Fire Protection for Storage Applications

Housekeeping

- Polling
- Post-webinar assessment
- Ask questions
- Chat window
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1. Attendee must register/sign in with all required info.
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3. Attendee must actively participate in classroom discussions via polling and chat
4. Attendee must achieve a passing score of 70% or higher on the final assessment (within 24 hrs.)
5. Successful completion will earn attendee 0.1 CEU

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Portfolio of Flagship Brands

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Introduction

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Location: Cranston, Rhode Island

Education:
- BS in Fire Protection and Safety Engineering and Technology, The Oklahoma State University (OSU)
- Currently studying for MS in Fire Safety and Explosion Protection, (OSU)

Poll Question 1

How comfortable are you with water-based fire protection for storage applications?

A. This is brand new to me.
B. I understand the concept but have limited experience.
C. I am very familiar with the topic.
D. I am extremely familiar with the topic.
Objectives

- Summarize Commodity Classification per NFPA 13
- Describe Storage Arrangements and Types
- Interpret the NFPA 13 Rack Storage Protection Tables

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What was the Problem?

Commodity Classes – Class I

- **Noncombustible product that meets one of the following criteria:**
  - Placed directly on wooden pallets
  - Placed in single-layer corrugated cartons, with or without single-thickness cardboard dividers, with or without pallets
  - Shrink-wrapped or paper-wrapped as a unit load with or without pallets

FM Global 8-1: A. Noncombustible materials on wood or FM Approved pallets. B. Noncombustible materials packaged in single-layer corrugated cardboard cartons with or without single thickness dividers, or in ordinary paper wrappings on wood or FM Approved pallets. Class 1 commodities may contain a negligible amount of plastic trim such as knobs or handles.
### Commodity Classes – Class II

- Noncombustible product that is in slatted wooden crates, solid wood boxes, multiple-layered corrugated cartons, or equivalent combustible packaging material, with or without pallets.

  ![Metal-lined double tri-wall corrugated carton on a wood pallet](image)

  **FM Global 8-1: 2.3.3.1** Classify stored materials that meet the following as Class 2 commodities: Noncombustible or Class 1 commodities stored in multiple-thickness corrugated cardboard cartons, slatted wooden containers, solid wooden boxes, or equivalent combustible packaging material on wood or FM Approved pallets.

### Commodity Classes – Class III

- A product fashioned from wood, paper, natural fibers, or Group C plastics with or without cartons, boxes, or crates and with or without pallets.

  **Group C plastics - (NFPA 13, 5.6.4.3)**
  1. Fluoroplastics (PCTFE — polychlorotrifluoroethylene; PTFE — polytetrafluoroethylene)
  2. Melamine (melamine formaldehyde)
  3. Phenolic
  4. PVC (polyvinyl chloride — flexible — PVCs with plasticizer content up to 20 percent)
  5. PVDC (polyvinylidene chloride)
  6. PVDF (polyvinylidene fluoride)
  7. PVF (polyvinyl fluoride)
  8. Urea (urea formaldehyde)

- A limited amount (5% by weight or volume or less) of Group A or Group B plastics.

  ![Trident gum and paper cups in compartmented cardboard cartons on wood pallets](image)

  **FM Global 8-1: 2.3.4.1** Classify stored materials that meet the following criteria as Class 3 commodities: A. Cellulosic materials, such as wood, paper, or natural textiles, on wood or FM Approved pallets. Products may or may not be stored in corrugated cardboard cartons. B. Classes 1, 2, and 3 materials containing no more than 5% plastic (unexpanded, expanded, or a combination of the two) by either weight or volume.
Commodity Classes – Class IV

- A product, with or without pallets, that meets one of the following criteria:
  - Constructed partially or totally of Group B plastics
    - Group B plastics:
      1. Chloroprene rubber
      2. Fluoroplastics (ECTFE — ethylene-chlorotrifluoro-ethylene copolymer; ETFE — ethylene tetrafluoroethylene-copolymer; FEP—fluorinated ethylene-propylene copolymer)
      3. Silicone rubber
  - Consists of free-flowing Group A plastic materials
  - Contains within itself or its packaging an appreciable amount (5% to 15% by weight or 5% to 25% by volume) of Group A plastics

![Image of a product on pallets]

A mixture of paper and plastic cups (15% plastic by weight) on wood pallets.

