3.2.3.2.10(B)]
22.37.1.4.2
Ceiling sprinklers shall be high-temperature sprinklers. [400:15.3.2.3.4.2]
22.37.1.4.3  Storage Protection for Class 2 Oxidizers with In-Rack Sprinklers.
(A)
In-rack sprinklers shall be quick-response sprinklers with an ordinary-temperature rating and have a K-factor of not less than K = 8.0. [400:15.3.2.3.4.3(A)]
In-rack sprinklers shall be designed to provide 25 psi (172 kPa) for the six most hydraulically remote sprinklers on each level. [400:15.3.2.3.4.3(B)]

The in-rack sprinklers shall be 8 ft to 10 ft (2.4 m to 3.0 m) spacings in the longitudinal flue space at the intersection of the transverse flue spaces. [400:15.3.2.3.4.3(C)]

22.37.1.4.4 Sprinkler Criteria for Class 3 Oxidizers.

22.37.1.4.4.1 Class 3 Oxidizers Less than 2300 lb (1043 kg).

(A) Sprinkler design criteria for buildings that require sprinkler protection and contain total quantities of Class 3 oxidizers less than 2300 lb (1043 kg) shall be in accordance with the requirements of 22.37.1.4.4.1(B). [400:15.3.2.4.13.1(A)]

(B) Facilities that require sprinkler protection and contain total quantities of Class 3 oxidizers greater than 200 lb (91 kg), but less than 2300 lb (1043 kg), shall follow the sprinkler design criteria in Table 22.37.1.4.4.1. [400:15.3.2.4.13.1(B)]

Table 22.37.1.4.4.1(B) Sprinkler Protection of Class 3 Oxidizers Stored in Total Quantities Greater than 200 lb (91 kg) but Less than 2300 lb (1043 kg)

<table>
<thead>
<tr>
<th>Storage Parameters</th>
<th>Shelf</th>
<th>Bulk or Pile</th>
<th>Bulk or Pile</th>
<th>Rack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum storage height</td>
<td>6 ft (1.8 m)</td>
<td>5 ft (1.5 m)</td>
<td>10 ft (3 m)</td>
<td>10 ft (3 m)</td>
</tr>
<tr>
<td>Maximum ceiling height</td>
<td>25 ft (7.6 m)</td>
<td>25 ft (7.6 m)</td>
<td>25 ft (7.6 m)</td>
<td>NA</td>
</tr>
<tr>
<td>Aisles — pile separation</td>
<td>4 ft (1.2 m) min. clear aisles</td>
<td>4 ft (1.2 m) min. clear aisles</td>
<td>8 ft (2.4 m) min. clear aisles</td>
<td>8 ft (2.4 m) min. clear aisles</td>
</tr>
<tr>
<td>Ceiling design criteria</td>
<td>0.45 gpm/ft²/2000 ft²</td>
<td>0.35 gpm/ft²/or 5000 ft²</td>
<td>0.65 gpm/ft²/5000 ft²</td>
<td>0.6 gpm/ft²/2000 ft²</td>
</tr>
<tr>
<td>In-rack sprinklers</td>
<td>NP</td>
<td>NP</td>
<td>NA</td>
<td>See 15.3.2.4.12.2.</td>
</tr>
<tr>
<td>Hose stream demand</td>
<td>500 gpm</td>
<td>500 gpm</td>
<td>500 gpm</td>
<td>500 gpm</td>
</tr>
<tr>
<td>Duration</td>
<td>120 minutes</td>
<td>120 minutes</td>
<td>120 minutes</td>
<td>120 minutes</td>
</tr>
</tbody>
</table>

For SI units, 1 gal = 3.79 L. NA: Not applicable. NP: Not permitted. [400: Table 15.3.2.4.12.1(B)]

22.37.1.4.4.2 Storage Protection for Class 3 Oxidizers In-Rack Sprinkler Criteria.

(A) Where required by Table 22.37.1.4.4.1(B), in-rack sprinkler protection shall be as follows:

1. In-rack sprinklers shall be installed above every level of oxidizer storage.
2. In-rack sprinklers shall be spaced at maximum 4 ft (1.2 m) intervals to provide one sprinkler in each flue space.

3. In-rack sprinklers shall be quick-response sprinklers with an ordinary-temperature rating and have a K-factor of not less than K = 8.0.

4. In-rack sprinklers shall be designed to provide 25 psi (172 kPa) for the six most hydraulically remote sprinklers on each level.

500:15.3.2.4.13.3(A)]

22.37.1.4.4.3 Class 3 Oxidizers Greater than or Equal to 2300 lb (1043 kg).

The sprinkler protection shall be in accordance with Table 22.37.1.4.4.3. [400:15.3.2.4.13.4(B)]

Table 22.37.1.4.4.3 Sprinkler Protection of Class 3 Oxidizers Stored in Total Quantities of Greater than or Equal to 2300 lb (1043 kg)

<table>
<thead>
<tr>
<th>Storage Parameters</th>
<th>Bulk or Pile</th>
<th>Rack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum storage height</td>
<td>5 ft (1.5 m)</td>
<td>10 ft (3 m)</td>
</tr>
<tr>
<td>Maximum ceiling height</td>
<td>25 ft (7.6 m)</td>
<td>NP</td>
</tr>
<tr>
<td>Aisles — pile separation</td>
<td>8 ft (2.4 m) min. clear aisles</td>
<td>8 ft (2.4 m) min. clear aisles</td>
</tr>
<tr>
<td>Ceiling design criteria</td>
<td>0.35 gpm/ft²/5000 ft² (1.32 L/min/m²/464.5 m²)</td>
<td>Predominant for other commodities but not less than ordinary hazard Group II</td>
</tr>
<tr>
<td>In-rack sprinklers</td>
<td>NP</td>
<td>See 15.3.2.4.12.4</td>
</tr>
<tr>
<td>Hose stream demand</td>
<td>500 gpm (1893 L/min)</td>
<td>500 gpm (1893 L/min)</td>
</tr>
<tr>
<td>Duration</td>
<td>120 minutes</td>
<td>120 minutes</td>
</tr>
</tbody>
</table>

NP: Not permitted.

[400: Table 15.3.2.4.12.3(B)]

22.37.1.4.4 Special In-Rack Sprinkler Protection for Class 3 Oxidizers.
(A) Where required by Table 22.37.1.4.4.3, special in-rack sprinkler protection shall be as shown in Figure 22.37.1.4.4.4(A). [400:15.3.2.4.13.5(A)]

Figure 22.37.1.4.4.4(A) Arrangement of Barriers and In-Rack Sprinklers for Special Fire Protection Provisions. [400: Figure 15.3.2.4.13.5(A)]
In-rack automatic sprinklers shall be provided under each horizontal barrier and arranged in accordance with 22.37.1.4.4(C) through 22.37.1.4.4(I). [400:15.3.2.4.13.5(K)]
For double-row racks, two lines of in-rack sprinklers shall be provided between the face of the rack and the longitudinal vertical barrier located in the center of the rack. [400:15.3.2.4.13.5(L)] (D)

For single-row racks, two lines of in-rack sprinklers shall be provided between each rack face. [400:15.3.2.4.13.5(M)] (E)

Three in-rack sprinklers shall be provided on each in-rack sprinkler line as follows:

1. Two sprinklers on each line shall be spaced approximately 1 1/2 in. (38.1 mm) from each transverse vertical barrier.
2. One in-rack sprinkler on each in-rack sprinkler line shall be located approximately equidistant between the transverse vertical barriers.

[400:15.3.2.4.13.5(N)]

(F)

In-rack sprinklers shall be of the upright or pendent type, with the fusible element located no more than 6 in. (152.4 mm) from the horizontal barrier. [400:15.3.2.4.13.5(O)]

(G)

In-rack sprinklers shall be K = 8.0, quick-response, ordinary-temperature-rated sprinklers. [400:15.3.2.4.13.5(Q)]

(H)

The in-rack sprinkler system shall be designed to supply 6 sprinklers on each line, with a total of 12 sprinklers operating at gauge pressure of 25 psi (172 kPa). [400:15.3.2.4.13.5(R)]

(I)

The design of the in-rack sprinkler system shall be independent of, and shall not be required to be balanced with, ceiling sprinkler systems. [400:15.3.2.4.13.5(S)]

22.37.1.4.4.5 Sprinkler Criteria for Class 4 Oxidizers.

(A)

Sprinkler protection for Class 4 oxidizers shall be installed on a deluge sprinkler system to provide water density of 0.35 gpm/ft² (14.4 L/min/m²) over the entire storage area. [400:15.3.2.5.4.6(A)]

(B)

Sprinkler protection shall be installed in accordance with NFPA 13. [400:15.3.2.5.4.6(B)]

(Reserved)
See attached word doc for new language in New Chapter 20.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Fri Sep 09 13:44:52 EDT 2016

Committee Statement

Committee Statement: Due to reformat.
New annex material submitted to identify an example of a commodity that display an unstable pile behavior during a full-scale fire test. The annex supports a new paragraph provided as part of the document reorganization.

Response Message:
Public Input No. 388-NFPA 13-2016 [New Section after A.20.3]
Public Input No. 389-NFPA 13-2016 [New Section after A.20.3]
Public Input No. 228-NFPA 13-2016 [Section No. 5.6]
Public Input No. 317-NFPA 13-2016 [New Section after A.20.5.6.3.5]
Chapter 20 – General Requirements for the Protection of Storage

Table 20.6.4.2 – Maximum Clearance from top of storage to ceiling for CMDA protection criteria

20.1 This chapter shall provide the necessary steps for identifying commodity, storage arrangements, storage heights and clearances as well as general protection criteria for storage conditions relative to Chapters 21 to 24.

20.1.1 Miscellaneous and Low Piled storage, meeting the criteria of Chapter 4 shall be protected in accordance with the relative occupancy hazard criteria reference in that section.

20.2 Protection of storage shall follow the following criteria:

1. Identify the storage commodity class in accordance with 20.3 and 20.4.
2. Identify the method of storage in accordance with 20.5.
3. Establish storage height, building height and associated clearances in accordance with 20.6.
4. Define the general protection criteria that are common to all storage protection options in accordance with 20.7 through 20.15.
5. Select the appropriate system/sprinkler technology for protection criteria (chapters 21 to 24).
6. System design and installation in accordance with the remainder of this document.

20.3.1 5.6.1.1 – Commodity classification and the corresponding protection requirements shall be determined based on the makeup of individual storage units, (i.e., unit load, pallet load), pallet load or module held together in some manner and normally transported by material-handling equipment.

20.3.2.2 Plastic Pallet. A pallet having any portion of its construction consisting of a plastic material that has not been Listed as equivalent to wood shall increase the class of commodity determined for a storage load in accordance with Sections 20.3.2.2.1 or 20.3.2.2.2.

20.3.2.2.1* 5.6.2.2* Unreinforced Plastic Pallets. Plastic pallets that have no secondary reinforcing shall be treated as unreinforced plastic pallets.

20.3.2.2.2 Reinforced Plastic Pallet. A plastic pallet incorporating a secondary reinforcing material (such as steel or fiberglass) within the pallet shall be considered as a reinforced plastic pallet.

20.3.2.5 Slave Pallet - Where solid, flat-bottom, combustible pallets are used in combination with CMDA sprinklers, Section 20.xxxx shall apply A special pallet captive to a material-handling system, (See Figure A.3.9.1.10.)

20.3.3* Open-Top Container -- A container of any shape that is entirely or partially open on the top and arranged so as to allow for the collection of discharging sprinkler water cascading through the storage array shall be considered outside the protection criteria of rack storage protection outlined in Chapter 21 through 24.

20.3.4 Solid Unit Load of Unexpanded Plastic (Either Cartoned or Exposed). A load that does not have voids (air) within the load and that burns only on the exterior of the load; and water from sprinklers might will reach most surfaces available to burn, shall allow a reduction in design density of CMDA sprinklers. See Table 15.2.2.5(a)(2).
20.3.5* Encapsulation.

20.4.9 Rubber Tires. Pneumatic tires for passenger automobiles, aircraft, light and heavy trucks, trailers, farm equipment, construction equipment (off-the-road), and buses shall be protected as rubber tire storage in accordance with Chapters 20 through 24.

20.4.10 Classification of Rolled Paper Storage. For the purposes of this standard, the classifications of paper described in 20.4.10.1 through 20.4.10.4 shall apply and shall be used to determine the sprinkler system design criteria in accordance with Chapters 20 through 24.

20.4.11 Plastic Motor Vehicle Components. Group A plastic automotive components and associated packaging material consisting of exposed, expanded Group A plastic dunnage, instrument panels, and plastic bumper facia shall be permitted to be protected as defined in Chapter 23.

20.4.12 Retail Display/Storage of up to Cartoned Group A plastics Group A plastics combined with Class I to IV in a retail/storage environment (Big Box Retail) combine customer picking areas with storage above within the retail area shall be permitted to be protected in accordance with Retail Display/Storage of up to Cartoned Group A plastics in Chapters 20 to 23.

20.4.12 Baled Cotton — A natural seed fiber wrapped and secured in industry-accepted materials, usually consisting of burlap, woven polypropylene, or sheet polyethylene, and secured with steel, synthetic or wire bands, or wire; also includes linters (lint removed from the cottonseed) and motes (residual materials from the ginning process) shall be protected as baled cotton in accordance with Chapter 21 (See Table A.3.9.6.1.)

20.4.13 Carton Records Storage. A Class III commodity consisting predominantly of paper records in cardboard cartons shall be permitted to be protected as Cartoned Record storage in accordance with Chapters 21 or 23.

20.5 Storage Arrangement

20.5.1 General Storage arrangements defined in this section shall be used to select the appropriate protection criteria in Chapters 21 through 24.

20.5.1.1 Other storage arrangements not covered by this section shall be considered outside the scope of this standard. Storage arrangements and related protection requirements shall be categorized by the following methods of Storage:

- General Storage

20.5.2 Palletized Storage — On floor storage of commodities on pallets or other storage aids that form horizontal spaces between tiers of storage shall be considered as palletized storage.

20.5.2.1 Closed Array — When the vertical flues between pallet loads are 6 in (152mm) or less, the arrangement shall be considered closed array. A storage arrangement where air movement through the pile is restricted because of 6 in. (152 mm) or less vertical flues.

20.5.2.2* Open Array — When the vertical flues between pallet loads are greater than 6 in (152mm), the arrangement shall be considered open array. A storage arrangement where air movement through the pile is enhanced because of vertical flues larger than 6 in. (152 mm).
20.5.2.3*  Pile Stability, Stable Piles -- Those arrays where collapse, spillage of content, or leaning of stacks across flue spaces is not likely to occur soon after initial fire development shall be considered as stable piles.

20.5.2.4*  Pile Stability, Unstable Piles -- Those arrays where collapse, spillage of contents, or leaning of stacks across flue spaces occurs soon after initial fire development shall be considered as unstable piles.

20.5.3  Solid-Piled Storage -- Storage of commodities stacked on each other shall be considered as solid piled storage. 3.9.2.1.1 Closed Array -- When solid piled storage has vertical flues between the piles of 6 in (152mm) or less, the storage arrangement shall be considered as closed array. A storage arrangement where air movement through the pile is restricted because of 6 in. (152 mm) or less vertical flues.

20.5.3.1 Closed Array - When solid piled storage has vertical flues between the piles of 6 in (152mm) or less, the storage arrangement shall be considered as closed array.

20.5.3.2*  Open Array -- When solid piled storage has vertical flues between the piles of greater than 6 in (152mm), the storage arrangement shall be considered as open array. A storage arrangement where air movement through the pile is enhanced because of vertical flues larger than 6 in. (152 mm).

20.5.3.3*  –Pile Stability, Stable Piles -- Those arrays where collapse, spillage of content, or leaning of stacks across flue spaces is not likely to occur soon after initial fire development shall be considered as stable piles.

20.5.3.4*  Pile Stability, Unstable Piles -- Those arrays where collapse, spillage of contents, or leaning of stacks across flue spaces occurs soon after initial fire development shall be considered as unstable piles.

20.5.4  Bin Box Storage -- Storage in five-sided wood, metal, or cardboard boxes with open face on the aisles in which boxes are self-supporting or supported by a structure so designed that little or no horizontal or vertical space exists around boxes shall be considered as bin box storage.

20.5.5*  -Shelf Storage -- Storage on structures up to and including 30 in. (0.76 m) deep and separated by aisles at least 30 in. (0.76 m) wide shall be considered as shelf storage.

20.5.6*  -Back-to-Back Shelf Storage -- Two solid or perforated shelves up to 30 in. (0.76 m) in depth each, not exceeding a total depth of 60 in. (1.52 m), separated by a longitudinal vertical barrier such as plywood, particleboard, sheet metal, or equivalent, with a maximum 0.25 in. (6.4 mm) diameter penetrations and no longitudinal flue space and a maximum storage height of 15 ft (4.57 m) shall be considered as back to back storage.

20.5.7  Rack General Rack storage shall include any combination of vertical, horizontal, and diagonal members that supports stored materials in accordance with 20.5.7.

20.5.7.2 Shelving
20.5.7.2.4.1 Shelving material that is less than 50% open, or placement of loads that block openings that would otherwise serve as the required flue spaces, greater than 20 ft² (1.9 m²) in area shall be treated as solid shelf racks. Solid shelves having an area equal to or less than 20 ft² (1.9 m²) are defined as open racks. Shelves of wire mesh, slats, or other materials more than 50 percent open and where the flue spaces are maintained are defined as open racks.

20.5.7.4 Flues
A.20.5.7 Many factors affect the protection of rack storage. Section 20.5.7 defined the variables that limit or change the available protection criteria found in Chapters 21 to 24. Section 20.5.7.1 through 20.5.7.2 identify the general terms of rack storage which identify which type of rack and shelving criteria is to be used in Chapter 21 to 24.

20.5.7.1 Open Rack — Racks without shelving or with shelving in racks that are fixed in place with shelves having a solid surface and a shelf area equal to or less than 20 ft² (1.9 m²) or with shelves having a wire mesh, slatted surface, or other material with openings representing at least 50 percent of the shelf area including the horizontal area of rack members and where the flue spaces are maintained shall be protected as open rack.

20.5.7.2 Shelving

20.5.7.2.1 Rack Shelf Area — The area of the horizontal surface of a shelf in a rack defined by perimeter aisle(s) or nominal 6 in. (152 mm) flue spaces on all four sides, or by the placement of loads that block openings that would otherwise serve as the required flue spaces shall be considered to determine the rack shelf area.

20.5.7.2.2 Slatted Shelf Rack — A rack where shelves are fixed in place with a series of narrow individual solid supports used as the shelf material and spaced apart with regular openings shall be protected as a slatted shelf rack.

20.5.7.2.3 Solid Shelf Rack — A rack that is not defined as an open rack where shelves are fixed in place with a solid, slatted, or wire mesh barrier used as the shelf material and having limited openings in the shelf area shall be protected as a solid shelf rack.

20.5.7.2.4* Solid Shelving — Shelving that is fixed in place, slatted, wire mesh, or other type of shelves located within racks. The area of a solid shelf is defined shall be measured by perimeter aisle or flue space on all four sides or by the placement of loads that block openings that would otherwise serve as the required flue spaces.

20.5.7.2.4.1 Shelving material that is less than 50% open, or placement of loads that block openings that would otherwise serve as the required flue spaces, greater than 20 ft² (1.9 m²) in area shall be treated as solid shelf racks.

20.5.7.3 Aisles.

20.5.7.3.1* Aisles required by Chapters 21 through 25 shall not be obstructed unless Chapters 21 through 25 include specific guidance allowing obstructions over the aisle.

20.5.7.3.2* Aisle Width.

The horizontal dimension between the face of the loads in racks under consideration shall determine the aisle width for protection criteria.

20.5.7.4 Flues

20.5.7.4.1 —Longitudinal Flue Space — The space between rows of storage perpendicular to the direction of loading with a width not exceeding 24 in. (610 mm) between storage shall be considered as the longitudinal flue.
20.5.7.4.1.1 16.1.10.1 For Class I to IV and Group A plastic in double-row and multiple-row open racks, a longitudinal (back-to-back clearance between loads) flue space shall not be required for Storage Up to and Including 25 ft (7.6 m). See Section C.13.

20.5.7.4.1.2 16.1.11.1.1 For Class I to IV and Group A plastic Nominal 6 in. (152.4 mm) longitudinal flue spaces shall be provided in double rows for storage over 25 ft (7.6 m).

20.5.7.4.2 Transverse Flue Space — The space between rows of storage parallel to the direction of loading shall be considered as the transverse flue. (See Figure A.3.9.3.6.)

20.5.7.5 Bulkhead — A vertical barrier across the rack shall be considered a bulkhead.

20.5.7.6 Horizontal Barrier — A solid barrier in the horizontal position covering the entire rack, including all flue spaces at certain height increments, to prevent vertical fire spread shall be considered a horizontal barrier.

20.5.7.7* Single-Row Racks — Racks that have no longitudinal flue space and that have a depth up to 6 ft (1.8 m) with aisles having a width of at least 3.5 ft (1.1 m) between loads on racks shall be protected as single-row racks.

20.5.7.8 Double-Row Racks — Racks less than or equal to 12 ft (3.7 m) in depth or single-row racks placed back to back having an aggregate depth up to 12 ft (3.7 m), with aisles having an aisle width of at least 3.5 ft (1.1 m) between loads on racks shall be protected as double row racks.

20.5.7.9 Multiple-Row Racks — Racks greater than 12 ft (3.7 m) in depth or single- or double-row racks separated by aisles less than 3.5 ft (1.1 m) wide having an overall width greater than 12 ft (3.7 m) shall be protected as multiple row racks.

20.5.7.10 Movable Racks — Racks on fixed rails or guides that can be moved back and forth only in a horizontal, two-dimensional plane shall be protected as movable racks. A moving aisle is created as abutting racks are either loaded or unloaded, then moved across the aisle to abut other racks.

20.5.7.11 Portable Racks — Racks that are not fixed in place and can be arranged in any number of configurations shall be protected as portable racks.

20.5.8 Rubber Tires — Pneumatic tires for passenger automobiles, aircraft, light and heavy trucks, trailers, farm equipment, construction equipment (off-the-road), and buses. Section 20.5.8.1 through 20.5.8.8 identify the general terms of rubber tire storage which identify which type protection criteria that shall be included in Chapter 21 to 24.

20.5.8.1 Banded Tires — A storage method in which a number of When tires are strapped together, they shall be considered as banded.

20.5.8.2 Horizontal Channel — Any uninterrupted space in excess of 5 ft (1.5 m) in length between horizontal layers of stored tires shall be considered as the horizontal channel. Such channels can be formed by pallets, shelving, racks, or other storage arrangements.

20.5.8.3 Laced Tire Storage — Tires stored where the sides of the tires overlap, creating a woven or laced appearance shall be considered as laced tire storage. (See Figure A.3.9.4.9(g).)

20.5.8.5 On-Side Tire Storage — Tires stored horizontally or flat shall be considered as on-side storage.
20.5.8.6 On-Tread Tire Storage — Tires stored vertically or on their treads shall be considered as on-tread storage.

20.5.8.7 Palletized Tire Storage — Storage on portable racks of various types utilizing a conventional pallet as a base shall be considered as palletized storage.

20.5.8.8 Pyramid Tire Storage — On-floor storage in which tires are formed into a pyramid to provide pile stability shall be considered as pyramid storage.

20.5.9* Roll Paper Section 20.5.9.1 through 20.5.9.11 identify the general terms of roll paper which identify which type of protection criteria that shall be used in Chapter 21 to 24.

20.5.9.1 -Paper (General Term) — The term for Storage of all kinds of felted sheets made from natural fibrous materials, usually vegetable but sometimes mineral or animal, and formed on a fine wire screen from water suspension where stored in rolled form shall be protected as roll paper storage.

20.5.9.2 Closed Array (Paper) — Where a vertical storage arrangement in which the distances between columns in both directions are short [not more than 2 in. (50 mm) in one direction and 1 in. (25 mm) in the other], the storage array shall be considered as closed array.

20.5.9.3 Open Array (Paper) — Where a vertical storage arrangement in which the distance between columns in both directions is lengthy (all vertical arrays other than closed or standard), the storage array shall be considered as open array.

20.5.9.4 Standard Array (Paper) — Where a vertical storage arrangement in which the distance between columns in one direction is short [1 in. (25 mm) or less] and is in excess of 2 in. (50 mm) in the other direction, the storage array shall be considered as standard array.

