# Understanding
# Fire Protection Requirement
# For
# Storage Occupancies

## Per NFPA 13
## &
## FM Global Data Sheet 8- 9

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# Warehouses and other storage facilities require unique fire sprinkler solutions

Driven by Occupancy Hazard

Driven by Commodity Hazard

*Sprinkler systems are designed to control or suppress fires in their earliest stages and must be designed and installed for the occupancy they protect. While occupancy classifications help to design for the severity of the fire hazard that sprinklers must protect for, commodity classifications provide additional, more specific information regarding the factors that contribute to that fire hazard.*

# Unique Challenges

- Multiple factors combine to create a high fire hazard in warehouses.
- Packaging materials, the goods stored are often highly flammable. Plus, the dense packing and high stacking of items can block water flow in a situation where high ceilings already make it harder to deliver water. Together, the features of storage occupancies create a very challenging situation.

# Let’s Understand the Terminologies First !!!

# Available Height for Storage

*Max. Height at which commodities can be stored above the floor and still maintain necessary clearance from structural members and the required clearance below sprinklers*

# Encapsulation

A method of packaging that either consists of a plastic sheet completely enclosing the sides and top of a pallet load containing a combustible commodity, a combustible package, or a group of combustible commodities or combustible packages, or consists of combustible commodities individually wrapped in plastic sheeting and stored exposed in a pallet load.

The term *encapsulated* does not apply to plastic-enclosed products or packages inside a large, neoplastic, enclosed container.

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

# Expanded Plastics ( Foamed or Cellular)

Those plastics, the density of which is reduced by the presence of numerous small cavities (cells), interconnecting or dispersed throughout their mass.

# Unexpanded Plastics

**Unexpanded plastics** are higher density materials that may be formed into different shapes such as drums, containers, toys etc.

# Free-Flowing Plastic Materials

Those plastics that fall out of their containers during a fire, fill flue spaces, and create a smothering effect on the fire.

# High-Piled Storage

Solid-piled, palletized, rack storage, bin box, and shelf storage in excess of 12 ft. (3.7 m) in height.

# Reinforced plastic pallet(RPP)

A plastic pallet incorporating a secondary reinforcing material (such as steel or fiberglass) within the pallet.

*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*

# Types of Storage Arrangements

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.

Should be made up of
Wood, metal or Cardboard

# Types of Storage Arrangements

Palletized Storage :

Storage of commodities on pallets or other storage aids that form horizontal spaces between tiers of storage.

# Types of Storage Arrangements

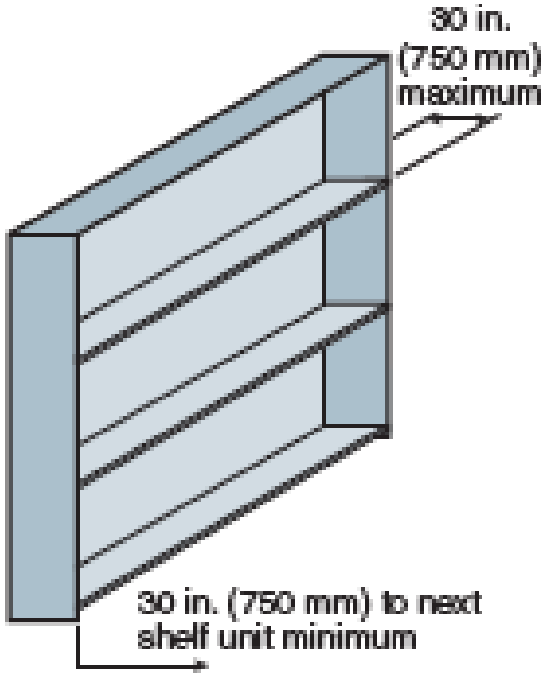
Solid Pile Storage :

Storage of commodities stacked on each other.