FM Commodity Classes – Class IV

FM Global 8-1:2.3.5.1 Treat stored materials that meet the following criteria as unexpanded plastic:
A. Total weight or volume of unexpanded plastic is more than 5% for a single pallet load.
B. Total volume of expanded plastic (foam plastic) is from 5% to 40% for a single pallet load.
C. Total volume of expanded plastic is greater than 5% and up to 10% when exposed or located on the outer portion of the material (i.e., protects or envelops the material).

See Figure 2. 2.3.5.2 If the material is considered unexpanded plastic and is stored in corrugated cardboard cartons, treat the commodity as cartoned unexpanded plastic (CUP)/Class 4. Otherwise, treat it as uncartoned unexpanded plastic (UUP). Some exceptions apply and are listed in Table 2 (Section 2.4).
Commodity Classes – Group A

- Plastic materials
  - Cartoned vs. Uncarton (Exposed)
  - Expanded vs. Nonexpanded
- Group A Plastics:
  - Natural Rubber
  - Acrylic
  - EPDM
  - Fiber-glass Reinforced Polyester
  - Nitrile-rubber
  - PET (Thermoplastic Polyester)
  - Polybutadiene
  - Polycarbonate
  - Polyethylene
  - Polypropylene
  - Polystyrene
  - Polyurethane
  - Highly Plasticized PVC
  - Nylon (nylon 6, nylon 6/6)

Expanded or Unexpanded?

16-oz (450 g) Polystyrene Plastic Jars in compartmented cardboard cartons

Expanded Polystyrene Trays Exposed

NFPA 13-20.4.5.2
Poll Question 2

Which option is another example of an expanded plastic commodity?

A. Red Solo Cup  
B. Styrofoam Coffee Cup  
C. Buzz Lightyear Action Figure

Mixed Commodities

- Protection requirements shall not be based on the overall commodity mix in a fire area.
- In general, mixed commodity storage shall be protected by the requirements for the highest classified commodity and storage arrangement.
- The protection requirements for the lower commodity class shall be permitted to be utilized where all of the following are met:
  - Up to 10 pallet loads of a higher hazard commodity shall be permitted to be present in an area not exceeding 48,000 ft² (3716 m²).
  - The higher hazard commodity shall be randomly dispersed with no adjacent loads in any direction (including diagonally).
  - 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.
- 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.
Encapsulation

- Plastic sheet completely enclosing the sides and top of a pallet load containing a combustible commodity
- Combustible commodities individually wrapped in plastic sheeting and stored exposed in a pallet load
- Where there are holes or voids in the plastic on the top of the carton that exceed more than half of the area of the cover, the term encapsulated does not apply

NFPA 13- 3.3.64, A.3.1.16

Plastic Pallet Types

- **Un-reinforced plastic pallets**
  - Melt fairly easily in a fire and are less of a fire challenge
  - Material
    - Polypropylene
    - High-density polyethylene
- **Reinforced plastic pallets**
  - Hold their structure and integrity longer allowing air gaps to remain longer within the pallet, which fuels the flames and creates a more intense fire
  - Material
    - Polypropylene
    - High-density polyethylene
- **Classification by Listing**
Storing Materials on Plastic Pallets

- One class upgrade for un-reinforced plastic pallets
  - Class II → Class III
  - Class IV → Group A Plastics

- Two class upgrade for reinforced plastic pallets
  - Class II → Class IV
  - Class IV → Group A Plastics

Other Types of Commodities

- Rubber Tire (Chapter 18)
- Rolled Paper (Chapter 19)
- Idle Pallet (20.14)
- Baled Cotton (21.10)
FM Guidelines

Idle Pallet (8-24)

Rubber Tire (8-3)

Rolled Paper (8-21)

Baled Fiber (8-7)

Storage Arrangements

- Idle Pallet Storage
- Miscellaneous Storage
- Solid Pile Storage
- Palletized Pile Storage
- Bin Box Storage
- Shelf Storage
- Rack Storage
Idle Pallet storage (Chapter 20)

Wood Pallets

Plastic Pallets

Miscellaneous Storage

- Incidental Storage < 12ft (3.7m)
- Storage < 10% of building area or 4000 ft² (372 m²) of the sprinklered area, whichever is greater
- Storage shall not exceed 1000 ft² (93 m²) in one pile or area
- Each such pile or area shall be separated from other storage areas by at least 25ft (7.6m)
Solid-Pile, Palletized, Bin Box, Self Storage, or Back-to-Back Shelf Storage (Chapters 20-25)

- **Solid Pile**
- **Palletized**
- **Bin Box**
- **Shelf Storage**
- **Back to Back Shelf**

Pile Stability

- **Stable Piles**: Arrays where collapse, spillage of content, or leaning of stacks across flue spaces is not likely to occur soon after initial fire development.