20.5.9.5 Banded Roll Paper Storage — Rolls provided with a circumferential steel strap [3/8 in. (9.5 mm) or wider] at each end of the roll, the rolls shall be considered banded.

20.5.9.6 Column — A single vertical stack of rolls shall be considered a column.

20.5.9.7 Core — The central tube around which paper is wound to form a roll shall be considered as the core.

20.5.9.8 Horizontal Roll Paper Storage — Rolls stored with the cores in the horizontal plane (on-side storage) shall be considered as horizontal storage.

20.5.9.9 Vertical Roll Paper Storage — Rolls stored with the cores in the vertical plane (on-end storage) shall be considered as vertical storage.

20.5.9.10 Wrapped Roll Paper Storage — Rolls provided with a complete heavy kraft covering around both sides and ends shall be considered as wrapped storage.

20.5.9.11 Roll Paper Storage Height — The maximum vertical distance above the floor at which roll paper is normally stored shall be considered as the storage height.

20.5.10 Plastic Motor Vehicle Components
20.5.10.1 Automotive components in this section. This definition does not include the storage of air bags, tires, and seats on portable racks.

Section 20.5.10.1 through 20.5.10.3 identify the general terms of plastic motor vehicle components which identify which protection criteria that shall be used in Chapter 23.

20.5.10.1 - Automotive Components on Portable Racks - Instrument panels, windshields, metal and plastic gasoline tanks, heater housings, door panels, interior trim, bumper facia, wiring harnesses, sheet metal, body components, engines, driveline components, steering mechanisms, auxiliary motors, and lighting — all with or without expanded Group A plastic dunnage shall be permitted to be protected as Automotive components in Chapter 23.

20.5.10.2 - Closed Array. Where portable racks have vertical flues between the racks is 6 inches (152mm) or less, the storage arrangement shall be considered as closed array. A storage arrangement where air movement through the pile is restricted because of 6 in. (152 mm) or less vertical flues.

20.5.11* (add annex from existing 20.3) Retail Display/Storage Section 20.5.7.1 identifies the general terms of retail display/storage which identify which type of protection criteria that shall be used in Chapter 21 to 24.

20.5.12 Baled Cotton Storage Section 20.5.12.1 identifies the general terms of baled cotton storage which identify which type of protection criteria that shall be used in Chapter 21.

20.5.12.1* – Tiered Storage — An arrangement in which bales are stored directly on the floor, two or more bales high shall be considered as tiered storage.

20.5.13 Cartoned Record Storage Section 20.5.13.1 through 20.5.13.2 identify the general terms of cartoned record storage which identify which type of rack and shelving criteria that shall be used in Chapter 21 to 24.

20.5.13.1* – Cartoned Records Storage — The protection criteria in Chapter 21 for Cartoned Records Storage shall be based on a Class III commodity consisting predominantly of paper records in cardboard cartons.

20.5.13.2 Catwalk — For the purposes of cartoned records storage, a storage aid consisting of either open metal grating or solid horizontal barriers supported from a rack storage system that is utilized as a walkway for access to storage at elevated levels. Catwalks are accessed using stairs and are not separate floors of a building.

20.6 Building Construction and Storage — heights and clearance

20.6.2.1 12.1.3.1 The maximum building height shall be measured to the underside of the roof deck or ceiling in the storage area or in accordance with 12.1.3.1.1 through 12.1.3.1.3.

20.6.3 Storage Height

20.6.3.1 The sprinkler system design shall be based on the storage height that routinely or periodically exist in the building and create the greatest water demand.

20.6.3.2 12.1.3.3 The sprinkler system design shall be based on the storage height and clearance to ceiling that routinely or periodically exist in the building and create the greatest water demand. Where
storage is placed above doors, the storage height shall be calculated from the base of storage above the door.

20.6.4.3 12.1.3.4.3 Where the clearance to ceiling exceeds 20 ft (6.1 m) for Palletized, Solid-Piled, Bin Box, Shelf, or Back-to-Back Shelf StorageChapters 14 and 15, the protection shall be based upon the storage height that would result in a clearance to ceiling of 20 ft (6.1 m).

20.6.4.4 12.1.3.4.4 Where the clearance to ceiling exceeds 20 ft (6.1 m) for Rack Storage of Class I to IV storage up to and including 25 ft (7.6m) in height, Section 16.2, the protection shall be based upon the storage height that would result in a clearance to ceiling of 20 ft (6.1 m) or providing one level of supplemental, quick-response in-rack sprinklers in accordance with Chapter 25 located directly below the top tier of storage and at every flue space intersection.

20.6.5.1* Unless the requirements of 20.6.5.2 through 20.6.5.5 8.5.6.2, 8.5.6.3, 8.5.6.4, or 8.5.6.5 are met, the clearance between the deflector and the top of storage or contents of the room shall be 18 in. (450 mm) or greater.

20.6.5.2 Where other standards specify greater clearance to storage minimums, they shall be followed. 20.6.5.3 A minimum clearance to storage of 36 in. (900 mm) shall be permitted for special sprinklers.

20.6.5.3.2 Where ESFR sprinkler systems are installed adjacent to sprinkler systems with standard-response sprinklers, a draft curtain of noncombustible construction and at least 2 ft (600 mm) in depth shall be required to separate the two areas.

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

20.6.5.4 A minimum clearance to storage of less than 18 in. (450 mm) between the top of storage and ceiling sprinkler defectors shall be permitted where proven by successful large-scale fire tests for the particular hazard.

20.6.5.5 The clearance from the top of storage to sprinkler defectors shall be not less than 36 in. (900 mm) where rubber tires are stored.

20.9.2 High-Expansion Foam — Reduction in Ceiling Density

20.9.1 General - High Expansion Foam systems
20.9.2 High-Expansion Foam — Reduction in Ceiling Density

20.9.2.1 15.5 High-Expansion Foam — Reduction in Ceiling Density. Using CMDA Sprinkler protection criteria for Palletized, Solid-Piled, Bin Box, Shelf, or Back-to-Back Shelf Storage of Class I Through Class IV Commodities, idle pallets, or plastics, where high expansion foam systems are used in combination with ceiling sprinklers, a reduction in ceiling density to one-half that required for Class I through Class IV commodities, idle pallets, or plastics shall be permitted without revising the design area, but the density shall be no less than 0.15 gpm/ft² (6.1 mm/min).

20.9.2.2 16.1.5.1.1 Using CMDA Sprinkler Protection Criteria for rack storage where high-expansion foam systems are used in combination with ceiling sprinklers, the minimum ceiling sprinkler design density shall be 0.2 gpm/ft² (8.1 mm/min) for Class I, Class II, or Class III commodities or 0.25 gpm/ft² (10.2 mm/min) for Class IV commodities for the most hydraulically remote 2000 ft² (186 m²) operating area.

20.9.2.3 16.1.5.1.3 Where high-expansion foam systems are used for rack storage of Class I to IV commodities over 25 ft (7.6 m) high up to and including 35 ft (10.7 m) high, they shall be used in combination with ceiling sprinklers.

20.9.2.5 18.6 Reduced-Discharge Density. Where high-expansion foam systems for rubber tire protection are installed in accordance with NFPA 11, a reduction in sprinkler discharge density to one-half the density specified in Table 18.4(a) 21.6.1(a) or 0.24 gpm/ft² (9.78 mm/min), whichever is higher, shall be permitted.

20.9.2.6 16.1.5.2 In-rack sprinklers for the protection of Class I to IV commodities shall not be required where high-expansion foam systems are used in combination with ceiling sprinklers.

20.10 Adjacent Hazards or Design Methods

20.11.1 Small [11/2 in. (40 mm)] Hose Connections. See Section C.5.

20.11.1 12.2.1 Hose Connection Small hose connections [11/2 in. (38 mm)] shall be provided where required by the authority having jurisdiction in accordance with xxxxxxx 8.17.5 for first-aid fire-fighting and overhaul operations.

20.12 Hose Stream Allowance and Water Supply Duration.

20.12.1 Hose Stream Allowance and Water Supply Duration. For Chapter 20 through 25 shall be in accordance with section 20.12.

20.13 – Discharge Considerations General

20.14.3.3 Where idle pallet storage is above a door, the idle pallet storage height and ceiling height shall be calculated from the base of storage above the door using the applicable protection criteria referenced in Section 20.14 12.12.

20.15 Column Protection – Rack Storage and Rubber Tire Storage

20.16.1 Class I, II, III, IV and Group A plastic commodities requiring a greater level of protection than is available from the overhead sprinkler system shall be permitted to be protected in accordance with 20.16.1.1 through 20.16.1.7.
A.20.5.2.4
Few commodities are anticipated to form unstable piles. An example of a commodity that has demonstrated in full-scale fire tests a behavior of progressively collapsing soon after a fire develops is uncartoned, empty, plastic, beverage bottles. Care should be exercised when applying the favorable protection allowance for unstable piles. Few commodities are likely to display unstable pile behavior.

A.20.5.7.3.1
Full-scale storage fire tests are typically performed with aisles left open. Obstructions such as catwalks, whether solid or open grate, are not typically evaluated in the full-scale fire tests forming the basis of this standard.
First Revision No. 911-NFPA 13-2016 [Global Input]

New language in Chapter 4 per re-org...

Supplemental Information

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Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
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Committee Statement

Committee Statement: Due to reorg
Response Message:
Public Input No. 146-NFPA 13-2016 [Section No. 5.3.2.1]
4.1.1 A building, where protected by an automatic sprinkler system installation, shall be provided with sprinklers in all areas except where specific sections of this standard permit the omission of sprinklers.

4.3.1.3 Commodity classification and storage arrangement referenced in 4.3.2 through 4.3.6 shall be determined in accordance with Sections 20.3 through 20.5 for miscellaneous and low-piled storage per sections 4.3.1.5 through 4.3.1.7.

4.3.1.4* Miscellaneous Storage.

A. 4.3.1.4 Miscellaneous Storage Miscellaneous storage is intended to be storage that is ancillary to the primary function of the building. One example is a manufacturing facility where storage on the manufacturing floor is limited.

A. 4.3.1.4.1 Miscellaneous storage shall not constitute more than 10 percent of the building area or 4000 ft² (372 m²) of the sprinklered area, whichever is greater.

A. 4.3.1.4.2 Miscellaneous storage shall not exceed 1000 ft² (93 m²) in one pile or area.

A. 4.3.1.4.3 Miscellaneous storage shall be separated from other storage piles or areas by at least 25 ft (7.6 m).

4.3.1.5 Low-piled Storage

4.3.1.6* Miscellaneous Tire Storage The storage of rubber tires that is incidental to the main use of the building:

4.3.1.6.1 Miscellaneous tire storage shall not exceed 2000 ft² (186 m²).

4.3.1.6.2 Miscellaneous tire storage piles on-tread, regardless of storage method, shall not exceed 25 ft (7.6 m) in the direction of the wheel holes.

4.3.1.7 In-rack Sprinklers. Miscellaneous and low-piled storage per Sections 4.3.1.5 through 4.3.1.7 that require in-rack sprinklers shall follow Chapter 25 for their installation and design requirements.

4.3.2*5.2* Light Hazard Occupancies Light hazard occupancies shall be defined as occupancies or portions of other occupancies where the quantity and/or combustibility of contents is low and fires with relatively low rates of heat release are expected. Light Hazard. The following shall be protected with light hazard occupancy criteria in this standard:

(1) spaces with low quantity and combustibility of contents.

4.3.3*5.3.1* Ordinary Hazard (Group 1) Ordinary Hazard (Group 1). The following shall be protected with ordinary hazard group 1 occupancy criteria in this standard:
(1) spaces with moderate quantity and low combustibility of contents

(2) stockpiles of contents with low combustibility that do not exceed 8 ft (2.4 m)

(3) miscellaneous storage or storage facilities of solid-piled, palletized, bin box, shelf, rack and back-to-back shelf storage of Class I commodities not exceeding 12 ft (3.7 m)

(4) miscellaneous storage or storage facilities of solid-piled, palletized, bin box, shelf, rack and back-to-back shelf storage of Class II commodities not exceeding 10 ft (3.0 m)

4.3.4*5.3.2* Ordinary Hazard (Group 2). Ordinary Hazard (Group 2). The following shall be protected with ordinary hazard group 2 occupancy criteria in this standard:

(1) spaces with moderate to high quantity and combustibility of contents

(2) stockpiles of contents with moderate to high combustibility that do not exceed 12 ft (3.7 m)

(3) miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack and back-to-back shelf storage of Class II commodities more than 10 ft (3.0m) and not exceeding 12 ft (3.7 m)

(4) miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack and back-to-back shelf storage of Class III commodities not exceeding 12 ft (3.7 m)

(5) miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack and back-to-back shelf storage of Class IV commodities not exceeding 10 ft (3.0 m)

(6) miscellaneous or low-piled storage of solid-piled, palletized, bin box, and shelf storage of Class IV commodities more than 10 ft (3.0m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 32 ft (9.8m)

(7) miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack and back-to-back shelf storage of Group A commodities not exceeding 5 ft (3.7 m)

(8) miscellaneous storage of rack storage of Group A commodities more than 10 ft (3.0m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 32 ft (9.8m) with the use of 1 level of in-rack sprinklers.

(9) miscellaneous storage of rack storage of exposed expanded Group A commodities more than 5 ft (1.5m) and not exceeding 10 ft (3.0 m) and a maximum ceiling height of 20 ft (5.1m) with the use of 1 level of in-rack sprinklers.

(10) miscellaneous tire storage stored on floor or in rack either on tread or on side not exceeding 5 ft (3.7m)

(11) miscellaneous tire storage stored on a fixed single-row rack either on tread or on side more than 5 ft (1.5m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 32 ft (9.8m) with the use of 1 level of in-rack sprinklers

(12) miscellaneous storage of mediumweight and heavyweight rolled paper stored on end not exceeding 10 ft (3.0m) and a maximum ceiling height of 30 ft (9.1m)
4.3.5*5.4.1* Extra Hazard (Group 1). Extra hazard (Group 1) occupancies shall be defined as occupancies or portions of other occupancies where the quantity and combustibility of contents are very high and dust, lint, or other materials are present, introducing the probability of rapidly developing fires with high rates of heat release but with little or no combustible or flammable liquids. Extra Hazard (Group 1). The following shall be protected with extra hazard group 1 occupancy criteria in this standard:

(1) spaces with very high quantity and combustibility of contents
(2) spaces where dust, lint, or other materials are present, introducing the probability of rapidly developing fires.
(3) miscellaneous or low-piled storage of rack and back-to-back shelf storage of Class IV commodities more than 10 ft (3.0m) and not exceeding 12 ft (3.7m) and a maximum ceiling height of 32 ft (9.8m)
(4) miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack, and back-to-back shelf storage of cartoned Group A commodities more than 5 ft (1.5m) and not exceeding 10 ft (3.0 m) and a maximum ceiling height of 15 ft (4.6m).
(5) miscellaneous tire storage stored on floor on side or in single-row rack (portable and fixed) either on tread or on side more than 5 ft (1.5m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 32 ft (9.8m)
(6) miscellaneous storage of tissue and lightweight rolled paper stored on end not exceeding 10 ft (3.0m) and a maximum ceiling height of 30 ft (9.1m)

4.3.6*5.4.2* Extra Hazard (Group 2). Extra hazard (Group 2) occupancies shall be defined as occupancies or portions of other occupancies with moderate to substantial amounts of flammable or combustible liquids or occupancies where shielding of combustibles is extensive. Extra Hazard (Group 2). The following shall be protected with extra hazard group 2 occupancy criteria in this standard:

(1) spaces with very high quantity and combustibility of contents
(2) spaces with substantial amounts of combustible or flammable liquids
(3) spaces where shielding of combustibles is extensive
(4) miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack, back-to-back shelf storage of cartoned Group A commodities more than 5 ft (1.5m) and not exceeding 10 ft (3.0 m) and a maximum ceiling height of 20 ft (5.1m)
(5) miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, rack, back-to-back shelf storage of cartoned Group A commodities more than 10 ft (3.0m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 17 ft (5.2m)
(6) miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, back-to-back shelf storage of cartoned Group A commodities more than 10 ft (3.0m) and not exceeding 12 ft (3.7 m) and a maximum ceiling height of 32 ft (9.8m)
(7) miscellaneous or low-piled storage of solid-piled, palletized, bin box, shelf, back-to-back shelf storage of exposed Group A commodities more than 5 ft (1.5m) and not exceeding 8 ft (2.4m) and a maximum ceiling height of 28 ft (8.5m)
(8) miscellaneous storage of solid‐piled, palletized, bin box, shelf, rack, back‐to‐back shelf storage of exposed Group A commodities more than 5 ft (1.5m) and not exceeding 10 ft (3.0m) and a maximum ceiling height of 15 ft (4.6m)

(9) miscellaneous storage of solid‐piled, palletized, bin box, shelf, rack, back‐to‐back shelf storage of exposed unexpanded Group A commodities more than 5 ft (1.5m) and not exceeding 10 ft (3.0m) and a maximum ceiling height of 20 ft (6.1m)

(10) miscellaneous storage of solid‐piled, palletized, bin box, shelf, back‐to‐back shelf storage of exposed Group A commodities more than 10 ft (3.0m) and not exceeding 12 ft (3.7m) and a maximum ceiling height of 17 ft (5.2m)

(11) miscellaneous storage of rack storage of exposed Group A commodities more than 10 ft (3.0m) and not exceeding 12 ft (3.7m) and a maximum ceiling height of 17 ft (5.2m)

4.3.7 High‐Piled Storage. Storage arrangements that do not meet the requirements of 4.3.2 through 4.3.6 shall be protected in accordance with Chapters 20 through 25.

4.3.94 Where K‐11.2 (160) or larger sprinklers are used with EH1 or EH2 design curves from Figure 13.2.1, the design area shall be permitted to be reduced by 25 percent but not below 2000 ft² (186 m²), regardless of temperature rating.

4.5.1 8.2.1 The maximum floor area on any one floor to be protected by sprinklers supplied by any one sprinkler system riser or combined system riser shall be as follows:

(1) Light hazard — 52,000 ft² (4830 m²)

(2) Ordinary hazard — 52,000 ft² (4830 m²)

(3) *Extra hazard — Hydraulically calculated — 40,000 ft² (3720 m²)

(4) High‐piled Storage — High‐piled storage (as defined in 3.9.1.16) and storage covered by other NFPA standards — 40,000 ft² (3720 m²)

(5) In‐rack Storage — 40,000 ft² (3716 m²)

4.5.4 The area protected by a single in‐rack system of sprinklers in racks shall not exceed 40,000 ft² (3716 m²), include all of the floor area occupied by the racks, including aisles, regardless of the number of levels of in‐rack sprinklers.

4.5.4.1 Multiple buildings attached by canopies, covered breezeways, common roofs, or a common wall(s) shall be permitted to be supplied by a single fire sprinkler riser.
19.1 Chapter 19 shall be utilized for design approaches and calculation procedures.

19.3.3.1.2.1 The maximum design area for miscellaneous and low-piled storage shall be 3000 ft² (279 m²).

Committee Statement

Committee Statement: New language needed per re-org
Response Message:
16.1.2.4 [20.16] Alternative Protection Scheme A.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Sep 08 18:06:04 EDT 2016

Committee Statement

Committee Statement: Labels the existing Alternative Protection in-rack sprinkler scheme for clarity.
Response Message:

Public Input No. 426-NFPA 13-2016 [Section No. 16.1.2.4]
Public Input No. 427-NFPA 13-2016 [New Section after 16.1.2.4]
**19.2.7** High Volume Low Speed (HVLS) Fans.

The installation of HVLS fans in buildings equipped with sprinklers, including ESFR sprinklers, shall comply with the following:

1. The maximum fan diameter shall be 24 ft (7.3 m).
2. The HVLS fan shall be centered approximately between four adjacent sprinklers.
3. The vertical clearance from the HVLS fan to sprinkler deflector shall be a minimum of 3 ft (0.9 m).
4. All HVLS fans shall be interlocked to shut down immediately upon receiving a waterflow signal from the alarm system in a waterflow alarm. Where the building is protected with a fire alarm system, this interlock shall be in accordance with the requirements of **NFPA 72**.

---

**Submitter Information Verification**

**Submitter Full Name:** AUT-SSD  
**Organization:** National Fire Protection Assoc  
**Street Address:**  
**City:**  
**State:**  
**Zip:**  
**Submittal Date:** Mon Aug 15 13:53:39 EDT 2016

**Committee Statement**

**Committee Statement:** The standard does not necessarily require a fire alarm system for a building. The text needs to be modified to allow cases where a fire alarm system is not required.
First Revision No. 898-NFPA 13-2016 [ Section No. 11.2.3.1.5.2 ]

19.3.3.1.5.2

The following unsprinklered concealed spaces shall not require a minimum area of sprinkler operation of 3000 ft\(^2\) (280 279 m\(^2\)):

(1) Noncombustible and limited-combustible concealed spaces with minimal combustible loading having no access. The space shall be considered a concealed space even with small openings such as those used as return air for a plenum.

(2) Noncombustible and limited-combustible concealed spaces with limited access and not permitting occupancy or storage of combustibles. The space shall be considered a concealed space even with small openings such as those used as return air for a plenum.

(3) Combustible concealed spaces filled entirely with noncombustible insulation.

(4) Light or ordinary hazard occupancies where noncombustible or limited-combustible ceilings are directly attached to the bottom of solid wood joists or solid limited-combustible construction or noncombustible construction so as to create enclosed joist spaces 160 ft\(^3\) (4.5 m\(^3\)) or less in volume, including space below insulation that is laid directly on top or within the ceiling joists in an otherwise sprinklered concealed space.

(5) Concealed spaces where rigid materials are used and the exposed surfaces comply with one of the following in the form in which they are installed in the space:

   (a) The surface materials have a flame spread index of 25 or less and the materials have been demonstrated to not propagate fire more than 10.5 ft (3.2 m) when tested in accordance with ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials, or ANSI/UL 723, Standard for Test for Surface Burning Characteristics of Building Materials, extended for an additional 20 minutes in the form in which they are installed in the space or

   (b) The surface materials comply with the requirements of ASTM E2768, Standard Test Method for Extended Duration Surface Burning Characteristics of Building Materials (30 min Tunnel Test).

(6) Concealed spaces in which the exposed materials are constructed entirely of fire-retardant-treated wood as defined by NFPA 703.

(7) Concealed spaces over isolated small rooms not exceeding 55 ft\(^2\) (5.1 m\(^2\)) in area.

(8) Vertical pipe chases under 10 ft\(^2\) (0.9 m\(^2\)), provided that in multifloor buildings the chases are firestopped at each floor using materials equivalent to the floor construction, and where such pipe chases contain no sources of ignition, piping shall be noncombustible, and pipe penetrations at each floor shall be properly sealed.

(9) Exterior columns under 10 ft\(^2\) (0.9 m\(^2\)) in area formed by studs or wood joists, supporting exterior canopies that are fully protected with a sprinkler system.

(10) Light or ordinary hazard occupancies where noncombustible or limited-combustible ceilings are attached to the bottom of composite wood joists either directly or on to metal channels not exceeding 1 in. (25 mm) in depth, provided the adjacent joist channels are firestopped into volumes not exceeding 160 ft\(^3\) (4.5 m\(^3\)) using materials equivalent to ½ in. (13 mm) gypsum board, and at least 3½ in. (90 mm) of batt insulation is installed at the bottom of the joist channels when the ceiling is attached utilizing metal channels.

(11) Cavities within unsprinklered wall spaces.

Supplemental Information

<table>
<thead>
<tr>
<th>File Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR_898_11.2.3.1.5.2.docx</td>
<td>Shows legislative changes. For staff use.</td>
</tr>
</tbody>
</table>
Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Sep 08 17:34:31 EDT 2016

Committee Statement

Committee Statement: In a building with wood frame construction, the wall cavities created when wall material is attached to wooden studs has never been sprinklered. Typically, users point to section 8.15.1.2.3 to allow the omission of sprinklers. Likewise, the user should not be kicked into a 3000 sq ft design area because the space bounded by the walls and the wood studs within a wall is not sprinklered, yet the standard does not explicitly have this exception. So, I am proposing it. Rather than propose an exception for all uses of 8.15.1.2.3, I am just proposing the exception to the 3000 sq ft rule for wall cavities.