# Types of Storage Arrangements

Shelf Storage :

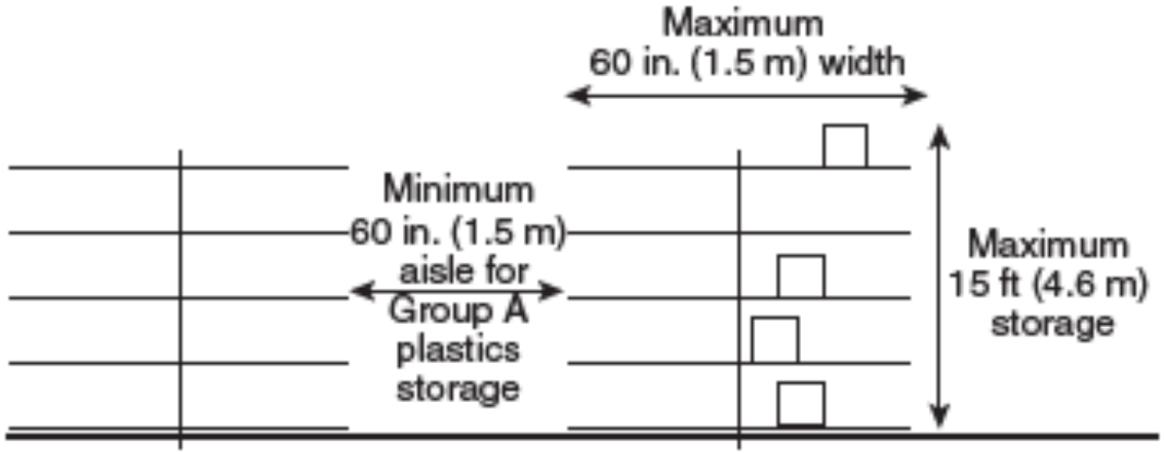
Storage on structures up to and including 30 in. (0.76 m) deep and separated by aisles at least 30 in. (0.76 m) wide.




# Types of Storage Arrangements

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).

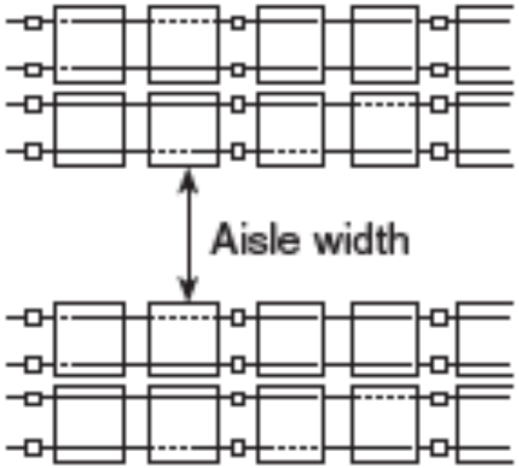


# Types of Storage Arrangements

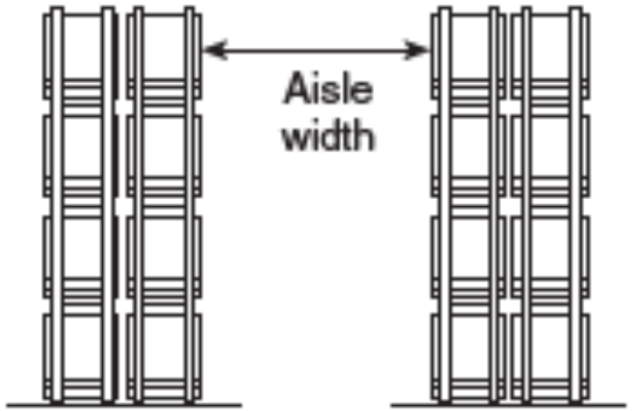
Rack Storage *(Can be fixed, single row, double row, multiple row )*

What is an Aisle…?