- **Stable Piles**: Arrays where collapse, spillage of contents, or leaning of stacks across flue spaces occurs soon after initial fire development.

- **Unstable Piles**: Arrays where collapse, spillage of contents, or leaning of stacks across flue spaces occurs soon after initial fire development.
Unstable Pile

Pile Stability

Note: Cartons that contain Group A plastic material are permitted to be treated as Class IV commodities under either of the following conditions:

1. There are multiple layers of corrugation or equivalent outer material that would significantly delay fire involvement of the Group A plastic.
2. The amount and arrangement of Group A plastic material within a carton with a single layer of corrugation would not be expected to significantly increase the fire hazard.

FIGURE 21.3.1 Decision Tree.
### Pile Stability

**Table 31.5.5,a** Design Densities for Palletized, Solid-Piled, Bin Box, or Shelf Storage of Group A Plastic Commodities (U.S. Customary Units)

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**Notes:**

1. Minimum clearance between sprinkler deflector and top of storage shall be maintained as required.
2. Column designations correspond to the configuration of plastics storage as follows:
   - A: Not required, not required
   - B: Nonexpanded, stable, solid load
   - C: Expanded, exposed, stable
   - D: Nonexpanded, stable, expanded
   - E: Expanded, exposed, unstable
3. E11 = Density required by Fire Hazard Group 1 design curve and 19.3.3.1.1
4. E12 = Density required by Extra Hazard Group 2 design curve and 19.3.3.1.1
5. Roof/ceiling height 60 ft or not prioritized.

### High Piled Storage

![High Piled Storage Image]
Rack Storage Arrangements (Chapters 21-25)

- Rack Storage (No Solid Shelves)
  - Single Row (3.3.191)
    - Racks that have no longitudinal flue space and that have a width up to 6ft (1.8m) with aisles at least 3.5ft (1.1m) from other storage.
  - Double Row (3.3.56)
    - Two single-row racks placed back-to-back having a combined width up to 12ft (3.7m), with aisles at least 3.5ft (1.1m) on each side.
  - Multiple Row (3.3.127)
    - Racks greater than 12ft (3.7m) wide or single- or double-row racks separated by aisles less than 3.5ft (1.1m) wide having an overall width greater than 12ft (3.7m).

Aisles and Flue Considerations

- The clear space normally maintained between commodities stored in racks or on the floor for the transfer of commodities to or from the rack or storage pile.
- The open spaces between rows of storage.
Storage Height & Clearance

- Increased clearance delays sprinkler operation time, resulting in a larger fire size at the time of operation.

- Increased clearance results in a larger fire plume above the top of storage, which reduces the ability of water from sprinklers to reach the seat of a fire.

- The minimum clearance between the sprinkler deflector and top of storage allows the proper spray pattern to develop.

- Clearance from Deflector to Storage: 20.6.6 (New to 2019)

- Excessive Clearance Protection: 25.9.5

NFPA 13

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#### Poll Question 3

What NFPA 13 Edition does your jurisdiction follow?

- A. 2019 Edition
- B. 2016 Edition
- C. 2013 Edition
- D. Earlier than 2013 Edition
- E. I have no idea!
Control Mode Sprinklers

![Heat release graph]

Control Mode Density Area (CMDA)

Density / Area Method

21.2* Control Mode Density/Area Sprinkler Protection Criteria for Palletized, Solid-Piled, Bin Box, Shelf, or Back-to-Back Shelf Storage of Class I Through Class IV Commodities.