Response Message:

Public Input No. 23-NFPA 13-2016 [Section No. 11.2.3.1.5.2]
Public Input No. 153-NFPA 13-2016 [New Section after 11.2.3.1.5.2]
Unless the requirements of 11.2.3.1.4 (4) 19.3.3.1.5.2 are met for buildings having unsprinklered combustible concealed spaces, as described in 9.2.1 and 9.3.19, the minimum design area of sprinkler operation for that portion of the building shall be eight sprinklers.

Committee Statement

Committee: 11.3.1.2 references the wrong section number. As written, the 2016 standard references the 2013 section number for exceptions to the 8 sprinkler design area.

Response Message: Public Input No. 274-NFPA 13-2016 [Section No. 11.3.1.2 [Excluding any Sub-Sections]]
19.4.3.3
For a deluge system water curtain providing proscenium opening protection in accordance with 19.15.17.2, the water curtain shall be calculated to supply all of the open sprinklers attached thereto.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Sep 08 17:46:42 EDT 2016

Committee Statement

Committee Statement:
Section 8.15.17.2, for deluge system water curtain protection of proscenium openings, says to see Chapter 11 for design criteria, but the current text only addresses automatic sprinklers and calls for a limited number of water curtain sprinklers to be calculated as per the “1.2 Rule”, whereas for a deluge system flow from all of the open sprinklers on the system will be involved.

Response Message:

Public Input No. 510-NFPA 13-2016 [Section No. 11.3.3]
19.4.4 Sprinkler-Protected Glazing.

Where the sprinkler-protected glazing is required to comply with 9.3.15, the water supply duration for the design area that includes the window sprinklers shall be not less than the required rating of the assembly.

19.4.4.1 For sprinkler-protected glazing, the number of sprinklers calculated for the glazing shall be the number in the length corresponding to the length parallel to the branch lines in the area determined by 19.6.4.2.

19.4.4.2 If a single fire can be expected to operate sprinklers for the sprinkler-protected glazing and within the design area of a hydraulically calculated system, the water supply to the sprinkler-protected glazing shall be added to the water demand of the hydraulic calculations and shall be balanced to the calculated area demand.

19.4.4.3 Hydraulic design calculations shall include a design area selected to include ceiling sprinklers adjacent to the sprinkler-protected glazing.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 15 14:41:30 EDT 2016

Committee Statement

Committee Statement: This proposal is add the requirements for calculating the sprinkler-protected glazing in conjunction with the ceiling sprinkler system, the same as for water curtains.
Response Message:

Public Input No. 511-NFPA 13-2016 [Section No. 11.3.5]
20.6.4.2
Protection of Class I-IV commodities with excessive clearance from the top of storage to the ceiling sprinkler deflectors shall be in accordance with Table 20.6.4.2.

<table>
<thead>
<tr>
<th>Storage Configuration</th>
<th>Where the clearance to ceiling exceeds</th>
<th>Protection is based upon the storage height that would result in a clearance to ceiling of...</th>
<th>In-rack Sprinklers*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palletized, solid-piled, bin box, shelf, or back-to-back shelf storage</td>
<td>20 ft (6.1 m)</td>
<td>20 ft (6.1 m)</td>
<td>N/A</td>
</tr>
<tr>
<td>Rack storage up to and including 25 ft (7.6 m) in height</td>
<td>20 ft (6.1 m)</td>
<td>20 ft (6.1 m)</td>
<td>Permitted as alternative to presumed clearance of 20 ft (6.1 m)</td>
</tr>
<tr>
<td>Rack storage over 25 ft (7.6 m) in height</td>
<td>10 ft (3.1 m)</td>
<td>10 ft (3.1 m)</td>
<td>Permitted as alternative to presumed clearance of 10 ft (3.1 m)</td>
</tr>
</tbody>
</table>

*When applying the supplemental in-rack sprinkler option, the ceiling density is based upon the given storage height with an assumed acceptable clearance to ceiling. Provide one level of supplemental, quick response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection.

20.6.4.3
Protection of Plastic and Rubber commodities with excessive clearance from the top of storage to the ceiling sprinkler deflectors shall be in accordance with Table 20.6.4.3.

<table>
<thead>
<tr>
<th>Storage Configuration</th>
<th>Where the clearance to ceiling exceeds</th>
<th>Protection is based upon the storage height that would result in a clearance to ceiling of...</th>
<th>In-rack Sprinklers*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palletized, solid-piled, bin box, shelf, or back-to-back shelf storage</td>
<td>20 ft (6.1 m)</td>
<td>20 ft (6.1 m)</td>
<td>N/A</td>
</tr>
<tr>
<td>Rack storage up to and including 25 ft (7.6 m) in height</td>
<td>10 ft (3.1 m)</td>
<td>10 ft (3.1 m)</td>
<td>Permitted as alternative to presumed clearance of 10 ft (3.1 m)</td>
</tr>
<tr>
<td>Rack storage over 25 ft (7.6 m) in height</td>
<td>10 ft (3.1 m)</td>
<td>N/A</td>
<td>Required</td>
</tr>
</tbody>
</table>

*If in-rack sprinklers are required for the actual storage height with an acceptable clearance to ceiling, in-rack sprinklers are installed as indicated by that criteria. Provide one level of supplemental, quick response in-rack sprinklers located directly below the top tier of storage and at every flue space intersection.
Committee Statement

Committee Statement: This Public Input appeared as “Reject but Hold” in Public Comment No. 75 of the (A2015 cycle).

Section 12.1.3.4 (Clearance to Ceiling) contains numerous criteria, in which critical protection criteria for excessive clearance is obscured in subsections 12.1.3.4.3 through 12.1.3.4.8. These are even less prominent than the 2010 edition in which Section 12.1.3.4 was entitled “Excessive Clearance.” Furthermore, the narratives of the sections are cumbersome, referring to other chapter sections with no commodity description. The proposed Tables will draw attention to and define the various storage configurations. In addition to incorporation of this Table into Chapter 12, it is recommended that appropriate sections of Chapters 14, 15, 16, and 17 refer to these critical Tables in Chapter 12. Specifically, “maximum storage height” in the Tables in Chapter 14, 15, 16 and 17 should reference the minimum presumed heights mandated when excessive clearance occurs.

Response
Message:

Public Input No. 122-NFPA 13-2016 [Section No. 12.1.3.4]
First Revision No. 753-NFPA 13-2016 [Section No. 12.1.4.1]

20.6.7.1 The installation of HVLS fans in buildings equipped with sprinklers, including ESFR sprinklers, shall comply with the following:

1. The maximum fan diameter shall be 24 ft (7.3 m).
2. The HVLS fan shall be centered approximately between four adjacent sprinklers.
3. The vertical clearance from the HVLS fan to sprinkler deflector shall be a minimum of 3 ft (900 mm).
4. All HVLS fans shall be interlocked to shut down immediately upon receiving a waterflow signal from the alarm system, a waterflow alarm.
5. Where the building is protected with a fire alarm system, this interlock shall be in accordance with the requirements of NFPA 72.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 15 14:00:19 EDT 2016

Committee Statement

Committee Statement: See FR 752
Response Message:
20.13.3 Dry Pipe and Preaction Systems.

For dry pipe systems and preaction systems using control mode density/area (CMDA) criteria, the area of sprinkler operation shall be increased by 30 percent without revising the density.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 15 19:22:12 EDT 2016

Committee Statement

Committee Statement: The design area for CMSA sprinklers in a dry-pipe or preaction system has already been increased by NFPA 13. Technically, this section requires it to be increased again, which was never the intent. This section has only ever applied to the density/area approach.

Response Message:
Public Input No. 154-NFPA 13-2016 [Section No. 12.5]
Unless indicated otherwise, the minimum water supply requirements for a hydraulically designed sprinkler system shall be determined by adding the hose stream allowance from Table 20.12.2.6 to the water demand for sprinklers.

**Table 20.12.2.6 Hose Stream Allowance and Water Supply Duration**

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Sprinkler Type</th>
<th>Sprinkler Spacing Type</th>
<th>Number of Ceiling Sprinklers in Design Area</th>
<th>Size of Design Area at Ceiling</th>
<th>Hose Stream Allowance gpm</th>
<th>Water Supply Duration (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I-IV Commodities, Group A plastics, idle wood pallets, idle plastic pallets and miscellaneous storage</td>
<td>Control mode density/area (CMDA)</td>
<td>Standard and extended-coverage</td>
<td>NA</td>
<td>Up to 1200 ft² (110 m²)</td>
<td>250</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Over 1200 ft² (111 m²) up to 1500 ft² (140 m²)</td>
<td>500</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Over 1500 ft² (139 m²) up to 2600 ft² (240 m²)</td>
<td>500</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Over 2600 ft² (240 m²)</td>
<td>500</td>
<td>150</td>
</tr>
<tr>
<td>Control Mode Specific Application (CMSA)</td>
<td>Standard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Up to 12</td>
<td>NA</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Over 12 to 15</td>
<td>NA</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Over 15 to 25</td>
<td>NA</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Over 25</td>
<td>NA</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Up to 6</td>
<td>NA</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Up to 8±</td>
<td>NA</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Over 6 to 8</td>
<td>NA</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Over 8 to 12</td>
<td>NA</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Over 12</td>
<td>NA</td>
<td>500</td>
</tr>
<tr>
<td>Early Suppression Fast Response (ESFR)</td>
<td>Standard</td>
<td>Extended-coverage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Up to 12</td>
<td>NA</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Over 12 to 15</td>
<td>NA</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Over 15 to 25</td>
<td>NA</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Over 25</td>
<td>NA</td>
<td>500</td>
</tr>
<tr>
<td>On-floor rubber tire storage up to 5 ft (1.5 m) in height</td>
<td>CMDA &amp; CMSA</td>
<td>Standard and extended-coverage</td>
<td>Any</td>
<td>Any</td>
<td>250</td>
<td>120</td>
</tr>
<tr>
<td>Rubber tire storage</td>
<td>CMDA</td>
<td>Standard and extended-coverage</td>
<td>Up to 5000 ft² (372 m²)</td>
<td>750</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CMSA</td>
<td>Standard</td>
<td>Up to 15</td>
<td>NA</td>
<td>500</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>ESFR</td>
<td>Standard</td>
<td>Up to 12</td>
<td>NA</td>
<td>250</td>
<td>60</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Over 12 to 20</td>
<td>NA</td>
<td>500</td>
<td>180</td>
</tr>
<tr>
<td>Roll paper</td>
<td>CMDA</td>
<td>Standard</td>
<td>Up to 4000 ft² (372 m²)</td>
<td>500</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CMSA</td>
<td>Standard</td>
<td>Up to 25</td>
<td>NA</td>
<td>500</td>
<td>120</td>
</tr>
<tr>
<td>Commodity</td>
<td>Sprinkler Type</td>
<td>Sprinkler Spacing Type</td>
<td>Number of Ceiling Sprinklers in Design Area*</td>
<td>Size of Design Area at Ceiling</td>
<td>Hose Stream Allowance</td>
<td>Water Supply Duration (minutes)</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------</td>
<td>------------------------</td>
<td>---------------------------------------------</td>
<td>-----------------------------</td>
<td>-----------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>ESFR</td>
<td>Standard</td>
<td>Up to 12</td>
<td>NA</td>
<td>500</td>
<td>1900</td>
<td>120</td>
</tr>
<tr>
<td>Alternative Protection per 16.1.2.4 or 17.1.2.9</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>500</td>
<td>1900</td>
</tr>
</tbody>
</table>

NA: Not applicable.

* For CSMA and ESFR sprinklers, the additional sprinklers included in the design area for obstructions do not need to be considered in determining the total number of sprinklers in this column.

† Limited to a maximum of 144 ft² (13.4 m²) per sprinkler.

‡ For storage on-tread, on-side, and laced tires in open portable steel racks or palletized portable racks, with pile height up to 25 ft (7.6 m) and building height up to 30 ft (9.1 m) with K-14.0 (K-200) or K16.8 (K-240) ESFR sprinklers, the water supply duration is 180 minutes.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Tue Aug 16 11:17:13 EDT 2016

Committee Statement

Committee Statement: This proposal seeks to rectify a discrepancy that was introduced during the Second Draft of the cycle leading up to the 2016 edition of the standard, whereby the water supply durations for all of the ESFR protection schemes were changed to 180 minutes (3 hr), whereas in NFPA 13-2013 only one of the ESFR schemes called for a 3 hr duration, while all of the others only specified 1 hr. This appears to be a transcription error that went unnoticed by the Technical Committee.

Public Comment No. 313 and Second Revision No. 146 sought to move the hose stream allowances and water supply duration from the Rubber Tire Storage tables in Chapter 18 to Table 12.8.6, to consolidate water supply information into a single source in the general requirements. However, while in NFPA 13-2013, Table 18.4(d) had a 3 hr duration called up only for on-tread, on-side, and laced tires in open portable steel racks or palletized portable racks, while all of the other 11 piling methods only required 1 hr durations, but in NFPA 13-2016, Table 12.8.6 now specifies 180 minutes (3 hr) for all ESFR protection of rubber tires.

This change was inadvertent. None of the public comments and none of the discussions at the Technical Committee meetings suggested that the 1 hr durations should be revised upwards, so there is no substantiation for the current requirements. They should therefore be changed back. This change was inadvertent. The Technical Committee did not take any action to change the figure after the First Draft. They should therefore be corrected again.

Response Message:

Public Input No. 527-NFPA 13-2016 [Section No. 12.8.6]
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)

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**Supplemental Information**

- **File Name**: FR_790_Table_14.3.1.xlsx
- **Description**: Added K25 to table. For staff use

**Submitter Information Verification**

- **Submitter Full Name**: AUT-SSD
- **Organization**: National Fire Protection Assoc
- **Street Address**:
- **City**:
- **State**:
- **Zip**:
- **Submittal Date**: Tue Aug 16 16:20:58 EDT 2016

**Committee Statement**

- **Committee Statement**: Added K25.2 CMSA to the charts according to the UL listing data.
- **Response Message**: Public Input No. 369-NFPA 13-2016 [Section No. 14.3.1]
22.1.5  Open Wood Joist Construction.

22.1.5.1  Where CMSA sprinklers are installed under open wood joist construction, their minimum operating pressure one of the following shall be 50 psi provided:

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

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

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

(4) 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).

22.7.2  For CMSA sprinklers where each joist channel of open wood joist construction is fully firestopped to its full depth at intervals not exceeding 20 ft (6.1 m), the lower pressures specified in Table 14.3.1 shall be permitted to be used.

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:

(1) Pile height

(2) Clearance to ceiling

(3) Pile stability

(4) Array

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 16 14:05:53 EDT 2016

Committee Statement

Committee Statement: The standard currently has a problem in that it is not mutually exclusive. The statement in section 14.3.3.2 contradicts the statement in section 14.3.3.1. This kind of situation works better as a list of...
options for the designer, who can pick from the best of four options depending on the sprinkler being used and the water supply. Note that this should happen everywhere that CMSA sprinklers are discussed, which will probably be only once if the reorganization is successful, so this concept has only been submitted once in the storage chapters. If the reorganization is not successful, then this concept will need to be repeated.

Response Message:

Public Input No. 174-NFPA 13-2016 [Section No. 14.3.3]
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

<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Commodity Class</th>
<th>Maximum Storage Height</th>
<th>Maximum Ceiling/Roof Height</th>
<th>K-Factor/Orientation</th>
<th>Type of System</th>
<th>Numt of Des Sprink</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palletized</td>
<td>Cartoned nonexpanded plastics</td>
<td>20 6.1</td>
<td>30 9.1</td>
<td>11.2 (160) Upright</td>
<td>Wet</td>
<td>25</td>
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<td>25 7.6</td>
<td>30 9.1</td>
<td>16.8 (240) Upright</td>
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<td>Cartoned nonexpanded plastics</td>
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<td>30 9.1</td>
<td>11.2 (160) Upright</td>
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<td>Cartoned or exposed expanded plastics</td>
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<td>16.8 (240) Upright</td>
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</tr>
</tbody>
</table>

Supplemental Information

National Fire Protection Association Report
http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...
Committee Statement

**Committee Statement:** Based on test data presented to the committee.

**Response Message:**
20.5.8.4.1.1

In For Class I through IV and Group A plastic in double-row and multiple-row open racks, a longitudinal (back-to-back clearance between loads) flue space shall not be required, for storage up to and including 25 ft (7.6 m). (See Section C.13.)

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 15 19:23:01 EDT 2016

Committee Statement

Committee Statement: Move paragraph 16.1.10.1 to 20.5.7.4.1.1 as part of the NFPA 13 reorganization. It revision is not intended to introduce any technical change to the standard.
Response Message:

Public Input No. 232-NFPA 13-2016 [Section No. 16.1.10.1]
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) Stored Up to and Including 25 ft (7.6 m) in Height

<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Commodity Class</th>
<th>Maximum Storage Height</th>
<th>Maximum Ceiling/Roof Height</th>
<th>K-Factor/ Orientation</th>
<th>Type of System</th>
<th>Number of Design Sprinklers</th>
<th>Minimum Operating Pressure</th>
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<td>11.2 (160) Upright</td>
<td>Wet</td>
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<td>25</td>
</tr>
<tr>
<td>Single-, double-, and multiple-row racks (no open-top containers)</td>
<td>Class I or II</td>
<td>20</td>
<td>6.1</td>
<td>30</td>
<td>9.1</td>
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<td>Maximum Ceiling/ Roof Height</td>
<td>K-Factor/ Orientation</td>
<td>Type of System</td>
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**Supplemental Information**

**File Name**: FR_792_Table_16.2.2.1.xlsx  
**Description**: Added k25 sprinkler to table.

**Submitter Information Verification**

**Submitter Full Name**: AUT-SSD  
**Organization**: National Fire Protection Assoc  
**Street Address**:  
**City**:  
**State**:  
**Zip**:  
**Submittal Date**: Tue Aug 16 17:04:36 EDT 2016

**Committee Statement**

**Committee Statement**: Adds K25.2 based on test data presented to the committee.

**Response Message**: 

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National Fire Protection Association Report

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<th>Number of Design Sprinklers</th>
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<td>racks (no open-top</td>
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<td>25  7.6</td>
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<td>containers)</td>
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<td></td>
<td></td>
<td>Dry</td>
<td></td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>Class I or II</td>
<td></td>
<td>20  6.1</td>
<td>30  9.1</td>
<td>19.6 (280) Pendent</td>
<td>Wet</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40  12.1</td>
<td></td>
<td>25.2 (360) Pendent</td>
<td>Wet</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Class I or II</td>
<td></td>
<td>25  7.6</td>
<td>30  9.1</td>
<td>19.6 (280) Pendent</td>
<td>Wet</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25.2 (360) Pendent</td>
<td>Wet</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40  12.1</td>
<td></td>
<td>25.2 (360) Pendent</td>
<td>Wet</td>
<td>15</td>
<td>23</td>
</tr>
<tr>
<td>Class I or II</td>
<td></td>
<td>20  6.1</td>
<td>30  9.1</td>
<td>11.2 (160) Upright</td>
<td>Wet</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
<td></td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25  7.6</td>
<td>30  9.1</td>
<td>16.8 (240) Upright</td>
<td>Wet</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
<td></td>
<td>25</td>
<td>15</td>
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<tr>
<td></td>
<td></td>
<td>19.6 (280) Pendent</td>
<td></td>
<td>Wet</td>
<td></td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25.2 (360) Pendent</td>
<td></td>
<td>Wet</td>
<td></td>
<td>15</td>
<td>10</td>
</tr>
</tbody>
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Table 16.2.2.1 CMSA Sprinkler Design Criteria for Rack Storage of Class I Through Class IV Commodities (Encapsulated and Nonencapsulated) Stored Up to and Including 25 ft (7.6 m) in Height
<table>
<thead>
<tr>
<th>Height (in)</th>
<th>Width (in)</th>
<th>Class</th>
<th>Wet Condition</th>
<th>15 + 1 level of in-rack</th>
<th>23</th>
<th>1.6</th>
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<tbody>
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<td>Class III</td>
<td>40</td>
<td>12.1</td>
<td>Wet</td>
<td>15 + 1 level of in-rack</td>
</tr>
<tr>
<td>30</td>
<td>9.1</td>
<td>Class III</td>
<td>11.2 (160) Upright</td>
<td>Dry</td>
<td>25 + 1 level of in-rack</td>
<td>25</td>
</tr>
<tr>
<td>25</td>
<td>7.6</td>
<td>Class III</td>
<td>16.8 (240) Upright</td>
<td>Wet</td>
<td>25 + 1 level of in-rack</td>
<td>15</td>
</tr>
<tr>
<td>35</td>
<td>10.7</td>
<td>Class III</td>
<td>19.6 (280) Pendent</td>
<td>Wet</td>
<td>15 + 1 level of in-rack</td>
<td>15</td>
</tr>
<tr>
<td>40</td>
<td>12.2</td>
<td>Class III</td>
<td>25.2 (360) Pendent</td>
<td>Wet</td>
<td>15 + 1 level of in-rack</td>
<td>15</td>
</tr>
<tr>
<td>25</td>
<td>7.6</td>
<td>Class III</td>
<td>11.2 (160) Upright</td>
<td>Dry</td>
<td>25 + 1 level of in-rack</td>
<td>15</td>
</tr>
<tr>
<td>35</td>
<td>10.7</td>
<td>Class III</td>
<td>16.8 (240) Upright</td>
<td>Wet</td>
<td>25 + 1 level of in-rack</td>
<td>15</td>
</tr>
<tr>
<td>40</td>
<td>12.2</td>
<td>Class III</td>
<td>19.6 (280) Pendent</td>
<td>Wet</td>
<td>15 + 1 level of in-rack</td>
<td>15</td>
</tr>
<tr>
<td>25</td>
<td>7.6</td>
<td>Class III</td>
<td>11.2 (160) Upright</td>
<td>Wet</td>
<td>15 + 1 level of in-rack</td>
<td>15</td>
</tr>
<tr>
<td>25</td>
<td>7.6</td>
<td>Class III</td>
<td>16.8 (240) Upright</td>
<td>Wet</td>
<td>25 + 1 level of in-rack</td>
<td>15</td>
</tr>
<tr>
<td>25</td>
<td>7.6</td>
<td>Class III</td>
<td>19.6 (280) Pendent</td>
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<td>15 + 1 level of in-rack</td>
<td>15</td>
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<tr>
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<td>7.6</td>
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<tr>
<td>------------------</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11.2 (160) Upright</td>
<td>Wet</td>
<td>15</td>
<td>50</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>16.8 (240) Upright</td>
<td>Wet</td>
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<td>22</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>19.6 (280) Pendent</td>
<td>Wet</td>
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<td>16</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>25.2 (360) Pendent</td>
<td>Wet</td>
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<td>10</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11.2 (160) Upright</td>
<td>Wet</td>
<td>15</td>
<td>1 level of in-rack</td>
<td>50</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td>16.8 (240) Upright</td>
<td>Wet</td>
<td>15</td>
<td>22</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>19.6 (280) Pendent</td>
<td>Wet</td>
<td>15</td>
<td>16</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>25.2 (360) Pendent</td>
<td>Wet</td>
<td>15</td>
<td>10</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11.2 (160) Upright</td>
<td>Wet</td>
<td>20</td>
<td>1 level of in-rack</td>
<td>50</td>
<td>3.4</td>
</tr>
<tr>
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<td>16.8 (240) Upright</td>
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<td>1 level of in-rack</td>
<td>75</td>
<td>5.2</td>
</tr>
<tr>
<td></td>
<td>19.6 (280) Pendent</td>
<td>Wet</td>
<td>20</td>
<td>1 level of in-rack</td>
<td>22</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>19.6 (280) Pendent</td>
<td>Wet</td>
<td>15</td>
<td>1 level of in-rack</td>
<td>35</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>19.6 (280) Pendent</td>
<td>Wet</td>
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<td>25</td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>19.6 (280) Pendent</td>
<td>Wet</td>
<td>15</td>
<td>30</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>25.2 (360) Pendent</td>
<td>Wet</td>
<td>15</td>
<td>23</td>
<td>1.6</td>
<td></td>
</tr>
</tbody>
</table>
21.5.3 *
Exposed unexpanded nonexpanded Group A plastics protected with control mode density/area sprinklers shall be protected in accordance with one of the following: Table 21.5.3.