*The horizontal dimension between the face of the loads in racks under consideration.*




Plan View

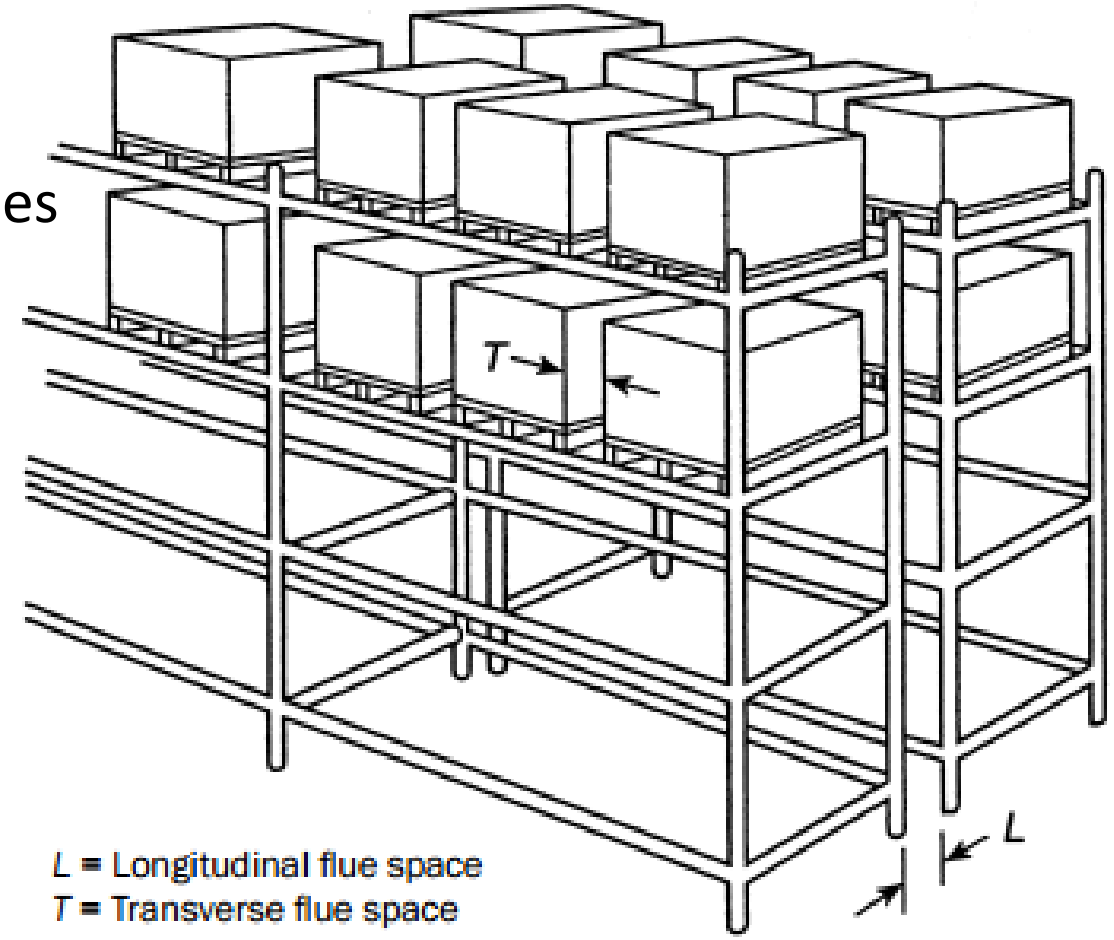



End View

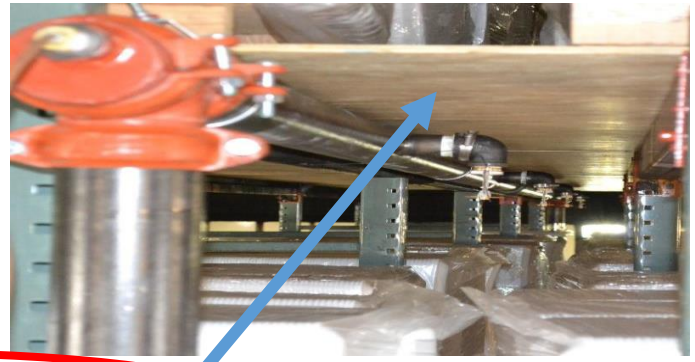
# Types of Storage Arrangements