21.2.1 Protection for Class I through Class IV commodities in the following configurations shall be provided in accordance with this section:

1. Nonencapsulated commodities that are solid-piled, palletized, or bin box storage up to 30 ft (9.1 m) in height
2. Nonencapsulated commodities on shelf storage up to 15 ft (4.6 m) in height
3. Encapsulated commodities that are solid-piled, palletized, bin box, or shelf storage up to 15 ft (4.6 m) in height
4. Back-to-back shelf storage up to 15 ft (4.6 m) in height
5. Encapsulated storage of solid-piled and palletized Class I through IV commodities permitted in accordance with 21.2.3 for storage heights over 15 ft (4.6 m) up to and including 20 ft (6.1 m)
Control Mode Density Area (CMDA)

Density / Area Method

FIGURE 21.2.2.1 Sprinkler System Design Curves for 20 ft (6.1 m) High Storage — Ordinary Temperature-Rated Sprinklers.

Control Mode Density Area (CMDA)

Density / Area Method

FIGURE 21.4.1.2(a) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class 1 Nonencapsulated Commodity — Conventional Pallets.
### FM 8-9: Guidelines for Class I-V Commodities

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</tr>
</tbody>
</table>

*An acceptable attic design is 35° 40′ (2) when a 32° (1.8) on minimum linear spacing is used.

### Standard Spray Sprinkler Data Sheets

- **NFPA 13:** Standard for the Installation of Sprinkler Systems
- **Design Criteria:**
  - Minimum Operating Pressure: 125 psi
  - Maximum Operating Pressure: 200 psi
  - Temperature Range: 140°F to 165°F
  - Water Flow Rate: 10 to 20 gpm
  - Sprinkler Sensitivity: 55 to 65°F

For detailed specifications and technical data, please refer to the respective product data sheets provided by Johnson Controls.
Large Drop and Specific Application Control Mode Sprinklers

- **Large Drop Sprinkler.** A type of specific application control mode sprinkler that is capable of producing characteristic large water droplets and that is listed for its capability to provide fire control of specific high-challenge fire hazards.

- **Specific Application Control Mode Sprinkler For Storage Use.** A type of spray sprinkler listed at a minimum operating pressure or density with a specific number of operating sprinklers for a given protection scheme.

- **Design:**
  - Calculate a specific # of sprinklers at a specific pressure
Control Mode Specific Application (CMSA) Sprinklers (2010)

- Control Mode Specific Application (CMSA) Sprinkler. A type of spray sprinkler that is capable of producing characteristic large water droplets and that is listed for its capability to provide fire control of specific high-challenge fire hazards.
  
  - A high challenge fire can have an upward draft equivalent to 30 – 35 mph (50 – 56 km/h)
  
  - The Larger K-factors produce larger water droplets at lower pressures
  
  - Large flow rates might be required for some high challenge applications

NFPA 13, – CMSA Protection Table Example
NFPA 13– CMSA Protection Table Example

Table 35.3.4.2.1 CMSA Ceiling Level Sprinkler Design Criteria for Rack Storage of Class I Through Class IV Commodities (Eco-Encapsulated and Nonencapsulated) Supplemented with In Rack Sprinklers

<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Composite Class</th>
<th>Maximum Storage Height ft</th>
<th>Maximum Ceiling/ Roof Height ft</th>
<th>Type of System</th>
<th>No. of Ceiling Sprinklers to Design</th>
<th>No. of Required Levels of In Rack Sprinklers</th>
<th>Minimum Ceiling Sprinkler Operating Pressure psi</th>
<th>°f</th>
</tr>
</thead>
<tbody>
<tr>
<td>For III</td>
<td>Single, double, and multiple rack (see open stop maintenance)</td>
<td>30</td>
<td>1.3</td>
<td>11</td>
<td>1.2 (L-3) Synthetic</td>
<td>Yes</td>
<td>20</td>
<td>One-level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16.0 (L-3) Synthetic</td>
<td>Yes</td>
<td>20</td>
<td>One-level</td>
<td>25</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>33</td>
<td>1.3</td>
<td>11</td>
<td>1.2 (L-3) Synthetic</td>
<td>Yes</td>
<td>15</td>
<td>One-level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16.0 (L-3) Synthetic</td>
<td>Yes</td>
<td>15</td>
<td>One-level</td>
<td>25</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>33</td>
<td>1.3</td>
<td>30</td>
<td>9.1</td>
<td>11</td>
<td>1.2 (L-3) Synthetic</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16.0 (L-3) Synthetic</td>
<td>Yes</td>
<td>25</td>
<td>One-level</td>
<td>25</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>25</td>
<td>7.6</td>
<td>30</td>
<td>9.1</td>
<td>11</td>
<td>1.2 (L-3) Synthetic</td>
<td>Yes</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16.0 (L-3) Synthetic</td>
<td>Yes</td>
<td>25</td>
<td>One-level</td>
<td>25</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>33</td>
<td>1.3</td>
<td>11</td>
<td>1.2 (L-3) Synthetic</td>
<td>Yes</td>
<td>25</td>
<td>One-level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16.0 (L-3) Synthetic</td>
<td>Yes</td>
<td>25</td>
<td>One-level</td>
<td>25</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>33</td>
<td>1.3</td>
<td>IV</td>
<td>20</td>
<td>3.8</td>
<td>30</td>
<td>9.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16.0 (L-3) Synthetic</td>
<td>Yes</td>
<td>20</td>
<td>One-level</td>
<td>20</td>
<td>3.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>33</td>
<td>1.3</td>
<td>11</td>
<td>1.2 (L-3) Synthetic</td>
<td>Yes</td>
<td>15</td>
<td>One-level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16.0 (L-3) Synthetic</td>
<td>Yes</td>
<td>15</td>
<td>One-level</td>
<td>22</td>
<td>1.5</td>
<td></td>
</tr>
</tbody>
</table>