Table 21.5.3 Control Mode Density/Area Sprinkler Protection Criteria for Exposed Unexpanded Group A Plastics

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Storage height</th>
<th>Maximum Ceiling Height</th>
<th>In-Racks Requirements</th>
<th>Ceiling Sprinklers Density Clearance to Ceiling Up to 10 ft</th>
<th>Ceiling Sprinkler Operating Area</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>ft (m)</td>
<td>ft (m)</td>
<td></td>
<td>gpm/ft² (mm/min)</td>
<td>ft² (m²)</td>
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<tr>
<td>Exposed Unexpanded Group A plastic</td>
<td>10 ft (3.1 m)</td>
<td>20 ft (6.1 m)</td>
<td>Not Required</td>
<td>0.80 gpm/ft² (32.6 mm/min)</td>
<td>2500 ft² (232 m²)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Figure 25.9.3.2(a)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Figure 25.9.3.2(b)</td>
<td>0.45 gpm/ft² (18.3 mm/min)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Figure 25.9.3.2(c)</td>
<td>0.30 gpm/ft² (12.2 mm/min)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15 ft (4.6 m)</td>
<td>25 ft (7.6 m)</td>
<td></td>
<td>0.45 gpm/ft² (18.3 mm/min)</td>
<td>2000 ft² (186 m²)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Figure 25.9.3.2(d)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Figure 25.9.3.2(e)</td>
<td>0.60 gpm/ft² (24.5 mm/min)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Figure 25.9.3.2(f)</td>
<td>0.45 gpm/ft² (18.3 mm/min)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20 ft (6.1 m)</td>
<td>25 ft (7.6 m)</td>
<td></td>
<td>0.80 gpm/ft² (32.6 mm/min)</td>
<td>1500 ft² (139 m²)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Figure 25.9.3.2(g)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Figure 25.9.3.2(h)</td>
<td>0.60 gpm/ft² (24.5 mm/min)</td>
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<tr>
<td></td>
<td></td>
<td>30 ft (9.1 m)</td>
<td></td>
<td>0.30 gpm/ft² (12.2 mm/min)</td>
<td>2000 ft² (186 m²)</td>
</tr>
<tr>
<td></td>
<td>25 ft (7.6 m)</td>
<td>35 ft (10.7 m)</td>
<td></td>
<td>0.80 gpm/ft² (32.6 mm/min)</td>
<td>1500 ft² (139 m²)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Figure 25.9.3.2(i)</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Figure 25.9.3.2(j)</td>
<td>0.30 gpm/ft² (12.2 mm/min)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Figure 25.9.3.2(k)</td>
<td>0.30 gpm/ft² (12.2 mm/min)</td>
<td></td>
</tr>
</tbody>
</table>

Maximum 10 ft (3.0 m) storage in a maximum 20 ft (6.1 m) high building with ceiling sprinklers designed for a minimum 0.8 gpm/ft² (32.6 mm/min) density over 2500 ft² (232 m²) and no in-rack sprinklers required as shown in Figure 17.2.1.4(a).

Maximum 10 ft (3.0 m) storage in a maximum 20 ft (6.1 m) high building with ceiling sprinklers designed for a minimum 0.45 gpm/ft² (18.3 mm/min) density over 2000 ft² (186 m²) and one level of in-rack sprinklers required at alternate transverse flues as shown in Figure 17.2.1.4(b).

Maximum 10 ft (3.0 m) storage in a maximum 20 ft (6.1 m) high building with ceiling sprinklers designed for a minimum 0.3 gpm/ft² (12.2 mm/min) density over 2000 ft² (186 m²) and one level of in-rack sprinklers required in every transverse flue as shown in Figure 17.2.1.4(c).

Maximum 15 ft (4.6 m) storage in a maximum 25 ft (7.6 m) high building with ceiling sprinklers designed for a minimum 0.45 gpm/ft² (18.3 mm/min) density over 2000 ft² (186 m²) and one level of in-rack sprinklers required at alternate transverse flues as shown in Figure 17.2.1.4(d).

Maximum 15 ft (4.6 m) storage in a maximum 25 ft (7.6 m) high building with ceiling sprinklers...
designed for a minimum 0.3 gpm/ft² (12.2 mm/min) density over 2000 ft² (186 m²) and one level of in-rack sprinklers required in every transverse flue as shown in Figure 17.2.1.4(e).

Maximum 20 ft (6.1 m) storage in a maximum 25 ft (7.6 m) high building with ceiling sprinklers designed for a minimum 0.6 gpm/ft² (24.4 mm/min) density over 2000 ft² (186 m²) and one level of in-rack sprinklers required at alternate transverse flues as shown in Figure 17.2.1.4(f).

Maximum 20 ft (6.1 m) storage in a maximum 25 ft (7.6 m) high building with ceiling sprinklers designed for a minimum 0.45 gpm/ft² (18.3 mm/min) density over 2000 ft² (186 m²) and one level of in-rack sprinklers required at alternate transverse flues as shown in Figure 17.2.1.4(g).

Maximum 20 ft (6.1 m) storage in a maximum 30 ft (9.1 m) high building with ceiling sprinklers designed for a minimum 0.8 gpm/ft² (32.6 mm/min) density over 1500 ft² (139 m²) and one level of in-rack sprinklers required at alternate transverse flues as shown in Figure 17.2.1.4(h).

Maximum 20 ft (6.1 m) storage in a maximum 30 ft (9.1 m) high building with ceiling sprinklers designed for a minimum 0.6 gpm/ft² (24.4 mm/min) density over 1500 ft² (139 m²) and one level of in-rack sprinklers required in every transverse flue as shown in Figure 17.2.1.4(i).

Maximum 20 ft (6.1 m) storage in a maximum 30 ft (9.1 m) high building with ceiling sprinklers designed for a minimum 0.3 gpm/ft² (12.2 mm/min) density over 2000 ft² (186 m²) and two levels of in-rack sprinklers required in every transverse flue as shown in Figure 17.2.1.4(j).

Maximum 25 ft (7.6 m) storage in a maximum 35 ft (11 m) high building with ceiling sprinklers designed for a minimum 0.8 gpm/ft² (32.6 mm/min) density over 1500 ft² (139 m²) and one level of in-rack sprinklers required in every transverse flue as shown in Figure 17.2.1.4(k).

Maximum 25 ft (7.6 m) storage in a maximum 35 ft (11 m) high building with ceiling sprinklers designed for a minimum 0.3 gpm/ft² (12.2 mm/min) density over 2000 ft² (186 m²) and two levels of in-rack sprinklers required in every transverse flue as shown in Figure 17.2.1.4(l).

**Figure 21.5.1.5(a)** Exposed Nonexpanded Group A Plastic Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building with No In-Rack Sprinklers.

**Figure 21.5.1.5(b)** Exposed Nonexpanded Group A Plastic Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building with One Level of In-Rack Sprinklers.
Figure 21.5.1.5(c) Exposed Nonexpanded Group A Plastics Up to 10 ft (3.0 m) in Height in Up to a 20 ft (6.1 m) High Building with One Level of Closely Spaced In-Rack Sprinklers.

Figure 21.5.1.5(d) Exposed Nonexpanded Group A Plastics Up to 15 ft (4.6 m) in Height in Up to a 25 ft (7.6 m) High Building with One Level of In-Rack Sprinklers.
Figure 21.5.1.5(e) Exposed Nonexpanded Group A Plastics Up to 15 ft (4.6 m) in Height in Up to a 25 ft (7.6 m) High Building with One Level of Closely Spaced In-Rack Sprinklers.

Figure 21.5.1.5(f) Exposed Nonexpanded Group A Plastics Up to 20 ft (6.1 m) in Height in Up to a 25 ft (7.6 m) High Building with One Level of In-Rack Sprinklers.
Figure 21.5.1.5(g) Exposed Nonexpanded Group A Plastics Up to 20 ft (6.1 m) in Height in Up to a 25 ft (7.6 m) High Building with One Level of Closely Spaced In-Rack Sprinklers.

Figure 21.5.1.5(h) Exposed Nonexpanded Group A Plastics Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building with One Level of In-Rack Sprinklers.
Figure 21.5.1.5(i) Exposed Nonexpanded Group A Plastics Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building with One Level of Closely Spaced In-Rack Sprinklers.

Figure 21.5.1.5(j) Exposed Nonexpanded Group A Plastics Up to 20 ft (6.1 m) in Height in Up to a 30 ft (9.1 m) High Building with Two Levels of Closely Spaced In-Rack Sprinklers.
Figure 21.5.1.5(k) Exposed Nonexpanded Group A Plastics Up to 25 ft (7.6 m) in Height in Up to a 35 ft (10.7 m) High Building with One Level of Closely Spaced In-Rack Sprinklers.

Figure 21.5.1.5(l) Exposed Nonexpanded Group A Plastics Up to 25 ft (7.6 m) in Height in Up to a 35 ft (10.7 m) High Building with Two Levels of Closely Spaced In-Rack Sprinklers.
The 2013 and 2016 NFPA 13 Standard Figure 17.2.1.4 (j) is in error as it shows the highest level of in-rack sprinklers above the top tier of storage. All other figures provided in the standard show that in-rack sprinklers are never installed above the top tier of storage. Ceiling-level sprinklers provide the protection above the top tier of storage. How effective could this in-rack sprinkler be when located above the top tier of storage? Therefore, as two levels of in-rack sprinklers are required per section 17.2.1.4 (10), I recommend the two levels be shown at the 10-foot and 15-foot levels.

This PI recommends that the two levels of in-rack sprinklers be shown at the 10 and 15 ft tier levels as opposed to at the 10 and 20 ft tier levels since the storage is only 20 ft high.
Note: Sprinklers labeled 1 and 3, 2 and 3, or 2 and 4 shall be required when the storage height exceeds 15 ft (4.6 m) but does not exceed 20 ft (6.1 m).
First Revision No. 794-NFPA 13-2016 [Section No. 17.2.2.1 [Excluding any Sub-Sections]]
Protection of single-, double-, and multiple-row rack storage for nonexpanded 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

<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Commodity Class</th>
<th>Maximum Storage Height</th>
<th>Maximum Ceiling/Roof Height</th>
<th>K-Factor/Orientation</th>
<th>Type of System</th>
<th>Number of Design Sprinklers</th>
<th>Min Ope Pressure psi</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ft  m</td>
<td>ft  m</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>30 9.1</td>
<td>11.2 (160) Upright 16.8 (240) Upright 19.6 (280) Pendent</td>
<td>Wet</td>
<td>15</td>
<td>50</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25 7.6</td>
<td>30 9.1</td>
<td>11.2 (160) Upright 16.8 (240) Upright 19.6 (280) Pendent</td>
<td>Wet</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25 7.6</td>
<td>35 11</td>
<td>11.2 (160) Upright 16.8 (240) Upright 19.6 (280) Pendent</td>
<td>Wet</td>
<td>30+1 level of in-rack</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20 6.1</td>
<td>25 7.6</td>
<td>11.2 (160) Upright 16.8 (240) Upright</td>
<td>Wet</td>
<td>15</td>
<td>50</td>
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<tr>
<td></td>
<td></td>
<td>20 6.1</td>
<td>30 9.1</td>
<td>11.2 (160) Upright 16.8 (240) Upright</td>
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<td>75</td>
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<td></td>
<td>25 7.6</td>
<td>30 9.1</td>
<td>11.2 (160) Upright 16.8 (240) Upright</td>
<td>Wet</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25 7.6</td>
<td>35 11</td>
<td>11.2 (160) Upright 16.8 (240) Upright</td>
<td>Wet</td>
<td>30+1 level of in-rack</td>
<td>50</td>
</tr>
<tr>
<td>Exposed nonexpanded plastics</td>
<td></td>
<td>25 7.6</td>
<td>30 9.1</td>
<td>11.2 (160) Upright 16.8 (240) Upright</td>
<td>Wet</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td>Storage Arrangement</td>
<td>Commodity Class</td>
<td>Maximum Storage Height</td>
<td>Maximum Ceiling/Roof Height</td>
<td>K-Factor/Orientation</td>
<td>Type of System</td>
<td>Number of Design Sprinklers</td>
<td>Min Ope Pres psi</td>
</tr>
<tr>
<td>---------------------</td>
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<td></td>
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<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td></td>
<td>Wet</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Wet</td>
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<tr>
<td></td>
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<td></td>
<td>Wet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16.8 (240) Upright</td>
<td>Wet</td>
</tr>
</tbody>
</table>

*Minimum 8 ft (2.4 m) aisle.

**Supplemental Information**

**File Name**: FR_794_Table_17.2.2.1.xlsx  
**Description**: Added K25 sprinklers to table. For staff use.

**Submitter Information Verification**

**Submitter Full Name**: AUT-SSD  
**Organization**: National Fire Protection Assoc  
**Street Address**:  
**City**:  
**State**:  
**Zip**:  
**Submittal Date**: Tue Aug 16 17:23:25 EDT 2016

**Committee Statement**

**Committee Statement**: Adds K-25.2 sprinkler per test data presented to committee

**Response Message**: 
23.7.4.1
The maximum sprinkler deflector distance below the ceiling shall be 14 in. (350 mm).

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 16 16:09:07 EDT 2016

Committee Statement

Committee Statement: The research supporting this design criteria was done with 14 inch deflector distance from the ceiling.

This is the distance used in the testing program. The allowance of up to 18 inches currently associated with the sprinklers has not justified by the tests.

Response Message:
Public Input No. 459-NFPA 13-2016 [New Section after 17.2.3.5.4]
17.3.2.3
The design area shall be a rectangular area having a dimension parallel to the branch lines at least 1.2 times the square root of the area protected by the number of sprinklers to be included in the design area. Any fractional sprinkler shall be included in the design area.

Submitter Information Verification
Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Tue Aug 16 16:10:31 EDT 2016

Committee Statement
Committee Statement: The statement contradicts section 23.4.4.3.1. You are not supposed to use the area actually protected by the number of sprinklers in the design area, instead, you are supposed to base the shape of the design area on the MAXIMUM allowable area of coverage for the sprinklers. For example, consider a situation where 15 sprinklers are in the design area and you are allowed to space the CMSA sprinklers at 130 sq ft per sprinkler, but the sprinklers are actually only spaced at 100 sq ft per sprinkler. To determine the number of sprinklers on a branch line, you are required by 23.4.4.3.1 to take 1.2 times the square root of 1950 sq ft, not 1.2 times the square root of 1500 sq ft. The difference is usually one sprinkler with 6 sprinklers along the branch line if you do it correctly and 5 sprinklers along the branch line if you do it incorrectly.

Response
Message: Public Input No. 175-NFPA 13-2016 [Section No. 17.3.2.3]
24.3.3 Protection of Class I through Class IV and cartoned unexpanded nonexpanded plastic commodities stored on single-, double-, or multiple-row racks without solid shelves or solid-piled, palted, shelf, or bin-box storage arrangements shall be permitted to be protected in accordance with Table 24.3.3.

Table 24.3.3 CMSA K-25.2 Upright Pendant Standard Coverage Sprinkler Design Criteria for Single-, Double-, and Multiple-Row Racks Without Solid Shelves and Solid-Piled, Palted Storage Arrangement of Class I Through IV and Cartoned Unexpanded Nonexpanded Plastic Commodities

<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Commodity Class</th>
<th>Maximum Storage Height</th>
<th>Maximum Ceiling/ Roof Height</th>
<th>K-Factor Orientation</th>
<th>System Type</th>
<th>Number of Design Sprinklers</th>
<th>Minimum Operating Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid-piled, palletized, and single-, double-, and multiple-row racks without solid shelves (no open top containers)</td>
<td>Class I–IV encapsulated and nonencapsulated, and cartoned nonexpanded plastics</td>
<td>25</td>
<td>7.6</td>
<td>30</td>
<td>9.1</td>
<td>25.2 (360) Upright Pendant</td>
<td>Wet</td>
</tr>
</tbody>
</table>

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 16 18:21:38 EDT 2016

Committee Statement

Committee Statement: This testing was done with pendant sprinklers, not upright sprinklers. The table was mislabeled when it was put into the 2016 Edition of the standard. Supporting information is available on the NFPA 13 2016 Edition TerraView.

Replace the word "upright" with "pendent" both in the title of Table 21.3.3 as well as within this table.

Response Message:

Public Input No. 102-NFPA 13-2016 [Section No. 21.3.3]
24.6 In-Rack Sprinkler Protection Criteria for Open-Frame Rack Storage of Class I Through Class IV and Plastic Commodities.

24.6.1 Protection of closed-top Class I through Class IV and plastic commodities stored on single-, double-, or multiple-row racks without solid shelves shall be permitted to be protected in accordance with this section.

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

24.6.3 In-rack sprinklers shall be standard-coverage, quick-response, pendent, and 160°F (70°C) nominally rated.

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

24.6.3.2 Minimum K-22.4 (K-320) sprinklers shall be installed where the minimum required flow exceeds 100 gpm (380 L/min).
Depending on the type of storage rack being protected, in-rack sprinklers shall be positioned horizontally in accordance with Figure 24.6.4(a) through Figure 24.6.4(f) and the following:

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

2. Except as shown in Figure 24.6.4(c), all in-rack sprinklers shall be located within the footprint of the rack structure.

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

Figure 24.6.4(a) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Single-Row Racks Up to 3 ft (0.9 m) Deep.

Figure 24.6.4(b) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Single-Row Racks Up to 6 ft (1.8 m) Deep.

Figure 24.6.4(c) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Single-Row Racks Up to 6 ft (1.8 m) Deep Located Against a Wall.

Figure 24.6.4(d) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Double-Row Racks Up to 9 ft (2.7 m) Deep.

Figure 24.6.4(e) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Double-Row Racks Up to 12 ft (3.7 m) Deep.

Figure 24.6.4(f) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Multiple-Row Racks.
24.6.5

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

24.6.5.1

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

24.6.5.2

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

24.6.6

Regardless of the number of in-rack sprinkler levels installed, the number of sprinkler levels for the in-rack sprinkler system design shall be based on the single most hydraulically remote in-rack sprinkler level and the minimum number of in-rack sprinklers for this level in accordance with Table 24.6.6.

Table 24.6.6 Number of Sprinklers in the In-Rack Sprinkler Design

<table>
<thead>
<tr>
<th>IRAS Installation Arrangement; Figure</th>
<th>Number of Sprinklers in the In-Rack Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-row racks up to 3 ft (0.9 m) Deep; Figure 21.6.4(a)</td>
<td>Class I through IV Cartoned Plastics</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Single-row racks up to 6 ft (1.8 m) deep; Figures 21.6.4(b) and 21.6.4(c)</td>
<td>5</td>
</tr>
<tr>
<td>Double- and multiple-row racks; Figures 21.6.4(e) and 21.6.4(f)</td>
<td>6</td>
</tr>
</tbody>
</table>

*This represents 6 sprinklers in the most remote rack as well as 6 sprinklers in the nearest adjacent rack. See Figures 21.6.4(d), 21.6.4(e) and 21.6.4(f) to determine which 6 sprinklers to account for in the in-rack sprinkler design for double- and multiple-row racks.
The minimum flow required in the system design shall be from the most remote in-rack sprinkler in accordance with Table 24.6.7.

Table 24.6.7 Minimum Flow in the In-Rack Sprinkler Design

<table>
<thead>
<tr>
<th>Maximum Vertical IRAS Installation Increment, ft (m)</th>
<th>Commodity Hazard</th>
<th>Min. K-Factor</th>
<th>Minimum Flow from Most Remote IRAS, gpm (L/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 (9.1)</td>
<td>Class I through IV and cartoned nonexpanded plastic</td>
<td>14.0 (200)</td>
<td>65 (250)</td>
</tr>
<tr>
<td></td>
<td>Cartoned expanded plastic</td>
<td>14.0 (200)</td>
<td>100 (380)</td>
</tr>
<tr>
<td></td>
<td>Exposed plastic</td>
<td>22.4 (320)</td>
<td>120 (455)</td>
</tr>
<tr>
<td>40 (12.2)</td>
<td>Class I through IV and cartoned nonexpanded plastic</td>
<td>22.4 (320)</td>
<td>121 (455)</td>
</tr>
</tbody>
</table>

A hose stream allowance of 250 gpm (950 L/min) shall be included as part of the in-rack sprinkler system design obtained from Section 24.6.

The water supply requirements obtained from Section 24.6 shall be available for a minimum of 60 minutes.

The water supply for the in-rack sprinkler system shall be capable of providing the required in-rack sprinkler system design obtained from Section 24.6, independent of the design requirements of the ceiling sprinkler system protecting this same area.

The ceiling sprinkler system shall be designed and installed in accordance with the guidelines outlined in Chapters 16 or 17, depending on the commodity hazard, except as modified in Section 24.6.

Where the in-rack sprinkler system is designed and installed in accordance with Section 24.6, the top level of in-rack sprinklers shall be considered to be a floor for design purposes of the ceiling sprinkler system.

As a result, the storage height above the top level of in-rack sprinklers shall be permitted to be in excess of 10 ft (3.0 m).

The water supply for the ceiling system shall be capable of providing the required ceiling sprinkler system design obtained from either Chapter 16 or Chapter 17 independent of the design requirements of the in-rack sprinkler system obtained from Section 24.6 and protecting this same area.

Supplemental Information

<table>
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<th>Description</th>
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Submitter Information Verification
<table>
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<td>This is new guidance for in-rack sprinkler protection that utilizes ESFR sprinklers as in-racks and eliminates the need for hydraulic balancing of the in-rack sprinkler system with the ceiling sprinkler system. Support for this public input has been provided in a separate document.</td>
</tr>
</tbody>
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<table>
<thead>
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<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Message:</td>
</tr>
</tbody>
</table>
22.4.1.1 The automatic sprinkler system shall be a wet pipe system, a dry pipe system, a preaction system, or an open-head sprinkler deluge system, whichever is most appropriate for the portion of the spray operation being protected. [33:9.4.1]

Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global

22.4.1.6(1)(a) An open head sprinkler deluge system designed to discharge a minimum density of 24.4 mm/min (0.6 gpm/ft²)

Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global

22.4.2.1(3) Sprinklers shall provide a minimum flow of 114 L/min (30 gpm) per head sprinkler at a minimum of 1 bar (15 psi) pressure.

Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global
22.4.2.1.2
Sprinkler systems protecting stacks and ducts that are subject to freezing shall be of a nonfreezing type or be a manually controlled open-head sprinkler system. [33:9.4.6.2]

Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global

Public Input
22.7.1.4.2 High-velocity open head nozzles each capable of providing a discharge rate of 1.26 L/sec (20 gpm) at a gauge pressure of 345 kPa (50 psi) shall be installed. [40:6.5.6.2]

Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global

Public Input
22.7.2.1 In areas or rooms where nitrate film is handled, the area that is protected per sprinkler head shall not exceed 64 ft\(^2\) (6 m\(^2\)) with sprinklers not being more than 8 ft (2.4 m) apart. [40:5.1.4]

Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global

Public Input
22.7.2.2.1 Cabinets having a capacity of more than 34 kg (75 lb), or 15 standard rolls, of film shall be provided with at least one automatic sprinkler head. [40:6.2.5.1]
**Statement of Problem and Substantiation for Public Input:** The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

**Submitter and Organization:** Wes Baker of FM Global

**Public Input**

22.7.2.3 **Motion Picture Film Laboratories.** In all cases, sprinklers shall be arranged so that not more than two machines are protected by any one sprinkler head. [40:9.2.5.2]

**Statement of Problem and Substantiation for Public Input:** The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

**Submitter and Organization:** Wes Baker of FM Global

**Public Input**

22.16.2.3 Where sprinklers are selected for the protection of ovens, furnaces, or related equipment, the use of closed-head sprinkler systems shall be prohibited and only deluge sprinkler systems shall be used where the following conditions exist:

**Statement of Problem and Substantiation for Public Input:** The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

**Submitter and Organization:** Wes Baker of FM Global

**Public Input**

22.21.1.1.1 Because the counterflow tower design lends itself to either closed- or open-head sprinkler systems, the following systems shall be permitted to be used:

**Statement of Problem and Substantiation for Public Input:** The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

**Submitter and Organization:** Wes Baker of FM Global
The open-head sprinkler deluge system shall be used in crossflow towers to maximize the water distribution and heat detection activation. [214:5.2.2.2]

**Statement of Problem and Substantiation for Public Input:** The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

**Submitter and Organization:** Wes Baker of FM Global

Closed-head sprinkler discharge outlets for dry-pipe and preaction systems shall be installed in the upright position only. [214:5.2.4.1.3]

**Statement of Problem and Substantiation for Public Input:** The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

**Submitter and Organization:** Wes Baker of FM Global

Where remote manual release valves are not required, an inspector’s test valve shall be provided for each pilot-head operated system. [214:5.2.6.2.2]

**Statement of Problem and Substantiation for Public Input:** The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

**Submitter and Organization:** Wes Baker of FM Global

The maximum coverage per sprinkler head shall be limited to 80 ft² (7.5 m²).
**Statement of Problem and Substantiation for Public Input:** The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

**Submitter and Organization:** Wes Baker of FM Global

**Public Input**

22.35.1.3.5(2)

The water supply shall be capable of supplying a constant flow of water with all heads sprinklers functioning for a period of 10 minutes.