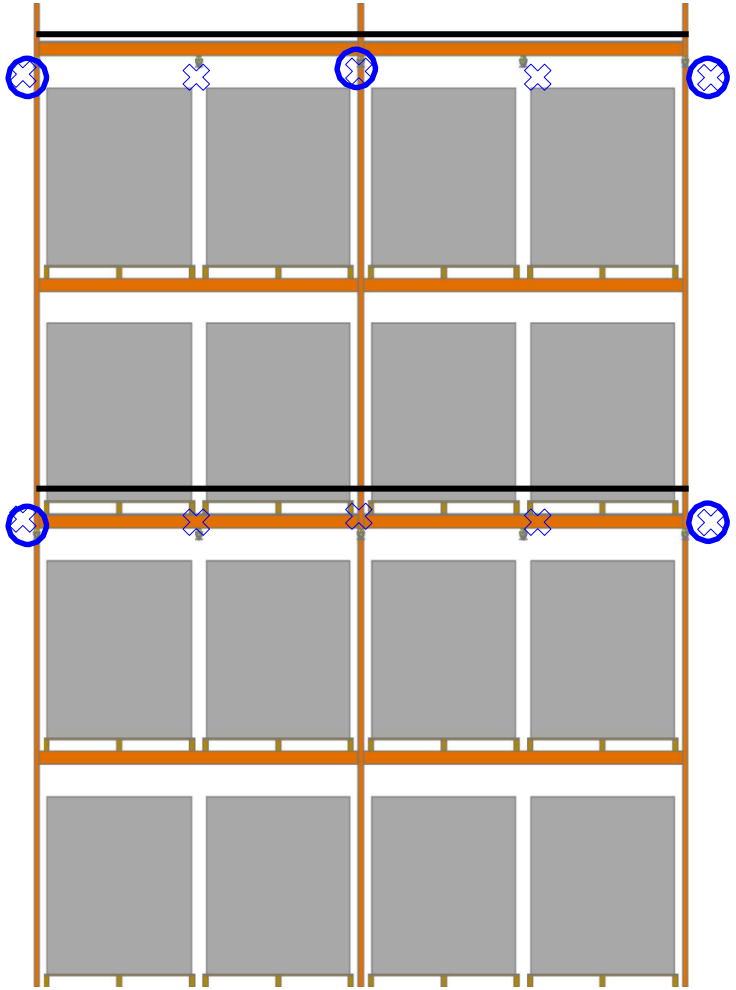
Rack Storage :

What is an Longitudinal & Transverse  Flue Spaces



# Use of Sprinkler in Racks





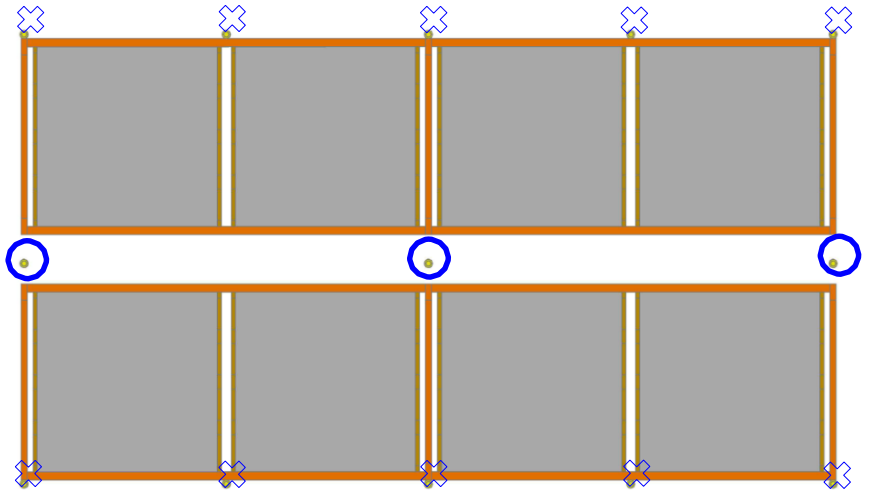
Elevation View

Prevents vertical spread of fire.