CMSA Data Sheets
Intermediate Level Sprinkler/ In-Rack Storage Sprinklers

A sprinkler equipped with integral shields to protect its operating elements from the discharge of sprinklers installed at higher elevations (3.3.205.4.8).

25.3.1 In-Rack Sprinkler Water Shield for Storage of class 1 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.

25.3.5.2 In-rack Sprinkler Water Shields for Group A Plastic Storage. Where in-rack sprinklers are not shielded by horizontal barriers, water shield shall be provided above the sprinkler, or listed intermediate level/rack storage sprinklers shall be used.

16.2.6 Sprinklers subject to mechanical injury shall be protected with listed guards.
Poll Question 4

What are the metal discs installed on intermediate sprinklers

A. Heat collectors
B. Water shields
C. An ornamental item for aesthetics
D. A complimentary Frisbee

In-Rack Sprinkler Protection

<table>
<thead>
<tr>
<th>Commodity Class</th>
<th>Storage Rack Type</th>
<th>Storage Height</th>
<th>Applicable Table and/or Figure for Horizontal Spacing of In-Rack Sprinklers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I through IV</td>
<td>Single-row</td>
<td>Over 25</td>
<td>Table 25.9.2.1.1 and Figures 25.9.2.1.1(a)–(c)</td>
</tr>
<tr>
<td></td>
<td>Double-row</td>
<td>Over 25</td>
<td>Table 25.9.2.2.1 and Figures 25.9.2.2.1(a)–(f)</td>
</tr>
<tr>
<td></td>
<td>Multiple-row</td>
<td>Over 25</td>
<td>Table 25.9.2.3.1 and Figures 25.9.2.3.1(a)–(c)</td>
</tr>
<tr>
<td>Group A plastics</td>
<td>Single-, double-, and multiple-row</td>
<td>Up to 25</td>
<td>Figures 25.9.3.1(a)–(c)</td>
</tr>
<tr>
<td>Group A plastics, cartoned</td>
<td>Single-row</td>
<td>Over 25</td>
<td>Figures 25.9.4.1.1(a)–(d)</td>
</tr>
<tr>
<td></td>
<td>Double-row</td>
<td>Over 25</td>
<td>Figures 25.9.4.1.1(a)–(c)</td>
</tr>
<tr>
<td></td>
<td>Multiple-row</td>
<td>Over 25</td>
<td>Figures 25.9.4.3.1(a)–(f)</td>
</tr>
<tr>
<td>Group A plastics, exposed nonexpanded</td>
<td>Single-row, maximum 3 ft (0.9 m) deep</td>
<td>Over 25</td>
<td>Figure 25.9.4.1.3</td>
</tr>
<tr>
<td></td>
<td>Multiple-row</td>
<td>Over 25</td>
<td>Figures 25.9.4.3.1(a)–(f)</td>
</tr>
</tbody>
</table>
In-Rack Sprinkler Protection

Other In-Rack Sprinkler Protection Requirements
### Other In-Rack Sprinkler Protection Requirements