**Statement of Problem and Substantiation for Public Input:** The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

**Submitter and Organization:** Wes Baker of FM Global

**Public Input**

22.35.1.3.5(3) The sprinkler head activation temperature shall not be less than 65.6°C (150°F) or greater than 148.9°C (300°F). [120:9.4.6.13]

**Statement of Problem and Substantiation for Public Input:** The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

**Submitter and Organization:** Wes Baker of FM Global

**Public Input**

22.35.2.1.1 Deluge water spray systems, foam systems, closed-head sprinkler systems, or dry-chemical systems automatically actuated by rise in temperature shall be installed at main and secondary belt conveyor drives. [120:9.4.6.1]

**Statement of Problem and Substantiation for Public Input:** The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.
Submitter and Organization: Wes Baker of FM Global

Public Input

22.35.2.1.3 Piping for the deluge, foam, or closed-head sprinkler system shall be metal and listed for sprinkler applications. [120:9.4.6.3]

Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global

Public Input

22.35.2.1.7.5

A closed sprinkler head shall be used over the electrical controls. [120:9.4.6.11.3]

Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global

Public Input

22.36.1.3.5 As exposure protection, automatic water-only deluge (open-head) sprinkler systems shall be provided between mixer-settler trains if spaced closer than 15.24 m (50 ft) from each other. [122:13.19.2]

Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global

Public Input

22.37.1.3.3
Where required for detached storage buildings containing Class I organic peroxide formulations in quantities exceeding 2000 lb (907 kg), automatic sprinkler protection shall be open-head deluge-type, designed and installed in accordance with NFPA 13. [400:14.2.6.3]

Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global

Public Input

Figure 22.37.1.4.4.4(A) Sprinkler head-(located in the figure)

Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global

Public Input

A.9.2.1.3.3.4 An example of language for the label is as follows:

CAUTION: DO NOT REMOVE THIS LABEL.

Relocation of this device should only be performed by qualified and/or licensed individuals that are aware of the original system design criteria, hydraulic criteria, sprinkler head-listing parameters, and knowledge of the state and local codes including NFPA 13 installation standards. Relocation of the device without this knowledge could adversely affect the performance of this fire protection and life safety system.

Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global

Public Input
A.12.6 The higher flow rate of the K-16.8 sprinkler results in greater friction losses in the initial operating heads sprinklers as compared to the K-8 sprinkler. Combined with the lower pressure available on the water supply curve, the end result is a self-regulating K-factor allowing greater initial pressures without a negative impact.

The ability to use lower-rated temperatures, such as 155°F (68°C) in lieu of 286°F (141°C), shows that the performance of the initial operating sprinklers is effective in controlling the fire. Therefore, using high-temperature heads sprinklers to reduce the number of surrounding rings of sprinklers to open is not necessary when using the K-16.8 technology.

Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global

Public Input

A.22.4.1.1 Spray application operations should be located only in buildings that are completely protected by an approved system of automatic sprinklers. If the operations are located in unsprinklered buildings, sprinklers should be installed to protect spray application processes where practical. Because of the rapidity and intensity of fires that involve spray operations, the available water should be ample to simultaneously supply all sprinkler heads likely to open in one fire without depleting the available water for use by hose streams. Noncombustible draft curtains can be used to limit the number of sprinklers that will open.

Even when areas adjacent to coating operations are considered under reasonably positive fire control by adequate automatic sprinkler protection, damage is possible if operations are conducted on floors above those containing contents that are highly susceptible to water damage. Waterproofing and drainage of spray room floors can assist in reducing water damage on floors below. Proper drainage of the large volume of water frequently necessary to extinguish spray finishing room fires often presents considerable difficulty. [33: A.9.4]

Automatic sprinklers in spray areas, including the interior of spray booths and exhaust ducts, should be wet pipe, preaction, or deluge system so that water can be placed on the fire in the shortest possible time. Automatic sprinklers in spray booths and exhaust ducts should be of the lowest practical temperature rating. The delay in application of water with ordinary dry pipe sprinklers can permit a fire to spread so rapidly that final extinguishment is difficult without extensive resulting damage.

The location of the sprinkler's heads inside spray booths should be selected with care in order to avoid heads sprinklers being placed in the direct path of spray and yet afford protection for the entire booth interior. When sprinkler's heads are in the direct path of spray, even one day’s operation can result in
deposits on the sprinkler heads that insulate the fusible link or choke open head sprinkler orifices to the extent that sprinklers cannot operate efficiently.

Automatic sprinklers should also be located so that areas subject to substantial accumulations of overspray residue are protected. Generally, sprinklers are located no more than 4 ft (1.2 m) from side walls of booths and rooms and from dry overspray collectors (where applicable). Sprinklers in booths or rooms should be on Extra Hazard Occupancy spacing of 90 ft² (8.4 m²).

All sprinklers in spray areas should be controlled by an accessible control valve, preferably an outside stem and yoke (OS&Y) valve. [33: A.9.4]

**Statement of Problem and Substantiation for Public Input:** The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

**Submitter and Organization:** Wes Baker of FM Global

**Public Input**

A.22.4.2.1 Subsection 22.4.1.1 lists four types of automatic sprinkler systems and requires that the one “most appropriate for the portion of the spray area being protected” be used. Generally, an open-head sprinkler deluge system provides the highest level of protection, given that all sprinklers in the protected area flow simultaneously. This type of system is most appropriate for large, downdraft, water-wash spray booths when protecting automatic electrostatic spray application zones.

Wet pipe automatic sprinkler systems are appropriate for protecting spray booths that utilize nonelectrostatic application processes or operations using listed electrostatic application processes. Wet pipe systems are also generally used to protect exhaust plenums (eliminator or scrubber sections), exhaust ducts, and air recirculation filter houses.

Dry pipe systems have been included because some exhaust duct designs include sections that are subject to freezing.

Preaction systems have been included because some spray application processes and equipment can be damaged by unwanted water discharge. This damage can be disruptive and costly. Powder spray booths and solvent concentrator (air pollution abatement) systems are examples of systems where it is appropriate to use a preaction system. [33: A.9.4.1]

Water supply requirements for most industrial paint spray operations should be adequate to supply all automatic sprinklers in the spray area. Loss experience has shown that fires starting in the exhaust duct can spread to the spray booth and that fires starting in the booth can spread to the exhaust duct.

Sprinklers or sprinkler systems protecting stacks or ducts should be of a type not subject to freezing. Automatic systems are preferred, but manual systems are also acceptable. For some industries, such as the automotive industry, manually operated open-head sprinkler systems have proved to be effective protection for ducts and stacks. [33: A.9.4.6]
Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global

Public Input

A.22.7.1.3 See Figure A.22.7.1.3. The illustration shows the location of sprinklers' heads and the decomposition vent. [40:A.6.3]

Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global

Public Input

A.22.14.2.1 In facilities that are under the supervision of an operator or other person familiar with the equipment, during all periods that equipment is energized, the normal delay between the initial outbreak of a fire and the operation of a sprinkler system will provide adequate time for operators to shut down the power by use of the electrical disconnecting means as prescribed in Section 10.4 of NFPA 75. In other instances where a fire can operate sprinklers' heads before discovery by personnel, a method of automatic detection should be provided to automatically de-energize the electronic equipment as quickly as possible.

To minimize damage to electronic computer equipment located in sprinkler-protected areas, it is important that power be off prior to the application of water on the fire. [75: A.8.1.2]

Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global

Public Input

A.22.17.1.8
Experience has shown that, when water is discharged through conventional sprinklers heads into a hyperbaric atmosphere, the spray angle is reduced because of increased resistance to water droplet movement in the denser atmosphere. This is so, even though the water pressure differential is maintained above chamber pressure. Therefore, it is necessary to compensate by increasing the number of sprinklers heads. It is recommended that spray coverage tests be conducted at maximum chamber pressure.

Some chamber configurations, such as small-diameter horizontal cylinders, could have a very tiny floor, or even no floor at all. For horizontal cylinder chambers and spherical chambers, floor level should be taken to mean the level at 1/4 diameter below the chamber centerline or actual floor level, whichever yields the larger floor area. [99: A.14.2.5.2.6]

**Statement of Problem and Substantiation for Public Input:** The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

**Submitter and Organization:** Wes Baker of FM Global

**Public Input**

A.22.22.1.2.1(B)(5) The use of firestops for draft control (e.g., to bank heat, facilitate the opening of sprinklers heads, and prevent the overtaxing of the sprinkler system) is particularly important in the design of sprinkler protection for combustible substructures. The fire walls and firestops of 4.3.3.4 and 4.3.3.5 of NFPA 307 should be incorporated into the sprinkler system design for draft control to the maximum extent practical; however, due to limitations in the size of the design area for the sprinkler system, additional firestops normally are needed. These additional or supplemental firestops need only have limited fire resistance, but they should be as deep as possible and be of substantial construction, such as double 3 in. (75 mm) planking, where exposed to the elements. Where not exposed to the possibility of physical damage, 3/4 in. (20 mm) treated plywood extending 48 in. (1.2 m) below stringers with solid blocking between stringers should provide adequate durability and reasonable effectiveness. [307: A.4.3.3.1.3.1(B)(5)]

**Statement of Problem and Substantiation for Public Input:** The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

**Submitter and Organization:** Wes Baker of FM Global

**Public Input**

A.22.36.1.3.3
The following best practices design guidance for automatic fire suppression systems is advised: For settler tanks or cells, use either Type 1 foam chambers or open head deluge sprinklers with foam discharge. When using foam chambers, provide a 3 percent aqueous filmforming foam (AFFF) foam discharge, in accordance with NFPA 11, with a density of 4.1 L/min/m² (0.1 gpm/ft²) over the entire settler area. When using open head deluge sprinklers, provide a 3 percent AFFF foam discharge, in accordance with NFPA 16, with a density of 6.5 L/min/m² (0.16 gpm/ft²). Design for a 20-minute discharge period.

For mixers, launders, drainage sumps, and piping trenches, use open head deluge sprinklers and provide a 3 percent AFFF foam discharge, in accordance with NFPA 16, with a density of 6.5 L/min/m² (0.16 gpm/ft²) and a 20-minute foam discharge period.

For the interior of tank farm vessels containing combustible or flammable liquids such as loaded organic tanks, coalescers, crud treatment tanks, and diluent tanks use a Type 1 foam chamber and provide a 3 percent automatic AFFF foam discharge, in accordance with NFPA 11, into each of the tanks with a density of 4.1 L/min/m² (0.1 gpm/ft²) and a 20-minute foam discharge period.

For the exterior surfaces of tank farm equipment containing combustible or flammable liquids such as loaded organic tanks, coalescers, crud treatment tanks, diluent tanks, crud treatment filters, centrifuges, pumps, and pipe racks, provide automatic open head (water only) deluge sprinklers based on a discharge density of 10.2 L/min/m² (0.3 gpm/ft²). [122: A.13.19.1.2]

Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global

Public Input

A.22.36.1.3.4

Actuation of automatic fire suppression systems can be done using ultraviolet/infrared (UV/IR) dual spectrum detectors, heat detection cable, rate of rise heat detectors, or standard air pilot heads sprinklers. High speed detection is considered advisable to suppress a solvent fire in its incipient stages. [122: A.13.19.1.3]

Statement of Problem and Substantiation for Public Input: The term “head” is no longer used within NFPA 13 as a description of a sprinkler and should be modified to be properly reflected in the indicated text.

Submitter and Organization: Wes Baker of FM Global
21.6 In-Rack Sprinkler Protection Criteria for Open-Frame Rack Storage of Class I Through Class IV and Plastic Commodities

21.6.1 Protection of closed-top Class I through Class IV and plastic commodities stored on single-, double-, or multiple-row racks without solid shelves shall be permitted to be protected in accordance with this section.

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

21.6.3 In-rack sprinklers shall be standard-coverage, quick-response, pendent, and 160°F (70°C) nominally rated. Install minimum K-14.0 (K-200) sprinklers when the minimum required flow is 100 gpm (380 L/min) or less. Install minimum K-22.4 (K-320) sprinklers when the minimum required flow exceeds 100 gpm (380 L/min).

21.6.4 Position in-rack sprinklers horizontally in accordance with Figures 21.6.4(a) through 21.6.4(f), depending on the type of storage rack being protected. The minimum horizontal distance between in-rack sprinklers is 27 in. (700 mm) with the maximum horizontal distance being 4.5 ft (1.4 m) unless shown otherwise in the applicable figures. Except as shown in Figure 21.6.4(c), locate all in-rack sprinklers within the footprint of the rack structure. Position all face sprinklers so that the horizontal distance between (1) the face of the storage rack, and (2) the outer edge of storage, if it protrudes into the storage aisle, does not exceed 18 in. (450 mm).

Figure 21.6.4(a) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Single-Row Racks up to 3 ft (0.9 m) Deep
Figure 21.6.4(b) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Single-Row Racks up to 6 ft (1.8 m) Deep

Figure 21.6.4(c) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Single-Row Racks up to 6 ft (1.8 m) Deep Located Against a Wall

Figure 21.6.4(d) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Double-Row Racks up to 9 ft (2.7 m) Deep

Figure 21.6.4(e) Plan View of In-Rack Sprinkler Arrangement for Open-Frame Double-Row Racks up to 12 ft (3.7 m) Deep
21.6.5 The maximum allowable vertical distance between in-rack sprinklers for cartoned expanded plastics, uncartoned unexpanded plastics and uncartoned expanded plastics is 30 ft (9.1 m). The maximum allowable vertical distance between in-rack sprinklers for Class I through Class IV and cartoned unexpanded plastics is 40 ft (12.2 m). Maintain a minimum 6 in. (150 mm) vertical distance between the top of storage and the in-rack sprinkler deflector.

21.6.6 Regardless of the number of in-rack sprinkler levels installed, base the number of sprinkler levels for the in-rack sprinkler system design on the single most hydraulically remote in-rack sprinkler level and the minimum number of in-rack sprinklers for this level per Table 21.6.6.

Table 21.6.6 Number of Sprinklers in the In-Rack Sprinkler Design

<table>
<thead>
<tr>
<th>IRAS Installation Arrangement; Figure</th>
<th>Number of Sprinklers in the In-Rack Design</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class I through IV and Cartoned Plastics</td>
</tr>
<tr>
<td>Single-row racks up to 3 ft (0.9 m) deep; 21.6.4(a)</td>
<td>4</td>
</tr>
<tr>
<td>Single-row racks up to 6 ft (1.8 m) deep; 21.6.4(b) and 21.6.4(c)</td>
<td>5</td>
</tr>
<tr>
<td>Double- and Multiple-row racks; 21.6.4(d), 21.6.4(e) and 21.6.4(f)</td>
<td>6</td>
</tr>
</tbody>
</table>

*This represents 6 sprinklers in the most remote rack as well as 6 sprinklers in the nearest adjacent rack.
See Figures 21.6.4(d), 21.6.4(e) and 21.6.4(f) to determine which 6 sprinklers to account for in the in-rack sprinkler design for double- and multiple-row racks.

21.6.7 Base the minimum flow required in the system design from the most remote in-rack sprinkler per Table 21.6.7.

<table>
<thead>
<tr>
<th>Max. Vertical IRAS Installation Increment, ft (m)</th>
<th>Commodity Hazard</th>
<th>Min. K-factor</th>
<th>Min. Flow from Most Remote IRAS, gpm (L/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 (9.1)</td>
<td>Class I through IV and Carton Unexpanded Plastic</td>
<td>14.0 (200)</td>
<td>65 (250)</td>
</tr>
<tr>
<td></td>
<td>Cartoned Expanded Plastic</td>
<td>14.0 (200)</td>
<td>100 (380)</td>
</tr>
<tr>
<td></td>
<td>Uncartoned Plastics</td>
<td>22.4 (320)</td>
<td>120 (455)</td>
</tr>
<tr>
<td>40 (12.2)</td>
<td>Class I through IV and Carton Unexpanded Plastic</td>
<td>22.4 (320)</td>
<td>120 (455)</td>
</tr>
</tbody>
</table>

21.6.8 Include a hose stream allowance of 250 gpm (950 L/min) as part of the in-rack sprinkler system design obtained from this section.

21.6.9 The water supply requirements obtained from this section shall be available for a minimum of 60 minutes.

21.6.10 The water supply for the in-rack sprinkler system shall be capable of providing the required in-rack sprinkler system design obtained from this section independent of the design requirements of the ceiling sprinkler system protecting this same area. It is not necessary to hydraulically balance the in-rack sprinkler system with the ceiling sprinkler system, nor account for them flowing simultaneously.

21.6.11 Design and install the ceiling sprinkler system in accordance with the guidelines outlined in Chapters 16 or 17, depending on the commodity hazard, except as modified in this section. When the in-rack sprinkler system is designed and installed in accordance with Section 21.6, the top level of in-rack sprinklers can be considered a floor for design purposes of the ceiling sprinkler system. As a result, the storage height above the top level of in-rack sprinklers can be in excess of 10 ft (3.0 m).

21.6.12 The water supply for the ceiling system shall be capable of providing the required ceiling sprinkler system design obtained from either Chapter 16 or 17 independent of the design requirements of the in-rack sprinkler system obtained from Section 21.6 and protecting this same area. It is not necessary to hydraulically balance the ceiling sprinkler system with the in-rack sprinkler system, nor account for them flowing simultaneously.
**Statement of Problem and Substantiation for Public Input:** This is new guidance for in-rack sprinkler protection that utilizes ESFR sprinklers as in-racks and eliminates the need for hydraulic balancing of the in-rack sprinkler system with the ceiling sprinkler system. Support for this public input has been provided in a separate document.

**Submitter and Organization:** Wes Baker of FM Global

**Public Input**

Figure 17.3.1.4(a) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) – Option 1.

**Statement of Problem and Substantiation for Public Input:** The word “cartoned” has been added to help clarify that the in-rack sprinkler protection arrangement shown in Figure 17.3.1.4(a) is specific to cartoned Group A plastics as indicated in Section 17.3.1.4.

**Submitter and Organization:** Wes Baker of FM Global

**Public Input**

Figure 17.3.1.4(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) – Option 2.

**Statement of Problem and Substantiation for Public Input:** The word “cartoned” has been added to help clarify that the in-rack sprinkler protection arrangement shown in Figure 17.3.1.4(b) is specific to cartoned Group A plastics as indicated in Section 17.3.1.4.

**Submitter and Organization:** Wes Baker of FM Global

**Public Input**

Figure 17.3.1.4(c) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Single-Row Racks, Storage Height Over 25 ft (7.6 m) – Option 3.

**Statement of Problem and Substantiation for Public Input:** The word “cartoned” has been added to help clarify that the in-rack sprinkler protection arrangement shown in Figure 17.3.1.4(c) is specific to cartoned Group A plastics as indicated in Section 17.3.1.4.

**Submitter and Organization:** Wes Baker of FM Global
Modify Sections 17.3.1.4, 17.3.1.5 and 17.3.1.7 as follows:

17.3.1.4 For protection of cartoned storage of Group A plastics, expanded or unexpanded, whether encapsulated or nonencapsulated, on single-row racks, in-rack sprinklers shall be arranged in accordance with one of the options in Figure 17.3.1.4(a) through Figure 17.3.1.4(c) or Figure 17.3.1.7(a). The highest level of in-rack sprinklers shall be not more than 10 ft (3.0 m) below the top of storage.

17.3.1.5 For protection of cartoned storage of Group A plastics, expanded or unexpanded, whether encapsulated or nonencapsulated, on double-row racks, in-rack sprinklers shall be arranged in accordance with one of the double-row rack options in Figure 17.3.1.5(a), or Figure 17.3.1.5(b), or. Figure 17.3.1.7(b) is an option for double-row racks up to 9 ft (2.7 m) deep or Figure 17.3.1.7(f) for double-row racks up to 12 ft (3.7 m) deep. The highest level of in-rack sprinklers shall be not more than 10 ft (3.0 m) below the top of storage.

17.3.1.7 For protection of storage of exposed uncartoned unexpanded Group A plastics, whether encapsulated or nonencapsulated, on single-racks or double-row racks, in-rack sprinklers shall be arranged in accordance with Figures 17.3.1.7(c) and 17.3.1.7(d) for single-row racks and Figures 17.3.1.7(e) and 17.3.1.7(f) for double-row racks. The highest level of in-rack sprinklers shall not be more than 10 ft (3.0 m) below the top of storage. Where these figures are used, aisles shall be at least 4 ft (1.2 m) wide and the ceiling sprinklers shall be designed for a minimum discharge density of 0.45 gpm/ft² over 2000 ft² (18.3 mm/min over 186 m²). When in-rack sprinklers are installed in accordance with Figures 17.3.1.7(d), 17.3.1.7(e) or 17.3.1.7(f), the ceiling and in-rack sprinkler systems do not need to be hydraulically balanced at their point of connection nor do they need to be accounted for operating simultaneously. Include a 250 gpm (950 L/min) hose stream allowance for the in-rack sprinkler design indicated in Figures 17.3.1.7(d) through 17.3.1.7(f); the water supply shall meet this sprinkler and hose demand for a minimum 60 minute duration.
Modify Figure 17.3.1.7 as follows:

**End View**

**Plan View**

*FIGURE 17.3.1.7(a) In-Rack Sprinkler Arrangement, Cartoned Expanded and Nonexpanded Group A Plastic and Exposed Nonexpanded Group A Plastic Commodities, Single-Row and Double-Row Racks Without Solid Shelves, Storage Height Over 25 ft (7.6 m).*
Add a new Figure 17.3.1.7(b) as follows:

**End View**

**Plan View**

X = Min. K-5.6 (K-80) sprinkler locations
Design based on 14 most remote IRAS (7 on top 2 levels) flowing min. of 30 gpm (114 L/min)

FIGURE 17.3.1.7(b) In-Rack Sprinkler Arrangement, Cartoned Group A Plastic Commodities, Double-Row Racks Without Solid Shelves, Storage Height Over 25 ft (7.6 m).
Add a new Figure 17.3.1.7(c) as follows:

**End View**

```
X
X
X
X
X
```

10 ft (3.0 m) maximum

**Plan View**

```
X  X  X  X  X  X  X  X
```

Maximum rack depth
3 ft (0.9 m)

5 ft (1.5 m) maximum

X = Min. K-5.6 (K-80) sprinkler locations

Design based on 14 most remote IRAS (7 on top 2 levels) flowing min. of 30 gpm (114 L/min)

FIGURE 17.3.1.7(c) In-Rack Sprinkler Arrangement, Uncartonied Unexpanded Group A Plastic Commodities, Single-Row Racks Without Solid Shelves, Storage Height Over 25 ft (7.6 m).
Add a new Figure 17.3.1.7(d) as follows:

FIGURE 17.3.1.7(d) In-Rack Sprinkler Arrangement, Uncarton Unexpanded Group A Plastic Commodities, Single-Row Racks Without Solid Shelves, Storage Height Over 25 ft (7.6 m).
Add a new Figure 17.3.1.7(e) as follows:

**FIGURE 17.3.1.7(e) In-Rack Sprinkler Arrangement, Uncartonned Unexpanded Group A Plastic Commodities, Double-Row Racks Without Solid Shelves, Storage Height Over 25 ft (7.6 m).**
Add a new Figure 17.3.17(f) as follows:

**FIGURE 17.3.17(f) In-Rack Sprinkler Arrangement, Cartoned Group A and Uncartonned Unexpanded Group A Plastic Commodities, Double-Row Racks Without Solid Shelves, Storage Height Over 25 ft (7.6 m).**
Statement of Problem and Substantiation for Public Input: Testing at FM Global has demonstrated that protection of uncartoned unexpanded plastics maintained over 25 ft high in open-frame storage racks cannot be adequately protected by a single line of in-rack sprinklers in the longitudinal flue as shown in Figure 17.3.1.7. The recommended guidance provides in-rack sprinkler protection options for single-row and double-row racks based on the recent testing at FM Global. Support for this guidance is being provided in a separate document.