= Horizontal Barrier

= Longitudinal Flue Space Sprinklers

= Face Sprinklers



Plan View

# Pile Stability

- Stable :Those arrays where collapse, spillage of content, or leaning of stacks across flue spaces is not likely to occur soon after initial fire development.
- Unstable : Those arrays where collapse, spillage of contents, or leaning of stacks across flue spaces occurs soon after initial fire development

# According to Survey

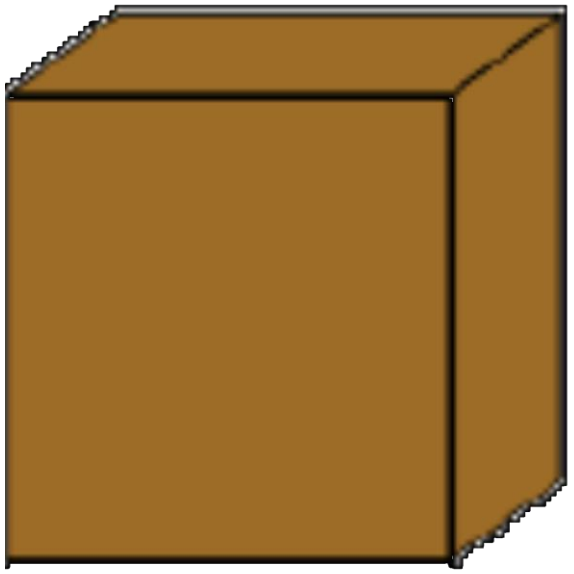
Fires in storage properties, . . . account for

I. 15.5 percent of nonresidential structure fires,
II. 19.5 percent of associated property damage,
III. 11.4 percent of associated civilian deaths, and
IV. 9.2 percent of associated civilian injuries.
V. In storage properties, the leading occupancies in which these fires occur are agriculture products storage facilities (38%), unclassified storage facilities (23%), and general-item storage facilities (14%)

# Design Checklist for Sprinkler System

- Commodity Class
- Type of Pallet
- Storage Arrangement
- Ceiling height, Storage Height, Ceiling Clerance
- If the Storage is miscellaneous ?
- Other Consideration