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

<table>
<thead>
<tr>
<th>Top of Storage</th>
<th>Commodity Class</th>
<th>Rack Type</th>
<th>Ceiling Sprinkler Type</th>
<th>No. of Required In-Rack Sprinklers</th>
<th>No. of In-Rack Sprinklers in the Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miscellaneous</td>
<td>Class I through IV, Group A plastics, and endive trucks</td>
<td>Any</td>
<td>Any</td>
<td>Any</td>
<td>1</td>
</tr>
<tr>
<td>Storage not meeting the definition of miscellaneous</td>
<td>Class I through III</td>
<td>Solid steel</td>
<td>Any</td>
<td>One</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open</td>
<td>CMIA</td>
<td>More than one</td>
<td>10 (5 on each of the top two levels)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open</td>
<td>CMID</td>
<td>More than one</td>
<td>10 (5 on each of the top two levels)</td>
</tr>
<tr>
<td></td>
<td>Class I through IV and Group A plastics</td>
<td>Open</td>
<td>ESFR</td>
<td>One</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Class IV</td>
<td>Open</td>
<td>CMIA</td>
<td>More than one</td>
<td>10 (5 on each of the top two levels)</td>
</tr>
<tr>
<td></td>
<td>Class IV and Group A plastics</td>
<td>Solid steel</td>
<td>Any</td>
<td>One</td>
<td>14 (7 on each of the top two levels)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open</td>
<td>CMIA</td>
<td>More than one</td>
<td>14 (7 on each of the top two levels)</td>
</tr>
<tr>
<td></td>
<td>Group A plastics</td>
<td>Open</td>
<td>CMIA</td>
<td>One</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Rubber tires</td>
<td>Open</td>
<td>CMIA</td>
<td>One</td>
<td>12</td>
</tr>
</tbody>
</table>

#### Table 25.12.2.1 In-Rack Sprinkler System Design: Minimum Required Flow/Pressure from In-Rack Sprinklers

<table>
<thead>
<tr>
<th>Top of Storage</th>
<th>Commodity Class</th>
<th>Rack Type</th>
<th>Ceiling Sprinkler Type</th>
<th>Storage Height</th>
<th>Minimum Design Flow/Pressure for In-Rack Sprinklers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miscellaneous</td>
<td>Class I through IV, Group A plastics, and endive trucks</td>
<td>Any</td>
<td>Any</td>
<td>Any</td>
<td>15 psi (1.0 bar)</td>
</tr>
<tr>
<td>Storage not meeting the definition of miscellaneous</td>
<td>Class I through IV</td>
<td>Open</td>
<td>CMIA</td>
<td>Up to 75</td>
<td>15 psi (1.0 bar)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CMIA</td>
<td>Any</td>
<td>Up to 75</td>
<td>15 psi (1.0 bar)</td>
</tr>
<tr>
<td></td>
<td>Class I through IV and Group A plastics</td>
<td>Open</td>
<td>CMIA</td>
<td>Over 75</td>
<td>Over 75 psi (115 L/min)</td>
</tr>
<tr>
<td></td>
<td>Solid steel</td>
<td>Any</td>
<td>Any</td>
<td>Any</td>
<td>15 psi (1.0 bar)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CMIA</td>
<td>Any</td>
<td>Any</td>
<td>15 psi (1.0 bar)</td>
</tr>
<tr>
<td></td>
<td>Group A plastics</td>
<td>Open</td>
<td>CMIA</td>
<td>Up to 75</td>
<td>15 psi (1.0 bar)</td>
</tr>
<tr>
<td></td>
<td>Rubber tires</td>
<td>Open</td>
<td>CMIA</td>
<td>Any</td>
<td>30 psi (2.1 bar)</td>
</tr>
</tbody>
</table>
In-Rack Sprinklers Data Sheets

Suppression Mode Sprinklers
Suppression Mode (SM) Sprinklers

- Vertical fire spread is reversed
- Sprinklers operate quickly, while heat release is small & reduce heat radiation
- High density water delivered direct to the base area of fire
- Fewer sprinklers operate, less water damage
- Design parameters much more critical
- Sprinkler Types:
  - Early Suppression Fast Response (ESFR)

NFPA 13 Table of Contents
Suppression Mode Sprinklers

- Sprinkler Type:
  - 14.0 (200) K Up & Pend
  - 16.8 (240) K Up & Pend
  - 22.4 (326) K Pend
  - 25.2 (360) K Pend

- Max Area of Coverage:
  - 100 sq.ft. (9.3 m²)

- Max Distance Between Sprinklers:
  - 12’ (3.7m) – 30’ (9.1m) Building
  - 10’ (3.01m) – >30’ (9.1m) Building

- Design:
  - Calculate a specific # of sprinklers at a specific
FM 8-9- Protection Table Example

Early Suppression Fast Response (ESFR) Data Sheets

*Class I-IV, Cartoned Nonexpanded Plastic*
Positioning ESFR-34 in the Market

In the storage market where flexibility is always important, the ESFR-34 has a clear advantage at 55’ (16,8m) ceiling heights.