Submitter and Organization: Wes Baker of FM Global

Public Input

5.3* Ordinary Hazard Occupancies.
5.3.1* Ordinary Hazard (Group 1).
5.3.1.1 Ordinary hazard (Group 1) occupancies shall be defined as occupancies, or portions of other occupancies, where the quantity and combustibility of the contents is low, quantity of combustibles is moderate, does not exceed the amount of miscellaneous storage of Class 1 and Class 2 provided for OH, Group 1 occupancies in Table 13.2.1, stockpiles of combustibles do not exceed 8 ft (2.4 m), and fires with moderate rates of heat release are expected.

Statement of Problem and Substantiation for Public Input: The current definition requires judgment and are subjective. Moderate rates of heat release are not readily understood and not quantified. This change makes it clear the amount of storage is acceptable using standard commodities. Further, this definition guides the user to protection recommendations.

Submitter and Organization: Angèle Morcos of FM Global

Public Input

5.3.2* Ordinary Hazard (Group 2).
5.3.2.1 Ordinary hazard (Group 2) occupancies shall be defined as occupancies, or portions of other occupancies, where the quantity and combustibility of contents does not exceed the amount of miscellaneous storage of Class 2, 3, 4, plastics, tires, and roll paper provided in Table 13.2.1, are moderate to high, stockpiles of contents with moderate rates of heat release do not exceed 12 ft (3.7 m), and stockpiles of contents with high rates of heat release do not exceed 8 ft (2.4 m).

Statement of Problem and Substantiation for Public Input: The current definition requires judgment and are subjective. Moderate rates of heat release are not readily understood and not quantified. This change makes it clear the amount of storage is acceptable using standard commodities. Further, this definition guides the user to protection recommendations.

Submitter and Organization: Angèle Morcos of FM Global

Public Input

5.6.1.1* Classification of Commodities.
5.6.1.1.1 Commodity classification and the corresponding protection requirements shall be determined based on the makeup of individual storage units (i.e., unit load, pallet load).

*5.6.1.1.1* The type and amount of materials used as part of the product, and its *interior and exterior* primary packaging, as well as the storage pallet shall be considered in the classification of the commodity.

**Statement of Problem and Substantiation for Public Input:** Commodity classification is based on interior and exterior packaging and needs to be accounted for. The term “primary” is misleading.

**Submitter and Organization:** Angèle Morcos of FM Global

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**Public Input**

Revised Figure 5.6.3.3.3(a) as follows:

- Add a solid vertical line at the 40% value found on the x-axis
- Add the word “Unexpanded” after the wording “Group A” in the center of the figure
- Add the word “Cartoned” in front of the word “Commodities” in the title of this figure
- Add the word “Expanded” between the wording “Group A” and “Plastic” in the x-axis title

**Statement of Problem and Substantiation for Public Input:** There were several mistakes made to this figure based on how it was illustrated compared to what was agreed to by the SSD Committee. The input provided restores this figure to its intended guidance.

**Submitter and Organization:** Angèle Morcos of FM Global

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5.6.3.4.2 The remaining materials shall be permitted to be metal, wood, paper, natural or synthetic fibers, or Group B or Group C plastics.

**Statement of Problem and Substantiation for Public Input:** FM Global has conducted commodity classification and large-scale testing with uncartoned synthetic yarn on cardboard spools in 2015 and 2016. Large-scale testing of solid-piled synthetic yarn required ceiling only protection equivalent to that
of uncartoned unexpanded plastic. Therefore, it is recommended that synthetic yarn not be grouped with commodities considered to be Class 3 or Class 4.

Submitter and Organization: Angèle Morcos of FM Global

Public Input

5.6.4.1.1.3 The remaining materials shall be permitted to be noncombustible, wood, paper, natural or synthetic fibers, or Group A, Group B, or Group C plastics.

Statement of Problem and Substantiation for Public Input: FM Global has conducted commodity classification and large-scale testing with uncartoned synthetic yarn on cardboard spools in 2015 and 2016. Large-scale testing of solid-piled synthetic yarn required ceiling only protection equivalent to that of uncartoned unexpanded plastic. Therefore, it is recommended that synthetic yarn not be grouped with commodities considered to be Class 3 or Class 4.

Submitter and Organization: Angèle Morcos of FM Global

Public Input

Table A.5.6.3 → Textile Materials/Products → Cloth; synthetic cloth → Class IV Group A, Nonexpanded Plastic

Statement of Problem and Substantiation for Public Input: FM Global has conducted commodity classification and large-scale testing with uncartoned synthetic yarn on cardboard spools in 2015 and 2016. Large-scale testing of solid-piled synthetic yarn required ceiling only protection equivalent to that of uncartoned unexpanded plastic. Therefore it is recommended that “Cloth; synthetic cloth” be removed from Table A.5.6.3 as an example of Class 4 commodities and be listed as a Group A, Nonexpanded Plastic.

Submitter and Organization: Angèle Morcos of FM Global

Public Input

Table A.5.6.3 → Textile Materials/Products → Fabric; rayon and nylon → Class 4 Group A, Nonexpanded Plastic

Statement of Problem and Substantiation for Public Input: FM Global has conducted commodity classification and large-scale testing with uncartoned synthetic yarn on cardboard spools in 2015 and 2016. Large-scale testing of solid-piled synthetic yarn required ceiling only protection equivalent to that of uncartoned unexpanded plastic. Therefore it is recommended that “Textile Materials/Products Fabric; rayon and nylon” be removed from Table A.5.6.3 as an example of Class 4 commodities and be listed as a Group A, Nonexpanded Plastic.

Public Input

Table A.5.6.3 → Textile Materials/Products → Fabric; synthetic (except rayon and nylon); up to 50/50 blend → Class 3 Group A, Nonexpanded Plastic
Statement of Problem and Substantiation for Public Input: FM Global has conducted commodity classification and large-scale testing with uncartoned synthetic yarn on cardboard spools in 2015 and 2016. Large-scale testing of solid-piled synthetic yarn required ceiling only protection equivalent to that of uncartoned unexpanded plastic. Therefore it is recommended that “Fabric; synthetic (except rayon and nylon); up to 50/50 blend” be removed from Table A.5.6.3 as an example of Class 3 commodities and be listed as a Group A, Nonexpanded Plastic.

Submitter and Organization: Angèle Morcos of FM Global

Public Input

Table A.5.6.3 → Textile Materials/Products → Thread or yarn; synthetic (except rayon and nylon); greater than 50/50 blend; paper or wood spools → Class 4 Group A, Nonexpanded Plastic

Statement of Problem and Substantiation for Public Input: FM Global has conducted commodity classification and large-scale testing with uncartoned synthetic yarn on cardboard spools in 2015 and 2016. Large-scale testing of solid-piled synthetic yarn required ceiling only protection equivalent to that of uncartoned unexpanded plastic. Therefore it is recommended that “Thread or yarn; synthetic (except rayon and nylon); greater than 50/50 blend; paper or wood spools” be removed from Table A.5.6.3 as an example of Class 4 commodities and be listed as a Group A, Nonexpanded Plastic.

Submitter and Organization: Angèle Morcos of FM Global

Public Input

Table A.5.6.3 → Textile Materials/Products → Thread or yarn; synthetic (except rayon and nylon); up to 50/50 blend; wood or paper spools → Class 3 Group A, Nonexpanded Plastic

Statement of Problem and Substantiation for Public Input: FM Global has conducted commodity classification and large-scale testing with uncartoned synthetic yarn on cardboard spools in 2015 and 2016. Large-scale testing of solid-piled synthetic yarn required ceiling only protection equivalent to that of uncartoned unexpanded plastic. Therefore it is recommended that “Thread or yarn; synthetic (except rayon and nylon); up to 50/50 blend; wood or paper spools” be removed from Table A.5.6.3 as an example of Class 3 commodities and be listed as a Group A, Nonexpanded Plastic.

Submitter and Organization: Angèle Morcos of FM Global

Public Input

24.1.5.2 Water supplies and environmental conditions shall be evaluated for conditions that contribute to unusual corrosive properties. Where conditions are found that contribute to unusual corrosive properties, the owner(s) shall notify the sprinkler system installer and a plan shall be developed to treat the system using one of the following methods:

1. Install a water pipe that is corrosion resistant
2. Treat all water that enters the system using an approved corrosion inhibitor
3. Implement an approved plan for monitoring the interior conditions of the pipe at established intervals and locations
4. Install corrosion monitoring station and monitor at established intervals
(5) Fill dry-pipe or preaction systems with nitrogen as a supervisory gas to mitigate against corrosion. When using a generator, use an approved nitrogen generator.

Statement of Problem and Substantiation for Public Input
FM Global has conducted testing to evaluate the use of nitrogen to mitigate against corrosion in dry-pipe. Corrosion rates of dry-pipe with nitrogen were 5% of the corrosion rate of the dry-pipe when house air was the supervisory gas. By filling the pipe with nitrogen, oxygen is removed within the pipe (one of the key components for corrosion) and decrease oxygen-related electrochemical reactions.

Relating to corrosion inhibitors: Compatibility tests of these chemicals with other materials used in fire protection systems should be carried out before their applications. Therefore, further study associated with corrosion inhibitor applications for corrosion mitigation is needed.

See FM Global research on corrosion mitigation:
http://www.fmglobal.com/~/media/Files/FMGlobal/Research%20Technical%20Reports/P14180.pdf?la=en&isGated=true&itemId={7CB761A3-943E-46EA-81B1-414E126425B7}

Submitter and Organization: Angèle Morcos, FM Global
<table>
<thead>
<tr>
<th>IRAS Installation Arrangement; Figure</th>
<th>Number of sprinklers in the In-Rack Design</th>
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<tr>
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<td>Class I through IV and Cartoned Plastics</td>
<td>Uncartoned Plastics</td>
</tr>
<tr>
<td>Single-row racks up to 3 ft (0.9 m) Deep; 21.6.4(a)</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Single-row racks up to 6 ft. (1.8 m) deep; 21.6.4(b) and 21.6.4©</td>
<td>5</td>
<td>5</td>
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<tr>
<td>Double- and Multiple-row racks; 21.6.4€ and 21.6.4(f)</td>
<td>6</td>
<td>6 &amp; 6</td>
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<tr>
<td>Maximum Vertical IRAS Installation Increment, ft (m)</td>
<td>Commodity Hazard</td>
<td>Min. K-factor</td>
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<td>--------------------------------------------------</td>
<td>-------------------------------------------------</td>
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<td>30 (9.1)</td>
<td>Class I through IV and Cartoned Unexpanded Plastic</td>
<td>14.0 (200)</td>
</tr>
<tr>
<td></td>
<td>Cartoned Expanded Plastic</td>
<td>14.0 (200)</td>
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<tr>
<td></td>
<td>Uncartonied Plastics</td>
<td>22.4 (320)</td>
</tr>
<tr>
<td>40 (12.2)</td>
<td>Class I through IV and Cartoned Unexpanded Plastic</td>
<td>22.4 (320)</td>
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First Revision No. 759-NFPA 13-2016 [New Section after 23.1.1]

4.6.1.1 Working plan submittals shall include the following:
(1) Working plans of the system(s), per 4.6.3
(2) Hydraulic calculations where systems are required to be calculated
(3) Data sheets for the system components where required by the AHJ
(4)* Signed owner’s certificate

4.6.1.2 Submittals shall be permitted to be in electronic format when approved by the authority having jurisdiction.

4.6.1.3 A copy of the approved plans shall be given to the owner or owner’s representative.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Mon Aug 15 16:08:34 EDT 2016

Committee Statement

Committee Statement: There are no minimum requirements that must be included in the actual submittal package.

Response Message: Public Input No. 603-NFPA 13-2016 [New Section after 23.1.1]
A.4.6.1.1(4)
It is the intent to provide the owner’s certificate for all new systems and where there is a change of occupancy and/or building use.
4.6.3
Working plans shall be drawn to an indicated scale, on sheets of uniform size, with a plan of each floor, and shall show those items from the following list that pertain to the design of the system:

1. Name of owner and occupant.
2. Location, including street address.
3. Point of compass.
4. Full height cross section or schematic diagram, including structural member information if required for clarity and including ceiling construction and method of protection for nonmetallic piping.
5. Ceiling/roof heights and slopes not shown in the full height cross section.
6. Location of partitions.
7. Location of fire walls.
8. Occupancy class of each area or room.
9. Location and size of concealed spaces, closets, attics, and bathrooms.
10. Any small enclosures in which no sprinklers are to be installed.
11. Size of city main in street and whether dead end or circulating; if dead end, direction and distance to nearest circulating main; and city main test results and system elevation relative to test hydrant.
12. Other sources of water supply, with pressure or elevation.
13. Make, type, model, and nominal K-factor of sprinklers, including sprinkler identification number.
14. Temperature rating and location of high-temperature sprinklers.
15. Total area protected by each system on each floor.
16. Number of sprinklers on each riser per floor.
17. Total number of sprinklers on each dry pipe system, preaction system, combined dry pipe–preaction system, or deluge system.
18. Approximate capacity in gallons of each dry pipe system.
19. Pipe type and schedule of wall thickness.
20. Nominal pipe size and cutting lengths of pipe (or center-to-center dimensions). Where typical branch lines prevail, it shall be necessary to size only one typical line.
21. Location and size of riser nipples.
22. Type of fittings and joints and location of all welds and bends. The contractor shall specify on drawing any sections to be shop welded and the type of fittings or formations to be used.
23. Type and locations of hangers, sleeves, braces, and methods of securing sprinklers when applicable.
24. All control valves, check valves, drain pipes, and test connections.
25. Size, location, and valve and piping arrangement for means to forward flow test at system demand.
26. Make, type, model, and size of alarm or dry pipe valve.
27. Make, type, model, and size of preaction or deluge valve.
28. Kind and location of alarm bells.
29. Size and location of standpipe risers, hose outlets, hand hose, monitor nozzles, and related equipment.
30. Private fire service main sizes, lengths, locations, weights, materials, point of connection to city main; the sizes, types and locations of valves, valve indicators, regulators, meters, and valve pits; and the depth that the top of the pipe is laid below grade.
31. Piping provisions for flushing.
32. Where the equipment is to be installed as an addition to an existing system, enough of the existing system indicated on the plans to make all conditions clear.
33. For hydraulically designed systems, the information on the hydraulic data nameplate.
34. A graphic representation of the scale used on all plans.
(35) Name and address, and phone number(s) of contractor.

(36) Hydraulic reference points shown on the plan that correspond with comparable reference points on the hydraulic calculation sheets.

(37) The minimum rate of water application (density or flow or discharge pressure), the design area of water application, in-rack sprinkler demand, and the water required for hose streams both inside and outside.

(38) The total quantity of water and the pressure required noted at a common reference point for each system.

(39) Relative elevations of sprinklers, junction points, and supply or reference points.

(40) If room design method is used, all unprotected wall openings throughout the floor protected.

(41) Calculation of loads for sizing and details of sway bracing.

(42) Zones of influence used in calculations for seismic bracing indicated on plans.

(43) The setting for pressure-reducing valves.

(44) Information about backflow preventers (manufacturer, size, type).

(45) Information about listed antifreeze solution used (type and amount).

(46) Size and location of hydrants showing size and number of outlets and if outlets are to be equipped with independent gate valves. Whether hose houses and equipment are to be provided, and by whom, shall be indicated. Static and residual hydrants that were used in flow tests shall be shown.

(47) Utility plans and/or plumbing plans necessary to show connection from water supply to fire sprinkler system.

(48) Size, location, and piping arrangement of fire department connections.

(49) Ceiling/roof heights and slopes not shown in the full height cross section.

(50) Edition year of NFPA 13 to which the sprinkler system is designed.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Mon Aug 15 16:44:41 EDT 2016

Committee Statement

Committee Statement:
Suggest changes allows reviewer to review seismic calculations to insure all the proper piping and sizes have been used in the calculations on the plans. By showing zones of influence for each calculation the reviewer insures that all calculations have been done properly and all equipment is sized properly.

There is no need to require labels of every room in a building. Most rooms will correlate with the overall occupancy of the building.

Response Message:
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<td>Public Input No. 622-NFPA 13-2016 [Section No. 23.1.3]</td>
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Table 19.6.3.1.1 shall be used to determine the equivalent length of pipe for fittings and devices unless manufacturer's test data indicate that other factors are appropriate.

**Table 19.6.3.1.1 Equivalent Schedule 40 Steel Pipe Length Chart**

<table>
<thead>
<tr>
<th>Fittings and Valves</th>
<th>1/2 in. (15 mm)</th>
<th>3/4 in. (20 mm)</th>
<th>1 in. (25 mm)</th>
<th>1 1/4 in. (32 mm)</th>
<th>1 1/2 in. (40 mm)</th>
<th>2 in. (50 mm)</th>
<th>2 1/2 in. (65 mm)</th>
<th>3 in. (80 mm)</th>
<th>3 1/2 in. (90 mm)</th>
<th>4 in. (100 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>45° elbow</td>
<td>—</td>
<td>1 (0.3)</td>
<td>1 (0.3)</td>
<td>1 (0.3)</td>
<td>2 (0.6)</td>
<td>2 (0.6)</td>
<td>3 (0.9)</td>
<td>3 (0.9)</td>
<td>3 (0.9)</td>
<td>4 (1.2)</td>
</tr>
<tr>
<td>90° standard elbow</td>
<td>1 (0.3)</td>
<td>2 (0.6)</td>
<td>2 (0.6)</td>
<td>3 (0.9)</td>
<td>4 (1.2)</td>
<td>5 (1.5)</td>
<td>6 (1.8)</td>
<td>7 (2.1)</td>
<td>8 (2.4)</td>
<td>10 (3)</td>
</tr>
<tr>
<td>90° long-turn elbow</td>
<td>0.5 (0.2)</td>
<td>1 (0.3)</td>
<td>2 (0.6)</td>
<td>2 (0.6)</td>
<td>2 (0.6)</td>
<td>3 (0.9)</td>
<td>4 (1.2)</td>
<td>5 (1.5)</td>
<td>5 (1.5)</td>
<td>6 (1.8)</td>
</tr>
<tr>
<td>Tee or cross (flow turned 90°)</td>
<td>3 (0.9)</td>
<td>4 (1.2)</td>
<td>5 (1.5)</td>
<td>6 (1.8)</td>
<td>8 (2.4)</td>
<td>10 (3)</td>
<td>12 (3.7)</td>
<td>15 (5.2)</td>
<td>17 (5.2)</td>
<td>20 (6.1)</td>
</tr>
<tr>
<td>Butterfly valve</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>6 (1.8)</td>
</tr>
<tr>
<td>Gate valve</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1 (0.3)</td>
</tr>
<tr>
<td>Vane type flow switch</td>
<td>6 (1.8)</td>
<td>9 (2.7)</td>
<td>10 (3)</td>
<td>14 (4.3)</td>
<td>17 (5.2)</td>
<td>22 (6.7)</td>
<td>—</td>
<td>30 (9.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swing check*</td>
<td>—</td>
<td>—</td>
<td>5 (1.5)</td>
<td>7 (2.1)</td>
<td>9 (2.7)</td>
<td>11 (3.3)</td>
<td>14 (4.3)</td>
<td>16 (4.9)</td>
<td>19 (5.8)</td>
<td>22 (6.7)</td>
</tr>
</tbody>
</table>

Note: Information on 1/2 in. pipe is included in this table only because it is allowed under 8.15.19.4 and 8.15.19.5.

*Due to the variation in design of swing check valves, the pipe equivalents indicated in this table are considered average.

**Supplemental Information**

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</table>

**Submitter Information Verification**

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Committee Statement

All flow switches are required to undergo a Hydraulic Friction Loss Test in accordance with Section 33 of UL Standard 346 - WATERFLOW INDICATORS FOR FIRE PROTECTIVE SIGNALING SYSTEMS. This friction loss test allows for up to 3 psi loss across the paddle for 4 inch and smaller sizes and 1 psi loss for sizes larger than 4 inch when subjected to a flow rate of 15 fps. The flow switch manufacturers have yet to publish their friction losses across these devices on their technical literature. These losses are not inconsequential, especially when compared to other values already within the Table. As with other fittings, valves and devices, the manufacturer is free to publish their specific pressure drop data to supersede the values within Table 23.4.3.1.1.

The added equivalent feet values are based on Schedule 40 pipe and a C-Factor of 120. Computations/worksheet attached.
19.9.2.6*
Where the total number of sprinklers above and below a ceiling exceeds the number specified in Table 19.9.2.4 for 2½ in. (65 mm) pipe, the pipe supplying such sprinklers shall be increased to 3 in. (75 mm) and sized thereafter according to the schedule shown in Table 23.7.2.4, Table 19.9.2.2.1 for the number of sprinklers above or below a ceiling, whichever is larger.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 15 17:09:35 EDT 2016

Committee Statement

Committee Statement: During the previous cycle, PI No. 39 and PC No. 176 endeavored to correct an editorial error in this section, which seems to have originated back when the 2002 edition of the standard was prepared. However, in both the First and Second Draft reports, the text was edited incorrectly. This proposal is offered to again try to correct the error.

Response Message:

Public Input No. 521-NFPA 13-2016 [Section No. 23.7.2.6]
First Revision No. 763-NFPA 13-2016 [Section No. 23.7.3.9]

19.9.3.9*

Where the total number of sprinklers above and below a ceiling exceeds the number specified in Table 19.9.3.7 for 3 in. (75 mm) pipe, the pipe supplying such sprinklers shall be increased to 3 1/8 in. (90 mm) or larger and sized thereafter according to the schedule shown in Table 23.7.3.5 or Table 19.9.2.2.1 for the number of sprinklers above or below a ceiling, whichever is larger.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:

Submittal Date: Mon Aug 15 17:10:29 EDT 2016

Committee Statement

Committee Statement: During the previous cycle, the Committee elected to change the reference in Section 23.7.3.9 from the (now) Table 23.7.2.2.1 to the (now) Table 23.7.3.5, due to a mistaken misconception that the original reference was incorrect. However, the reference to Table 23.7.2.2.1 was correct in the first place and it should not have been changed.

Table 23.7.3.5 is the pipe schedule for separations greater than 12 ft and stops at 60 sprinklers. Therefore, when the number (60 for 3" pipe) from Table 23.7.3.5 is exceeded, Table 23.7.3.5 cannot be utilized.

Table 23.7.2.2.1 is the pipe schedule for light hazard. It is applicable for the pipe sizing in the concealed space above, which is a light hazard occupancy, even when the occupancy below is ordinary hazard.

When similar confusion on this matter occurred previously, it was pointed out by the submitter of TCR proposal 13-42 and TCD comment 13-41, leading to the 1987 edition of NFPA 13 (using the older NFPA 13 references) that:

TCR 13-42:

“For example, a 3 in. steel pipe which is permitted to supply 40 sprinklers in an Ordinary Hazard area, may supply a total of 60 sprinklers when not more than 40 sprinklers protect the occupied area. … Section 4-4.4.2 classifies these typical ceiling spaces as light hazard and therefore pipe schedule requirements should be revised accordingly in Section 3-6.3.1.”

TCD 13-41:

As per A-3-6.3.1 the principle of the Committee's comment saying that the present wording meets their intent implies that this concealed space above the ceiling is classified as ordinary hazard. This contradicts the information in 4-4.4.2 which classifies the typical ceiling space as light hazard. If the classification of the occupied area as ordinary hazard has a bearing on the classification of the ceiling space for pipe sizing purposes, then such a "condition" should be written into 4-4.4.2 as an Exception to the rule. In addition, if the configuration of piping (above and below versus separate branch lines for occupied and concealed areas) has any bearing on the occupancy classification for the concealed
space such a condition also should be written into 4-4.4.2."

The Technical Committee of that time agreed with the submitter, and the reference to the light hazard table has been in this place since then up until the 2016 edition, and it should now be reinstated.

Response
Message:

Public Input No. 522-NFPA 13-2016 [Section No. 23.7.3.9]
5.1.5.2
Water supplies and environmental conditions shall be evaluated for conditions that contribute to unusual corrosive properties. Where conditions are found that contribute to unusual corrosive properties, the owner(s) shall notify the sprinkler system installer and a plan shall be developed to treat the system using one of the following methods:

1. Install a water pipe that is corrosion resistant
   Treat all water that enters the system using an approved corrosion inhibitor
2. Implement an approved plan for monitoring the interior conditions of the pipe at established intervals and locations
3. Install corrosion monitoring station and monitor at established intervals
4. Fill dry-pipe or preaction systems with nitrogen as a supervisory gas to mitigate against corrosion.
5. When using a generator, use an approved nitrogen generator.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Sep 19 14:20:35 EDT 2016

Committee Statement

Committee Statement: FM Global has conducted testing to evaluate the use of nitrogen to mitigate against corrosion in dry-pipe. Corrosion rates of dry-pipe with nitrogen were 5% of the corrosion rate of the dry-pipe when house air was the supervisory gas. By filling the pipe with nitrogen, oxygen is removed within the pipe (one of the key components for corrosion) and decrease oxygen-related electrochemical reactions.