# Commodity Classification

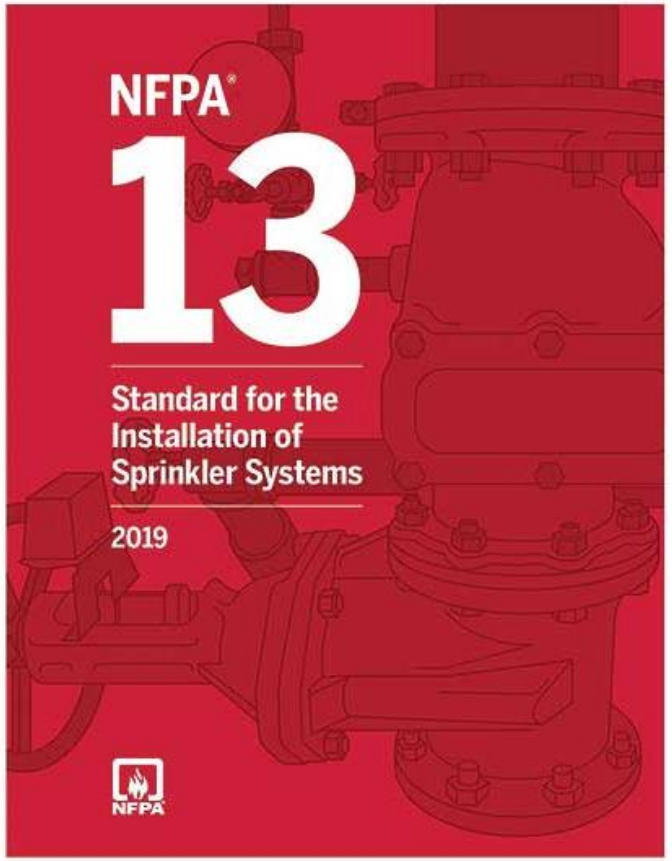


Warehouse commodity (Carton, packaging, plastic)

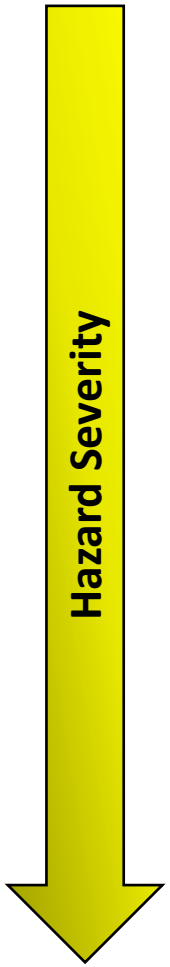
Plastic Group A-C

Class I -IV

Classify grouped commodity into one of seven hazard groups (Based on HRR)



# Commodity Classification




| Class Or Group | Class or Group Materials |
|---|---|
| **Class 1** | Essentially non-combustible products in corrugated cartons on combustible pallets |
| **Class 2** | Class I products in slatted wooden crates, solid wooden boxes or multiple thickness paperboard cartons with or without pallets |
| **Class 3** | Wood, paper, natural fiber cloth or Group C plastics with or without pallets. May contain a limited amount (5% by weight or volume or less) of Group A or Group B plastics |
| **Class 4** | Class I, II or III commodities in corrugated cartons with appreciable amounts (5-15% by weight, or 5-25% by volume) of Group A plastics |
| **Plastics** | Cartoned Unexpanded Group A Plastic |
| | Exposed Unexpanded Group A Plastic |
| | Cartoned Expanded Group A Plastic |
| | Exposed Expanded Group A Plastic |