**Value Proposition:**

- **Tallest ceiling-only protection** in the market
- **Narrowest aisles** when using at 55’ (16,8m) ceiling heights
- **Furthest distance** for thermal element to ceiling
- **Reduced flow requirements**

**Design Flexibility for Increased Storage**

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Viking ESFR-28 (FM)</th>
<th>JCI ESFR-34 (FM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIN</td>
<td>V0354</td>
<td>TY9286</td>
</tr>
<tr>
<td>Approval/Listing</td>
<td>FM Approval</td>
<td>FM Approval</td>
</tr>
<tr>
<td>K-Factor</td>
<td>28.0 / 404</td>
<td>33.5 / 487</td>
</tr>
<tr>
<td>Thread</td>
<td>5” NPT</td>
<td>1.5” NPT</td>
</tr>
<tr>
<td>Max Ceiling Height (R)</td>
<td>55’ / 16.8m</td>
<td>55’ / 16.8m</td>
</tr>
<tr>
<td>Max Commodity Height (R)</td>
<td>50’ / 15.2m</td>
<td>50’ / 15.2m</td>
</tr>
<tr>
<td>Commodity</td>
<td>Carpeted/Unexpanded</td>
<td>Carpeted/Unexpanded</td>
</tr>
<tr>
<td>Min. Aisle Width (ft)</td>
<td>8’ / 2.4m</td>
<td>8’ / 2.4m</td>
</tr>
<tr>
<td>Sprinklers in design</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Minimum Pressure</td>
<td>30 psi / 2.0 bar</td>
<td>30 psi / 2.0 bar</td>
</tr>
<tr>
<td>Flow per sprinkler</td>
<td>230 gpm (884 l/min)</td>
<td>249 gpm (943 l/min)</td>
</tr>
<tr>
<td>Max Flow (Theoretical)</td>
<td>2,254 gpm (8,332 l/min)</td>
<td>2,243 gpm (8,398 l/min)</td>
</tr>
<tr>
<td>Duration (Theoretical)</td>
<td>60 min</td>
<td>60 min</td>
</tr>
<tr>
<td>Racks</td>
<td>Single or Double</td>
<td>Single or Double</td>
</tr>
<tr>
<td>Center of Element to Ceiling</td>
<td>17” / 432mm</td>
<td>17” / 432mm</td>
</tr>
</tbody>
</table>

Pallet # Increase = 1,920
Pallet % Increase = 15.4%

Narrower aisles → more rows → more pallets → more value
Suppression Mode Sprinklers - Head Guard

Alternative Solutions
EAS-1 Protection Up to and Including Exposed Expanded Group A Plastics

Table C
ELECTRONIC SPRINKLER SYSTEM DESIGN CRITERIA

<table>
<thead>
<tr>
<th>CEILING HEIGHT (ft)</th>
<th>STORAGE HEIGHT (ft)</th>
<th>MINIMUM AREA (percent)</th>
<th>DOOR OPENING (percent)</th>
<th>MINIMUM INSTALLATION NO. OF SPRINKLERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 (9.1)</td>
<td>30 (9.1)</td>
<td>8 (25.6)</td>
<td>4 (12.7)</td>
<td>1 (3.0)</td>
</tr>
</tbody>
</table>

Chapter 24: Alternative Sprinkler Systems Designs for Chapters 20-25

EC-25

Upright

For use in high density applications such as “big box” retailing, extra hazard, and high-piled storage occupancies. Soiler type CMIA and CMSA. Applications and FM Approved for storage and non-storage applications. Minimum operating pressure of 7 psi (0.48 bar). The maximum coverage area per sprinkler is 226 ft² (21.0 m²), which is almost double the area offered by standard coverage sprinklers used for similar applications.
**Chapter 24: Alternative Sprinkler Systems Designs for Chapters 20-25**