Relating to corrosion inhibitors: Compatibility tests of these chemicals with other materials used in fire protection systems should be carried out before their applications. Therefore, further study associated with corrosion inhibitor applications for corrosion mitigation is needed.

See FM Global research on corrosion mitigation:
http://www.fmglobal.com/~/media/Files/FMGlobal/Research%20Technical%20Reports/P14180.pdf?la=en&isGated=true&itemId={7CB761A3-943E-46EA-81B1-414E126425B7}

Submitter and Organization: Angèle Morcos, FM Global

Response Message:
5.2.2.2
The volume and pressure of a public water supply shall be determined from waterflow test data or other approved methods.

5.2.2.2.1
Where a waterflow test is conducted, the volume and pressure available for use for a fire protection system shall be determined in accordance with 5.2.2.2.1.1. If knowledge of the water supply is unavailable, the volume and pressure shall be determined in accordance with 5.2.2.2.1.2.

5.2.2.2.1.1
Water supply adjustments shall be based on knowledge of the water supply and engineering judgment, taking into account daily and seasonal fluctuations, not extreme conditions.

5.2.2.2.1.2
If knowledge of the water supply is unavailable, the following formula shall be used to determine volume and pressure:

\[ P = (P_R - P_S) \left( \frac{Q}{Q_R} \right)^{0.85} + P_L \]  [5.2.2.2.1.2]

where:
- \( P \) = pressure available from the water supply to use for a fire protection system that will be calculated for a given flow \( Q \).
- \( P_R \) = residual pressure measured during the waterflow test while the flow \( Q_R \) was discharging from the water supply.
- \( P_S \) = static pressure measured during the waterflow test.
- \( Q \) = flow that will be used to calculate the available pressure from the water supply.
- \( Q_R \) = flow discharging from the water supply when \( P_R \) was measured.
- \( P_L \) = expected low static pressure at the location of the test results accounting for daily and seasonal fluctuations (not extreme conditions) obtained from the water utility.

5.2.2.2.1.3
Where the water authority does not provide a value for \( P_L \), the value of \( P_L \) shall be calculated from the following formula:

\[ P_L = P_S(0.9) \]  [5.2.2.2.1.3]

Supplemental Information

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Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
Committee Statement

Committee Statement: k

Response Message:

Public Input No. 87-NFPA 13-2016 [Section No. 24.2.2.2]
Public Input No. 126-NFPA 13-2016 [Section No. 24.2.2.2]
Public Input No. 160-NFPA 13-2016 [New Section after 24.2.2.2]
Public Input No. 158-NFPA 13-2016 [Section No. A.24.2.2.2]
Public Input No. 577-NFPA 13-2016 [New Section after 23.4.1]
Public Input No. 605-NFPA 13-2016 [New Section after 23.2.1.1]
Public Input No. 127-NFPA 13-2016 [New Section after 24.2.2.2]
Public Input No. 131-NFPA 13-2016 [Section No. A.24.2.2.2]
Public Input No. 117-NFPA 13-2016 [New Section after A.24.2.2.2]
Public Input No. 159-NFPA 13-2016 [New Section after A.24.2.2]
A.25.4.9
Specification of the type, amount, and arrangement of combustibles for any commodity classification is essentially an attempt to define the potential fire severity, based on its burning characteristics, so the fire can be successfully controlled by the prescribed sprinkler protection for the commodity class. In actual storage situations, however, many storage arrays do not fit precisely into one of the fundamental classifications; therefore, the user needs to make judgments after comparing each classification to the existing storage conditions. Storage arrays consist of thousands of products, which makes it impossible to specify all the acceptable variations for any class. As an alternative, a variety of common products are classified in this annex based on judgment, loss experience, and fire test results.

Table A.25.4.9 provides examples of commodities not addressed by the classifications in Section 20.5. The commodities listed in Table A.25.4.9 are outside the scope of NFPA 13 protection.

Table A.20.3 includes lithium ion batteries. Lithium ion batteries have been a research project within the NFPA Research Foundation. As a result, the following reports have been published:

1. "Lithium ion batteries hazard and use assessment" published July 2011 and available at the NFPA Research Foundation web site.
3. "Lithium Ion Batteries Hazard and Use Assessment Phase IIB, Flammability Characterization of Li-ion Batteries for Storage Protection" published April 2013 and available at the NFPA Research Foundation web site.

Table A.20.5 is an alphabetized list of commodities with corresponding classifications.

Table A.25.4.9 Examples of Commodities Not Addressed by Classifications in Section 5.6

Ammunition Components
- Bulk primers and powder

Batteries
- Lithium and other similar exotic metals
- Lithium-ion and other rechargeable batteries that contain combustible electrolyte

Boat Storage
- Stored on racks

Boxes, Crates
- Empty, wood slatted*

Carpet Rolls

Combustible Metals — unless specifically identified otherwise

Compressed or Liquefied Flammable Gases (i.e., filled propane cylinders) — unless specifically identified otherwise

Explosives
- Blasting primers and similar items

Fertilizers (nitrates)

Fireworks
- Consumer and display

Flammable and Combustible Liquids — unless specifically identified otherwise
- Liquids that contain greater than 20% alcohol

Hanging Garments, Bulk Storage

Lighters (butane)
- Loose in large containers (Level 3 aerosol)

**Storage Container**

- Large container storage of household goods

*Should be treated as idle pallets.*

---

**Submitter Information Verification**

**Submitter Full Name:** AUT-SSD  
**Organization:** National Fire Protection Assoc  
**Street Address:**  
**City:**  
**State:**  
**Zip:**  
**Submittal Date:** Mon Aug 15 17:57:36 EDT 2016

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**Committee Statement**

**Committee Statement:** These changes are offered in support of the NFPA 13 reorganization. The changes are not intended to introduce any technical change to the standard. In addition, a third paragraph has been added to direct the reader to NFPA Research Foundation Work on lithium ion batteries in storage.

**Response Message:**

Public Input No. 298-NFPA 13-2016 [Section No. A.5.6]
## Table A.20.4 Alphabetical Listing of Commodity Classes

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<th>Product Heading</th>
<th>Product</th>
<th>NFPA 13</th>
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<tbody>
<tr>
<td>Batteries</td>
<td>Dry cells (excludes lithium, lithium-ion, and other similar exotic metals or combustible electrolyte); without blister packing (if blister packed refer to commodity classification definitions)</td>
<td>Class I</td>
</tr>
<tr>
<td></td>
<td>Vehicle; any size (e.g., automobile or truck); empty plastic casing</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Vehicle; large (e.g., truck or larger); dry or wet (excludes lithium-ion and other cells containing combustible electrolyte) cells</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Vehicle; small (e.g., automobile); wet (excludes lithium-ion and other cells containing combustible electrolyte) cells</td>
<td>Class I</td>
</tr>
<tr>
<td>Empty Containers</td>
<td>Noncombustible</td>
<td>Class I</td>
</tr>
<tr>
<td></td>
<td>PET, bottles or jars</td>
<td>Class IV</td>
</tr>
<tr>
<td></td>
<td>Rigid plastic (not including PET), up to 32 oz. (1 L)</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Rigid plastic (not including PET), greater than 32 oz. (1 L)</td>
<td>Group A Expanded</td>
</tr>
<tr>
<td></td>
<td>Wood; solid sided (e.g., crates, boxes)</td>
<td>Class II</td>
</tr>
<tr>
<td>Film Rolls, Including Photographic</td>
<td>Film (polypropylene, polyesther, polyethylene); rolled on any reel type</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Film; 35 mm metal film cartridges in polyethylene cans; cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td></td>
<td>Film; motion picture or bulk rolls in polycarbonate, polyethylene or in metal cans; polyethylene bagged; cartoned</td>
<td>Class II</td>
</tr>
<tr>
<td></td>
<td>Film; rolls in polycarbonate plastic cassettes; cartoned</td>
<td>Class IV</td>
</tr>
<tr>
<td></td>
<td>Photographic paper; sheets; bagged in polyethylene; cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td>Flammable/Combustible Liquids</td>
<td>Aerosol; Level 1</td>
<td>Class III</td>
</tr>
<tr>
<td></td>
<td>Lighters; butane; blister-packed; cartoned</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Liquids; up to 20 percent alcohol (e.g. alcoholic beverages, flavoring extracts); greater than 5 gallon (20 L) plastic containers with wall thickness greater than ( \frac{1}{4} ) in. (6 mm)</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Liquids; up to 20 percent alcohol (e.g., alcoholic beverages, flavoring extracts); metal, glass or ceramic containers</td>
<td>Class I</td>
</tr>
<tr>
<td></td>
<td>Liquids; up to 20 percent alcohol (e.g., alcoholic beverages, flavoring extracts); plastic containers greater than 5 gallons (20 L) and wall thickness up to ( \frac{1}{4} ) in. (6 mm)</td>
<td>Class II</td>
</tr>
<tr>
<td></td>
<td>Liquids; up to 20 percent alcohol (e.g., alcoholic beverages, flavoring extracts); up to 5 gallons (20 L) plastic bottles or jars</td>
<td>Class I</td>
</tr>
<tr>
<td></td>
<td>Liquids; up to 20 percent alcohol (e.g., alcoholic beverages, flavoring extracts); wood containers</td>
<td>Class II</td>
</tr>
<tr>
<td>Product Heading</td>
<td>Product</td>
<td>NFPA 13</td>
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</tr>
<tr>
<td><strong>Food Products — Frozen</strong></td>
<td>Frozen foods; nonwaxed or nonplastic packaging</td>
<td>Class I</td>
</tr>
<tr>
<td></td>
<td>Frozen foods; plastic trays</td>
<td>Class III</td>
</tr>
<tr>
<td></td>
<td>Frozen foods; waxed or plastic-coated paper packaging</td>
<td>Class II</td>
</tr>
<tr>
<td><strong>Food Products — Non-Frozen</strong></td>
<td>Butter (stick or whipped spread) or margarine (up to 50 percent oil)</td>
<td>Class III</td>
</tr>
<tr>
<td></td>
<td>Dry foods (such as baked goods, candy, cereals, cheese, chocolate, cocoa, coffee, grains, granular sugar, nuts, etc.); bagged or cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td></td>
<td>Foods (e.g., coffee, fish products, fruit, meat products, nuts, poultry, etc.); metal cans</td>
<td>Class I</td>
</tr>
<tr>
<td></td>
<td>Fruits and vegetables (noncombustible semi-liquids); crushed; plastic containers up to 5 gallons (20 L)</td>
<td>Class I</td>
</tr>
<tr>
<td></td>
<td>Fruits and vegetables; fresh; wood spacers, non-plastic trays or containers</td>
<td>Class I</td>
</tr>
<tr>
<td></td>
<td>Margarine; over 50 and up to 80 percent oil</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Meat; fresh; no plastic packaging; uncartoned</td>
<td>Class I</td>
</tr>
<tr>
<td></td>
<td>Meat; fresh; no plastic packaging; cartoned</td>
<td>Class II</td>
</tr>
<tr>
<td></td>
<td>Meat; fresh; plastic trays</td>
<td>Class III</td>
</tr>
<tr>
<td></td>
<td>Milk; any container; stored in solid plastic crates</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Milk; paper containers, or plastic bottles or jars up to 5 gallons (20 L) plastic bottles or jars</td>
<td>Class I</td>
</tr>
<tr>
<td></td>
<td>Salt; bagged</td>
<td>Class I</td>
</tr>
<tr>
<td></td>
<td>Salt; cartoned</td>
<td>Class II</td>
</tr>
<tr>
<td></td>
<td>Snack foods (e.g., potato chips); plasticized aluminum bags; cartoned</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Syrup; wooden container</td>
<td>Class II</td>
</tr>
<tr>
<td><strong>Furniture and Bedding</strong></td>
<td>Furniture and bedding; with foam cushioning</td>
<td>Group A Expanded</td>
</tr>
<tr>
<td></td>
<td>Furniture; metal (e.g., file cabinets or desks with plastic trim); cartoned</td>
<td>Class I</td>
</tr>
<tr>
<td></td>
<td>Furniture; wood (e.g., doors, windows, cabinets, etc.); no plastic coverings or foam cushioning</td>
<td>Class III</td>
</tr>
<tr>
<td></td>
<td>Furniture; wood; plastic coverings nonexpanded plastic trim</td>
<td>Class IV</td>
</tr>
<tr>
<td></td>
<td>Box spring; standard (minimal plastic materials)</td>
<td>Class III</td>
</tr>
<tr>
<td></td>
<td>Box spring; wrapped in plastic cover</td>
<td>Class IV</td>
</tr>
<tr>
<td></td>
<td>Mattress; foam (in finished form)</td>
<td>Group A Expanded</td>
</tr>
<tr>
<td><strong>Housing Materials/Appliances</strong></td>
<td>Appliances; major (e.g., stoves, refrigerators); no appreciable plastic interior or exterior trim; cartoned</td>
<td>Class II</td>
</tr>
<tr>
<td></td>
<td>Appliances; major (e.g., stoves, refrigerators); no appreciable plastic interior or exterior trim; uncartoned</td>
<td>Class I</td>
</tr>
<tr>
<td></td>
<td>Appliances; no appreciable plastic exterior trim (interior of unit can have appreciable plastic)</td>
<td>Class III</td>
</tr>
<tr>
<td></td>
<td>Carpet tiles; cartoned</td>
<td>Group A Nonexpanded</td>
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<td></td>
<td>Fiberglass insulation; paper-backed rolls; bagged or unbagged</td>
<td>Class IV</td>
</tr>
<tr>
<td></td>
<td>Floor coverings; vinyl, stacked tiles</td>
<td>Class IV</td>
</tr>
<tr>
<td></td>
<td>Floor coverings; vinyl; rolled</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td>Product Heading</td>
<td>Product</td>
<td>NFPA 13</td>
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<tr>
<td><strong>Gypsum board</strong></td>
<td>Class I</td>
<td></td>
</tr>
<tr>
<td><strong>Housing materials (such as sinks, countertops, etc.); noncombustible, cartoned or crated</strong></td>
<td>Class II</td>
<td></td>
</tr>
<tr>
<td><strong>Paint; oil-based; friction-top metal containers; cartoned</strong></td>
<td>Class II</td>
<td></td>
</tr>
<tr>
<td><strong>Paint; water-based (latex); friction-top metal containers; cartoned</strong></td>
<td>Class IV</td>
<td></td>
</tr>
<tr>
<td><strong>Roofing shingles; asphalt-coated fiberglass</strong></td>
<td>Class III</td>
<td></td>
</tr>
<tr>
<td><strong>Roofing shingles; asphalt-impregnated felt</strong></td>
<td>Class IV</td>
<td></td>
</tr>
<tr>
<td><strong>Miscellaneous</strong></td>
<td><strong>Ammunition; small arms and shotgun; cartoned</strong></td>
<td>Class IV</td>
</tr>
<tr>
<td><strong>Charcoal; mineral spirit impregnated; bagged</strong></td>
<td>Group A Expanded</td>
<td></td>
</tr>
<tr>
<td><strong>Charcoal; standard (non-mineral spirit impregnated); bagged</strong></td>
<td>Class III</td>
<td></td>
</tr>
<tr>
<td><strong>Leather hides; baled</strong></td>
<td>Class II</td>
<td></td>
</tr>
<tr>
<td><strong>Leather; finished products (e.g., shoes, jackets, gloves, bags, luggage, Belts)</strong></td>
<td>Class III</td>
<td></td>
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<tr>
<td><strong>Motors; electric</strong></td>
<td>Class I</td>
<td></td>
</tr>
<tr>
<td><strong>Shock absorbers; metal dust cover</strong></td>
<td>Class I</td>
<td></td>
</tr>
<tr>
<td><strong>Shock absorbers; plastic dust cover</strong></td>
<td>Class III</td>
<td></td>
</tr>
<tr>
<td><strong>Skis; composite materials (plastic, fiberglass, foam, etc.)</strong></td>
<td>Class IV</td>
<td></td>
</tr>
<tr>
<td><strong>Tobacco products; cartoned</strong></td>
<td>Class III</td>
<td></td>
</tr>
<tr>
<td><strong>Toys; stuffed; foam or synthetic</strong></td>
<td>Group A Expanded</td>
<td></td>
</tr>
<tr>
<td><strong>Transformer; dry or empty (i.e., void of oil)-filled</strong></td>
<td>Class I</td>
<td></td>
</tr>
<tr>
<td><strong>Noncombustible Liquids</strong></td>
<td><strong>Liquids or semi-liquids; PET containers greater than 5 gallon (20 L) having a nominal wall thickness greater than 0.25 in (6 mm)</strong></td>
<td>Class IV</td>
</tr>
<tr>
<td><strong>Liquids or semi-liquids; PET containers up to 5 gallon (20 L) or greater than 5 gallon (20 L) having a nominal wall thickness up to 0.25 in (6 mm)</strong></td>
<td>Class I</td>
<td></td>
</tr>
<tr>
<td><strong>Liquids or semi-liquids (e.g., crushed fruits and vegetables); plastic containers up to 5 gallon (18.9 L) capacity</strong></td>
<td>Class I</td>
<td></td>
</tr>
<tr>
<td><strong>Liquids or semi-liquids; plastic (except PET) containers greater than 5 gallon (20 L) capacity having a nominal wall thickness greater than 0.25 in. (6 mm)</strong></td>
<td>Group A Nonexpanded</td>
<td></td>
</tr>
<tr>
<td><strong>Liquids or semi-liquids; plastic (except PET) containers greater than 5 gallon (20 L) capacity having a nominal wall thickness up to 0.25 in. (6 mm)</strong></td>
<td>Class II</td>
<td></td>
</tr>
<tr>
<td><strong>Liquids; cardboard drink boxes, plastic-coated, wax-coated, and/or aluminum-lined; uncartoned or on corrugated carton trays with plastic sheeting.</strong></td>
<td>Class I</td>
<td></td>
</tr>
<tr>
<td><strong>Liquids; cardboard drink boxes, plastic-coated, wax-coated, and/or aluminum-lined; stored in plastic containers</strong></td>
<td>Group A Nonexpanded</td>
<td></td>
</tr>
<tr>
<td><strong>Liquids; glass bottles or jars; cartoned</strong></td>
<td>Class I</td>
<td></td>
</tr>
<tr>
<td><strong>Liquids; pharmaceuticals (nonflammable); glass bottles or jars; cartoned</strong></td>
<td>Class II</td>
<td></td>
</tr>
<tr>
<td><strong>Liquids; plastic bottles or jars; stored in open or solid plastic crates</strong></td>
<td>Group A Nonexpanded</td>
<td></td>
</tr>
<tr>
<td>Product Heading</td>
<td>Product</td>
<td>NFPA 13</td>
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</tr>
<tr>
<td>Paper Products</td>
<td>Book signatures (paper part of book without hard cover)</td>
<td>Class II</td>
</tr>
<tr>
<td></td>
<td>Cartons (i.e., cardboard flats); corrugated; partially assembled</td>
<td>Class IV</td>
</tr>
<tr>
<td></td>
<td>Cartons (i.e., cardboard flats); corrugated; unassembled in neat piles</td>
<td>Class III</td>
</tr>
<tr>
<td></td>
<td>Cartons; wax-coated, single-walled corrugated</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Cellulosic paper products; nonwax-coated (e.g., books, cardboard games, cartoned tissue products, magazines, newspapers, paper cups, paper plates, paper towels, plastic-coated paper food containers, stationery)</td>
<td>Class III</td>
</tr>
<tr>
<td></td>
<td>Cellulosic paper products; wax-coated (e.g., paper plates, cups); loosely packed; cartoned</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Cellulosic paper products; wax-coated (e.g., paper plates, cups.); nested; cartoned</td>
<td>Class IV</td>
</tr>
<tr>
<td></td>
<td>Matches; paper-type; cartoned</td>
<td>Class IV</td>
</tr>
<tr>
<td></td>
<td>Matches; wooden; cartoned</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Rolled; lightweight; in storage racks</td>
<td>Class IV</td>
</tr>
<tr>
<td></td>
<td>Rolled; medium or heavyweight; in storage racks or on-side</td>
<td>Class III</td>
</tr>
<tr>
<td></td>
<td>Tissue products; plastic-wrapped; cartoned</td>
<td>Class III</td>
</tr>
<tr>
<td></td>
<td>Tissue products; plastic-wrapped; uncartoned</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td>Plastic/Rubber</td>
<td>ABS (Acrylonitrile-butadiene-styrene copolymer)</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Acetal (polyformaldehyde)</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Acrylic (polymethyl methacrylate)</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Automobile bumpers and dashboards</td>
<td>Group A Expanded</td>
</tr>
<tr>
<td></td>
<td>Butyl rubber</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Cellulose Acetate</td>
<td>Class IV</td>
</tr>
<tr>
<td></td>
<td>Cellulose Acetate Butyrate</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Chloroprene rubber</td>
<td>Class IV</td>
</tr>
<tr>
<td></td>
<td>Containers; nonexpanded plastic gridded or solid; collapsed or nested with no air spaces</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>ECTFE (ethylene-chlorotrifluoro-ethylene copolymer)</td>
<td>Class IV</td>
</tr>
<tr>
<td></td>
<td>EPDM (ethylene-propylene rubber)</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>ETFE (ethylene-tetrafluoroethylene copolymer)</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Ethyl Cellulose</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>FEP (fluorinated ethylene-propylene copolymer)</td>
<td>Class IV</td>
</tr>
<tr>
<td></td>
<td>FRP (fiberglass-reinforced polyester)</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Melamine (melamine formaldehyde)</td>
<td>Class III</td>
</tr>
<tr>
<td></td>
<td>Nitrile Rubber (acrylonitrile-butadiene rubber)</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Nylon (nylon 6, nylon 6/6)</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>PCTFE (polychlorotrifluoroethylene)</td>
<td>Class III</td>
</tr>
<tr>
<td></td>
<td>PET (Polyethylene Terephthalate — thermoplastic polyester)</td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td></td>
<td>Phenolic</td>
<td>Class III</td>
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<tr>
<td>Product Heading</td>
<td>Product</td>
<td>NFPA 13</td>
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</tr>
<tr>
<td>Plastics; stored in fully closed and solid (no openings), metal containers</td>
<td></td>
<td>Class I</td>
</tr>
<tr>
<td>Polybutadiene</td>
<td></td>
<td>Group A Nonexpanded</td>
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<tr>
<td>Polycarbonate</td>
<td></td>
<td>Group A Nonexpanded</td>
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<tr>
<td>Polyester elastomer</td>
<td></td>
<td>Group A Nonexpanded</td>
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<tr>
<td>Polyethylene</td>
<td></td>
<td>Group A Nonexpanded</td>
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<tr>
<td>Polypropylene</td>
<td></td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td>Polystyrene; foam products (plates, cups, etc.)</td>
<td></td>
<td>Group A Expanded</td>
</tr>
<tr>
<td>Polystyrene; rigid products</td>
<td></td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td>Polyurethane</td>
<td></td>
<td>Group A Expanded</td>
</tr>
<tr>
<td>PTFE (polytetrafluoroethylene)</td>
<td></td>
<td>Class III</td>
</tr>
<tr>
<td>PVC (polyvinyl chloride) products, up to 20% plasticizer</td>
<td></td>
<td>Class III</td>
</tr>
<tr>
<td>PVC (polyvinyl chloride) products, greater than 20% plasticizer</td>
<td></td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td>PVC resins; bagged</td>
<td></td>
<td>Class III</td>
</tr>
<tr>
<td>PVDC (polyvinylidene chloride)</td>
<td></td>
<td>Class III</td>
</tr>
<tr>
<td>PVDF (polyvinylidene fluoride)</td>
<td></td>
<td>Class III</td>
</tr>
<tr>
<td>PVF (polyvinyl fluoride)</td>
<td></td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td>Rubber; natural in blocks; cartoned</td>
<td></td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td>Rubber; natural; expanded</td>
<td></td>
<td>Group A Expanded</td>
</tr>
<tr>
<td>Rubber; natural; nonexpanded</td>
<td></td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td>Rubber; synthetic (santoprene)</td>
<td></td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td>SAN (styrene acrylonitrile)</td>
<td></td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td>SBR (styrene-butadiene rubber)</td>
<td></td>
<td>Group A Nonexpanded</td>
</tr>
<tr>
<td>Silicone rubber</td>
<td></td>
<td>Class IV</td>
</tr>
<tr>
<td>Urea (urea formaldehyde)</td>
<td></td>
<td>Class III</td>
</tr>
<tr>
<td>Plastic Containers</td>
<td>Bottles or jars (except PET) greater than 1 gallon (4 L) containing noncombustible solids</td>
<td></td>
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<tr>
<td></td>
<td>Bottles or jars (except PET) up to 1 gallon (4 L) containing noncombustible solids</td>
<td></td>
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<tr>
<td>Powders/Pills</td>
<td>Pharmaceutical pills; glass bottles or jars; cartoned</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pharmaceuticals pills; plastic bottles or jars; cartoned</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Polyvinyl Alcohol (PVA) resins; bagged</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Powders; combustible (ordinary such as sugar or flour); free-flowing; bagged</td>
<td></td>
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<tr>
<td></td>
<td>Powders; noncombustible free-flowing powdered or granular materials (cement, calcium chloride, clay, iron oxide, sodium chloride, sodium silicate, etc.)</td>
<td></td>
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<td></td>
<td>Powders; noncombustible; glass bottles or jars; cartoned</td>
<td></td>
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<td></td>
<td>Powders; noncombustible; PET bottles or jars</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Powders; noncombustible; plastic (other than PET) bottles or jars; uncartoned</td>
<td></td>
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<tr>
<td>Product Heading</td>
<td>Product</td>
<td>NFPA 13</td>
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<tr>
<td><strong>Product</strong></td>
<td><strong>Powders; noncombustible; plastic bottles or jars greater than 1 gallon (4 L) capacity</strong></td>
<td><strong>Group A Nonexpanded</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Powders; noncombustible; plastic bottles or jars up to 1 gallon (4 L) capacity; cartoned</strong></td>
<td><strong>Class IV</strong></td>
</tr>
<tr>
<td><strong>Textile Materials/Products</strong></td>
<td><strong>Cloth; natural fibers; baled</strong></td>
<td><strong>Class III</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Cloth; synthetic cloth</strong></td>
<td><strong>Class IV Group A Nonexpanded</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Clothing; natural fibers (e.g., wool, cotton) and viscose</strong></td>
<td><strong>Class III</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Cotton; cartoned</strong></td>
<td><strong>Class III</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Diapers; cotton or linen</strong></td>
<td><strong>Class III</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Diapers; plastic or nonwoven fabric; cartoned</strong></td>
<td><strong>Class IV</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Diapers; plastic or nonwoven fabric; plastic-wrapped; uncartoned</strong></td>
<td><strong>Group A Nonexpanded</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Fabric; rayon and nylon</strong></td>
<td><strong>Class IV Group A Nonexpanded</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Fabric; synthetic (except rayon and nylon); greater than 50/50 blend</strong></td>
<td><strong>Group A Nonexpanded</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Fabric; synthetic (except rayon and nylon); up to 50/50 blend</strong></td>
<td><strong>Class III Group A Nonexpanded Plastic</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Fabric; vinyl-coated (e.g. tablecloth); cartoned</strong></td>
<td><strong>Group A Nonexpanded</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Fibers; rayon and nylon; baled</strong></td>
<td><strong>Class IV</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Fibers; synthetic (except rayon and nylon); baled</strong></td>
<td><strong>Group A Nonexpanded</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Thread or yarn; rayon and nylon; wood or paper spools</strong></td>
<td><strong>Class IV</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Thread or yarn; rayon or nylon; plastic spools</strong></td>
<td><strong>Group A Nonexpanded</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Thread or yarn; synthetic (except rayon and nylon); greater than 50/50 blend; paper or wood spools</strong></td>
<td><strong>Class IV Group A Nonexpanded Plastic</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Thread or yarn; synthetic (except rayon and nylon); greater than 50/50 blend; plastic spools</strong></td>
<td><strong>Group A Nonexpanded</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Thread or yarn; synthetic (except rayon and nylon); up to 50/50 blend; plastic spools</strong></td>
<td><strong>Group A Nonexpanded</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Thread or yarn; synthetic (except rayon and nylon); up to 50/50 blend; wood or paper spools</strong></td>
<td><strong>Class III Group A Nonexpanded Plastic</strong></td>
</tr>
<tr>
<td><strong>Wax Products</strong></td>
<td><strong>Candles</strong></td>
<td><strong>Group A Expanded</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Paraffin or petroleum wax; blocks</strong></td>
<td><strong>Group A Expanded</strong></td>
</tr>
<tr>
<td><strong>Wire/Cable/Spools</strong></td>
<td><strong>Spools; plastic; empty</strong></td>
<td><strong>Group A Nonexpanded</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Spools; wood; empty</strong></td>
<td><strong>Class III</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Wire or cable; PVC insulated; metal or wood spools</strong></td>
<td><strong>Class II</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Wire or cable; PVC insulated; plastic spools</strong></td>
<td><strong>Class IV</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Wire; bare; metal spools, uncartoned</strong></td>
<td><strong>Class I</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Wire; bare; metal spools; cartoned</strong></td>
<td><strong>Class II</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Wire; bare; plastic spools; cartoned</strong></td>
<td><strong>Class IV</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Wire; bare; plastic spools; uncartoned</strong></td>
<td><strong>Group A Nonexpanded</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Wire; bare; wood or cardboard spools</strong></td>
<td><strong>Class II</strong></td>
</tr>
<tr>
<td><strong>Wood Products</strong></td>
<td><strong>Wood patterns</strong></td>
<td><strong>Class IV</strong></td>
</tr>
<tr>
<td>Product Heading</td>
<td>Product</td>
<td>NFPA 13</td>
</tr>
<tr>
<td>-----------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Wood products (e.g., fiberboard, lumber, particle board, plywood, pressboard with smooth ends and edges); bundled solid blocks</td>
<td></td>
<td>Class II</td>
</tr>
<tr>
<td>Wood products (e.g., fiberboard, lumber, particle board, plywood, pressboard with smooth ends and edges); unbundled or non-solid blocks</td>
<td></td>
<td>Class III</td>
</tr>
<tr>
<td>Wood products (e.g., toothpicks, clothespins and hangers)</td>
<td></td>
<td>Class III</td>
</tr>
</tbody>
</table>