<table>
<thead>
<tr>
<th>Storage Dewpoint</th>
<th>Community Class</th>
<th>Minimum Number of Sprinklers</th>
<th>Minimum Flow Rate</th>
<th>Type of Sprinkler</th>
<th>Minimum Operating Pressure</th>
<th>Minimum Coverage Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/19/2020</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Water Supply Duration and Other Standards**
## Water Supply Allowances

### Table 94.4.1 Hose Stream Allowance and Water Supply Duration

<table>
<thead>
<tr>
<th>Sprinkler Type</th>
<th>No. of Sprinklers in Design Area</th>
<th>Hose Stream Allowance (gpm)</th>
<th>Water Supply Duration (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>Up to 10</td>
<td>350</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Over 11 to 15</td>
<td>500</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Over 15 to 25</td>
<td>500</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Over 25</td>
<td>500</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Up to 6</td>
<td>750</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Extended coverage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Up to 8</td>
<td>250</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Over 8 to 12</td>
<td>350</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Over 13</td>
<td>500</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Over 15</td>
<td>500</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Over 17</td>
<td>500</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Over 25</td>
<td>500</td>
<td>150</td>
</tr>
</tbody>
</table>

### Water Supply Allowances: FM Global

### Table 14. Hose Demand and Water Supply Duration Design Guidelines

<table>
<thead>
<tr>
<th>Sprinkler Type</th>
<th>No. of Sprinklers in Ceiling Design</th>
<th>Hose Demand, gpm (l/min)</th>
<th>Duration, min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Up to 12</td>
<td>250 (900)</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>13 to 19</td>
<td>500 (1,900)</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>20 or more</td>
<td>500 (1,900)</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>22 or more</td>
<td>500 (1,900)</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>25 or more</td>
<td>500 (1,900)</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>27 or more</td>
<td>500 (1,900)</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>30 or more</td>
<td>500 (1,900)</td>
<td>120</td>
</tr>
</tbody>
</table>

*When the maximum lineal spacing is 12 ft (3.7 m), the hose demand can be 250 gpm (950 L/min) and the duration can be 60 minutes.*
Other Standards to Be Familiar With

<table>
<thead>
<tr>
<th>FM Technical Datasheets</th>
<th>NFPA Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM 2-0 Installation</td>
<td>NFPA 30: Flammable and Combustible Liquids Code</td>
</tr>
<tr>
<td>FM 8-24: Idle Pallet Storage</td>
<td>NFPA 30B: Code for the Manufacture and Storage of Aerosol Products</td>
</tr>
<tr>
<td>FM 8-33: Carousel Storage and Retrieval Systems</td>
<td>NFPA 24: Standard for the Installation of Private Fire Service Main</td>
</tr>
</tbody>
</table>

**NFPA 13: 28.4** 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

**Table 8: In-Rack Sprinkler Design Guidelines**

<table>
<thead>
<tr>
<th>Depth of ASRS Row</th>
<th>Tray or Container Material Composition</th>
<th>Maximum Vertical Distance Between In-Rack Sprinklers</th>
<th>N. of IRAS in Design</th>
<th>Design Flow from Most Remote IRAS, gpm @ 150 psig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 3 ft (0.9 m)</td>
<td>Noncombustible Closed-Top Container</td>
<td>10 ft (3.0 m)</td>
<td>4</td>
<td>30 (115)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 ft (4.5 m)</td>
<td>6</td>
<td>60 (230)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20 ft (6.0 m)</td>
<td>9</td>
<td>60 (230)</td>
</tr>
<tr>
<td></td>
<td>Com gutted or Expanded Plastic Trays or Containers</td>
<td>10 ft (3.0 m)</td>
<td>4</td>
<td>60 (230)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 ft (4.5 m)</td>
<td>6</td>
<td>60 (230)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20 ft (6.0 m)</td>
<td>9</td>
<td>60 (230)</td>
</tr>
<tr>
<td></td>
<td>Everything Else</td>
<td>10 ft (3.0 m)</td>
<td>4</td>
<td>60 (230)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 ft (4.5 m)</td>
<td>6</td>
<td>60 (230)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20 ft (6.0 m)</td>
<td>9</td>
<td>60 (230)</td>
</tr>
</tbody>
</table>

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Poll Question 4

What must the installing contractor provide to the building owner or representative?

A. Lunch
B. NFPA 25 and manufacturer’s technical data
C. Just the bill
D. NFPA 13

Questions?

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