**Submitter Information Verification**

**Submitter Full Name:** AUT-SSD  
**Organization:** National Fire Protection Assoc  
**Street Address:**  
**City:**  
**State:**  
**Zip:**  
**Submittal Date:** Mon Sep 19 14:12:39 EDT 2016

**Committee Statement**

FM Global has conducted commodity classification and large-scale testing with uncartoned synthetic yarn on cardboard spools in 2015 and 2016. Large-scale testing of solid-piled synthetic yarn required ceiling only protection equivalent to that of uncartoned unexpanded plastic. Therefore it is recommended that:

1. Cloth; synthetic cloth” be removed from Table A.5.6.3 as an example of Class 4 commodities and be listed as a Group A, Nonexpanded Plastic.

2. Textile Materials/Products Fabric; rayon and nylon” be removed from Table A.5.6.3 as an example of Class 4 commodities and be listed as a Group A, Nonexpanded Plastic.

3. Fabric; synthetic (except rayon and nylon); up to 50/50 blend” be removed from Table A.5.6.3 as an example of Class 3 commodities and be listed as a Group A, Nonexpanded Plastic.

4. Thread or yarn; synthetic (except rayon and nylon); greater than 50/50 blend; paper or wood spools” be removed from Table A.5.6.3 as an example of Class 4 commodities and be listed as a Group A, Nonexpanded Plastic.

5. Thread or yarn; synthetic (except rayon and nylon); up to 50/50 blend; wood or paper spools” be removed from Table A.5.6.3 as an example of Class 3 commodities and be listed as a Group A, Nonexpanded Plastic.

**Response Message:**

National Fire Protection Association Report http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...
**Committee Statement**

**Committee Statement:** The first sentence is incorrect and conflicts with Figures 5.6.3.3.3(a) & (b). The second sentence was in the wrong location. Additionally, the current text provided no additional clarification. There is value to stating that both can exist since it is Class IV has the opposite philosophy.

The first sentence is incorrect and conflicts with Figures 5.6.3.3.3(a) & (b). The second sentence was in the wrong location. Additionally, the current text provided no additional clarification. There is value to stating that both can exist since it is Class IV has the opposite philosophy. The task group believes that the information indicated in A.5.6.3.3.2 is adequately captured in the body of the standard and does not require Annex material.

**Response Message:**

Public Input No. 62-NFPA 13-2016 [Section No. A.5.6.3.3.2]
This section is included to compensate for possible delay in operation of sprinklers from fires in combustible concealed spaces found in wood frame, brick veneer, and ordinary construction.

In order for the minimum 3000 ft\(^2\) (279 m\(^2\)) requirement for the size of the remote area to not be extended to the adjacent area, the qualifying concealed space must be separated by the entire fire-rated assembly. Such assemblies often have combustible structural members separating the exterior membranes that can create a concealed combustible space that can qualify for omitting sprinkler protection. If the fire-rated assembly is the qualifying concealed space, an interior fire would greatly reduce the assigned fire-rated duration.

Composite wood joists are not considered solid wood joists for the purposes of this section. Their web members are too thin and easily penetrated to adequately compartment a fire in an unsprinklered space. Application of this item is not affected by the depth of the joist channel except in determining the volume. The concealed space above the insulation can be an attic, roof space, or floor space within a floor assembly.

The gypsum board (or equivalent material) used as the firestopping will compartment the concealed space and restrict the ability for fire to spread beyond 160 ft\(^3\) (4.5 m\(^3\)) zones covering multiple joist channels.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Mon Aug 15 16:05:50 EDT 2016

Committee Statement

Committee Statement: This Public Input appeared as “Reject but Hold” in Public Comment No. 204 of the (A2015 cycle) Second Draft Report.

The redundancy task group agrees with this PC. Moved location of annex text to correlate with relocation of text to section 11.1. The format is hard to read but the new locations are: A.11.1.8.1 / A.11.1.8.2(9) / A/11.1.8.2(10) The text between A.11.2.3.1.4(3) / A.11.2.3.1.4(4(d) / A.11.2.3.1.4(4(j) and A.12.9.1 / A.12.9.2(4) / A.12.9.2(10) are identical except that chap 12 is missing the first paragraph of ch 11 explaining why a larger area is needed.

Response Message:

Public Input No. 128-NFPA 13-2016 [Sections A.11.2.3.1.5.1, A.11.2.3.1.5.2(4), A.11.2.3.1.5.2(...]
The reasons for using larger orifice sprinklers in storage situations are based on a number of fire tests in recent years that continue to show an advantage of the larger orifice [K-11.2 (161) and K-16.8 (242)] sprinklers over the K-5.6 (80) and even the K-8 (115) orifice sprinklers. Following are four sets of fire test comparisons using constant densities [see Table A.21.1.2(a) and Table A.21.1.2(b)]:

Table A.21.1.2(a) Ceiling Type

<table>
<thead>
<tr>
<th>Fire Type</th>
<th>Ceiling Type</th>
<th>Sprinkler Distance Below Ceiling (in. (mm))</th>
<th>Time to Activation (seconds)</th>
<th>Size of Fire at Activation [Btu/s (kW)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast-growing fire</td>
<td>Insulated deck</td>
<td>1 (25)</td>
<td>76</td>
<td>450 (475)</td>
</tr>
<tr>
<td></td>
<td>Steel</td>
<td>1 (25)</td>
<td>97</td>
<td>580 (612)</td>
</tr>
<tr>
<td></td>
<td>Wood</td>
<td>1 (25)</td>
<td>71</td>
<td>420 (443)</td>
</tr>
<tr>
<td></td>
<td>Insulated deck</td>
<td>12 (300)</td>
<td>173</td>
<td>1880 (1985)</td>
</tr>
<tr>
<td></td>
<td>Steel</td>
<td>12 (300)</td>
<td>176</td>
<td>1930 (2035)</td>
</tr>
<tr>
<td></td>
<td>Wood</td>
<td>12 (300)</td>
<td>172</td>
<td>1900 (475)</td>
</tr>
<tr>
<td>Slow-growing fire</td>
<td>Insulated deck</td>
<td>1 (25)</td>
<td>281</td>
<td>220 (232)</td>
</tr>
<tr>
<td></td>
<td>Steel</td>
<td>1 (25)</td>
<td>375</td>
<td>390 (411)</td>
</tr>
<tr>
<td></td>
<td>Wood</td>
<td>1 (25)</td>
<td>268</td>
<td>200 (211)</td>
</tr>
<tr>
<td></td>
<td>Insulated deck</td>
<td>12 (300)</td>
<td>476</td>
<td>630 (665)</td>
</tr>
<tr>
<td></td>
<td>Steel</td>
<td>12 (300)</td>
<td>492</td>
<td>675 (712)</td>
</tr>
<tr>
<td></td>
<td>Wood</td>
<td>12 (300)</td>
<td>473</td>
<td>620 (654)</td>
</tr>
</tbody>
</table>

Table A.21.1.2(b) Ceiling Arrangement

<table>
<thead>
<tr>
<th>Situation</th>
<th>Fire Type</th>
<th>Time to Activate Sprinkler (seconds)</th>
<th>Size of Fire at Time of Activation [Btu/s (kW)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling with pocket</td>
<td>Fast</td>
<td>86 to 113</td>
<td>585 (617)</td>
</tr>
<tr>
<td>Sprinkler 12 in. below ceiling</td>
<td>Fast</td>
<td>172 to 176</td>
<td>1880 to 1900 (1985 to 2005)</td>
</tr>
<tr>
<td>Ceiling with pocket</td>
<td>Slow</td>
<td>288 to 395</td>
<td>490 (517)</td>
</tr>
<tr>
<td>Sprinkler 12 in. below ceiling</td>
<td>Slow</td>
<td>473 to 492</td>
<td>620 to 675 (654 to 712)</td>
</tr>
</tbody>
</table>

1. K-5.6 (80) vs. K-11.2 (161)
   (a) Commodity — idle wood two-way pallets
   (b) 2 stacks × 3 stacks × 8 ft (2.4 m) high
   (c) Ceiling height — 30 ft (9.1 m)
   (d) Density — constant 0.30 gpm/ft² (12.2 mm/min)
   (e) Test #1 — 165°F (74°C) rated, K-11.2 sprinklers
   (f) Test #2 — 165°F (74°C) rated, K-5.6 sprinklers
   (g) Test #1 results — 4 A.S. operated
   (h) Test #2 results — 29 A.S. operated, less fire control and greater temperatures

   (a) Commodity — idle wood four-way pallets
   (b) Two stacks × three stacks × 12 ft high (3.7 m)
(c) Ceiling height — 30 ft (9 m)
(d) Density — constant 0.6 gpm/ft² (24.4 mm/min)
(e) Test #1 — 286°F (141°C) rated, K-8 sprinklers
(f) Test #2 — 165°F (74°C) rated, K-11.2 sprinklers
(g) Test #3 — 165°F (74°C) rated, K-16.8 sprinklers
(h) Test #1 results — 10 A.S. operated, 1215°F (658°C) maximum steel temperature, fire spread to all sides
(i) Test #2 results — 13 A.S. operated, 200°F (94°C) maximum steel temperature, fire spread to three sides
(j) Test #3 results — 6 A.S. operated, 129°F (54°C) maximum steel temperature, fire spread (just reached) one side

(3) K-5.6 vs. K-16.8

(a) Commodity — FMRC standard plastic commodity rack style 9 ft (2.7 m) high
(b) Ceiling height — 30 ft (9.1 m)
(c) Density — 0.45 gpm/ft² (18.3 mm/min)
(d) Test #1 — K-5.6 orifice sprinklers
(e) Test #2 — K-16.8 orifice sprinklers
(f) Test #1 results — 29 A.S. operated, 14 pallet loads consumed
(g) Test #2 results — 5 A.S. operated, 2 pallet loads consumed

(4) K-8.0 vs. K-16.8

(a) Commodity — FMRC standard plastic commodity rack stage 14 ft (4.3 m) high
(b) Ceiling height — 25 ft (7.6 m)
(c) Density — 0.60 gpm/ft² (24.4 mm/min)
(d) Test #1 — K-8.0 sprinklers
(e) Test #2 — K-16.8 sprinklers
(f) Test #1 results — 29 A.S. operated, 25 pallet loads consumed
(g) Test #2 results — 7 A.S. operated, 4 pallet loads consumed

On an equal density basis, the fire test comparisons show the advantage of the larger orifices. A possibly even bigger advantage can be seen when investigating the performance of larger orifice sprinklers in the real world condition of high initial operating pressures.

The volume of water discharged through the larger K-factor for the initial sprinklers has three significant effects:

(1) First, the increase in sheer volume flowing through the larger orifice enhances performance. For example, a 165 psi (11.4 bar) initial operating pressure would provide 102.8 gpm (390 L/min) from a K-8, while the K-16.8 will discharge 215.8 gpm (815 L/min).

(2) Second, fire testing at high pressures [100+ psi (6.9 bar)] with K-5.6 and K-8 (when high fire updrafts occur) has shown less water penetration and more sprinkler skipping. When fire testing the K-11 and K-16.8 sprinklers at 100+ psi (6.9 bar), more water penetration is evident and little or no sprinkler skipping has occurred.

(3) Third, with such high initial discharge rates among K-16.8 sprinklers, the friction loss in the supply pipes would be greater. This would result in lower initial pressures than a K-8 as well as being farther down the water supply curve with greater flows resulting in lower initial operating pressures.

Figure A.21.1.2 highlights the differences between the K-8 and K-16.8 initial operating pressures.

Figure A.21.1.2 Available Pressure Comparison.
The higher flow rate of the K-16.8 sprinkler results in greater friction losses in the initial operating heads as compared to the K-8 sprinkler. Combined with the lower pressure available on the water supply curve, the end result is a self-regulating K-factor allowing greater initial pressures without a negative impact.

Table A.21.1.2(c) summarizes the paper product testing.

Table A.21.1.2(c) Paper Product Testing Results

<table>
<thead>
<tr>
<th>Test Date</th>
<th>Test Parameters</th>
<th>Sprinklers</th>
<th>Temperature (°F, °C)</th>
<th>Storage Type</th>
<th>Storage Height (ft, m)</th>
<th>Ceiling Height (ft, m)</th>
<th>Sprinkler Flow Pressure (psi, bar)</th>
<th>Number of Operated Sprinklers</th>
<th>Peak Gas Temperature (°F, °C)</th>
<th>Peak Steel Temperature (°F, °C)</th>
<th>Fire Spread Across Aisle (30 in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/25/98</td>
<td>Sprinklers</td>
<td>K-8</td>
<td>286°F (141°C)</td>
<td>4 tier pyramid</td>
<td>16 ft (4.9 m)</td>
<td>30 ft (9.1 m)</td>
<td>22.6 psi (1.6 bar)</td>
<td>15</td>
<td>—</td>
<td>—</td>
<td>N/A</td>
</tr>
<tr>
<td>3/18/98*</td>
<td>Sprinklers</td>
<td>K-8</td>
<td>286°F (141°C)</td>
<td>5 tier pyramid</td>
<td>22 ft (6.7 m)</td>
<td>31 ft (9.1 m)</td>
<td>175 psi (12.1 bar)</td>
<td>2</td>
<td>868°F (464°C)</td>
<td>—</td>
<td>Yes</td>
</tr>
<tr>
<td>4/4/98</td>
<td>Sprinklers</td>
<td>K-11</td>
<td>165°F (74°C)</td>
<td>4 tier pyramid</td>
<td>16 ft (4.9 m)</td>
<td>30 ft (9.1 m)</td>
<td>11.9 psi (0.82 bar)</td>
<td>10</td>
<td>—</td>
<td>421°F (216°C)</td>
<td>N/A</td>
</tr>
<tr>
<td>6/4/98†</td>
<td>Sprinklers</td>
<td>K-16.8</td>
<td>155°F (68°C)</td>
<td>5 tier pyramid</td>
<td>22 ft (6.7 m)</td>
<td>31 ft (9.1 m)</td>
<td>130 psi (9.0 bar)</td>
<td>2</td>
<td>424°F (217°C)</td>
<td>113°F (45°C)</td>
<td>No</td>
</tr>
</tbody>
</table>

*This test was run with a fire brigade response of 20:00 minutes.
†This test was run with a fire brigade response of 7:00 minutes.

The tests indicated that even at a high temperature of 286°F (141°C), the K-8 sprinklers operating at higher pressures were not effective in controlling the fire. Conversely, the K-16.8 sprinkler was able to control the fire at the lower temperature [155°F (68°C)], by operating sooner, and at lower, self-regulating flowing pressures.

Conclusions. The larger K-factor of the K-16.8 sprinkler is not affected by high initial operating pressures. In fact, the protection is enhanced, providing better fire protection.

The ability to use lower-rated temperatures, such as 155°F (68°C) in lieu of 286°F (141°C), shows that the performance of the initial operating sprinklers is effective in controlling the fire. Therefore, using high-temperature heads sprinklers to reduce the number of surrounding rings of sprinklers to open is not necessary when using the K-16.8 technology.

In short, the K-16.8 sprinkler proved highly effective when subjected to high initial operating pressures.
Committee Statement

Committee Statement: NFPA 13 does not define what a sprinkler head is. Change the term to sprinkler. The only change is located in the next to the last paragraph. Terraview has underlined all the tables.

Response Message:

Public Input No. 21-NFPA 13-2016 [Section No. A.12.6]
A.24.2.2.2
An adjustment to the waterflow test data to account for daily and seasonal fluctuations, possible interruption by flood or ice conditions, large simultaneous industrial use, future demand on the water supply system, or any other condition that could affect the water supply should be made as appropriate.

Submitter Information Verification
Submitter Full Name: AUT-SSD
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 15 12:24:05 EDT 2016

Committee Statement
Committee Statement: This Public Input appeared as “Reject but Hold” in Public Comment No. 234 of the (A2015 cycle) Second Draft Report.
This is one of a series of proposals to make the adjustment to the data from a waterflow test required instead of recommended. If the adjustment is not required, contractors that do the right thing and adjust the data from tests are at a disadvantage from contractors that don't make any adjustment. It is fundamentally wrong to not make an adjustment to the data due to daily and seasonal fluctuations. This proposal makes a simple and easy to understand adjustment that is standardized so that there is no argument over what is supposed to happen. It is the intent to have this be the only adjustment. If the water utility has already performed the adjustment, or if the AHJ has already mandated a safety margin or safety factor to the waterflow data obtained from the test, this adjustment would not apply.

Response Message:
Public Input No. 131-NFPA 13-2016 [Section No. A.24.2.2.2]
C.26  [16.1.10.3, 16.1.11.1.2, 17.1.9.3, 17.1.10.1.2]

During full-scale fire tests, flue space width and alignment are typically set with care for test consistency and repeatability. Some full-scale fire tests and fire experience have shown sprinkler protection designed and installed in accordance with this standard are able to tolerate random variations in flue width and vertical flue alignment. For example, see Test 7 in the National Quick Response Sprinkler Research Project: Large-Scale Fire Evaluation of Early Suppression Quick-Response (ESFR) Automatic Sprinklers (report available from the NFPA Research Foundation web site). For Test 7, transverse flue variations were substantial such that some flues at various tiers were completely closed (i.e., pallet loads placed immediately adjacent to each other), and the vertical alignment of one transverse flue was completely disrupted. The result was the operation of eight K14 (K200) ESFR sprinklers as well as minor aisle jump to both target racks. Reported damage was \( \frac{2}{3} \) pallet loads in the main rack array and \( \frac{1}{4} \) pallet load in the large racks. Findings such as Test 7 support the toleration of flue variations in the real world. However, ideally pallet loads should be positioned in racks with care to reduce the challenge faced by sprinklers should a fire occur.

Submitter Information Verification

Submitter Full Name: AUT-SSD
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Sep 09 09:20:01 EDT 2016

Committee Statement

Committee Statement: Provide annex material to explain a basis for random variation in flue width and vertical alignment. Provided details of one fire test investigating these variables.

Response Message:

Public Input No. 390-NFPA 13-2016 [New Section after A.16.1.9]