# Commodity Classification -

## Standardized Test Commodities

Class II

Cartoned Unexpanded Group A Plastic

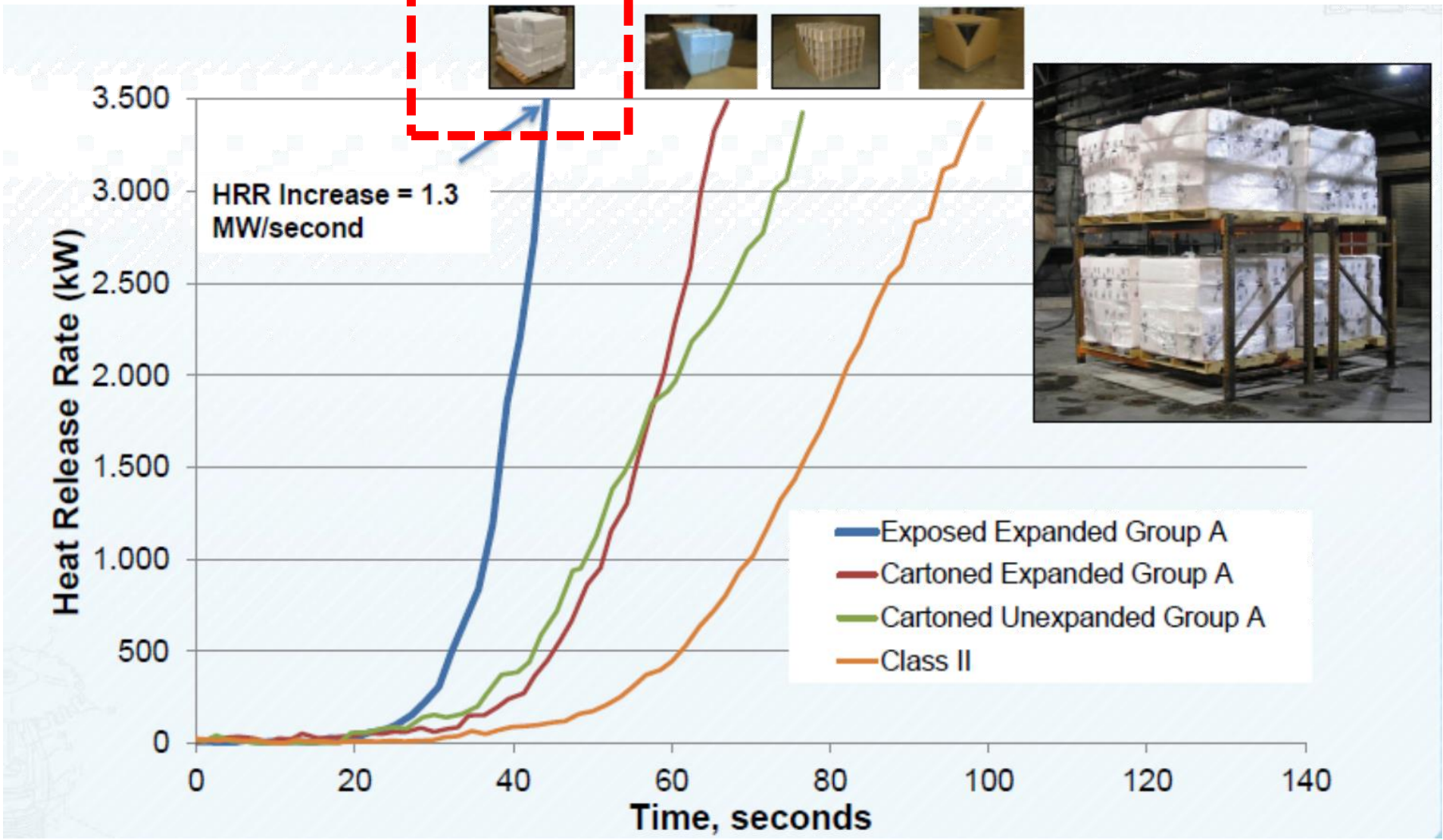
Class III

Cartoned, Expanded Group A Plastic

Class IV

Exposed, Expanded Group A Plastic

# HRR Growth Curve of Standard Test Commodities



# Type of Pallet

- Wood
- URPP – one Class Modification

*One class upgrade for un-reinforced plastic pallets*

*Class II → Class III*

*Class IV → Group A Plastics*

- RPP – Two Class Modification

*Two class upgrade for reinforced plastic pallets*

*Class II → Class IV*

*Class IV → Group A Plastics*

# Storage Arrangement

- **Rack**
- Single row
- Double row
- Multiple row
- **Shelf**
- Open rack
- Solid shelving
- Slatted shelf
- Solid Shelf
- **Back to Back Shelf**
- **Solid pile**
- **Pelletized**
- **Bin box**

# Storage Arrangements

- Bulk Storage
- Solid Pile Storage
- Palletized Pile Storage
- Rack Storage

NFPA #13 defines high-piled storage as any rack, palletized, or solid-pile storage in excess of 12’ in height.

# Storage Height and Clearance

“Fire severity is a function of height. The taller the burning materials, the more rapidly the flames will accelerate”

“Materials stored twice as high will burn much more than twice as fast.”

# Design Height can be determined by

(1) What the warehouse manager *says* the storage height will be limited to

(2) The elevation of the bottom of the lowest *beam* or structural roof member of the building. This is also refer to by those in the commercial real estate business as the building's "clear height"

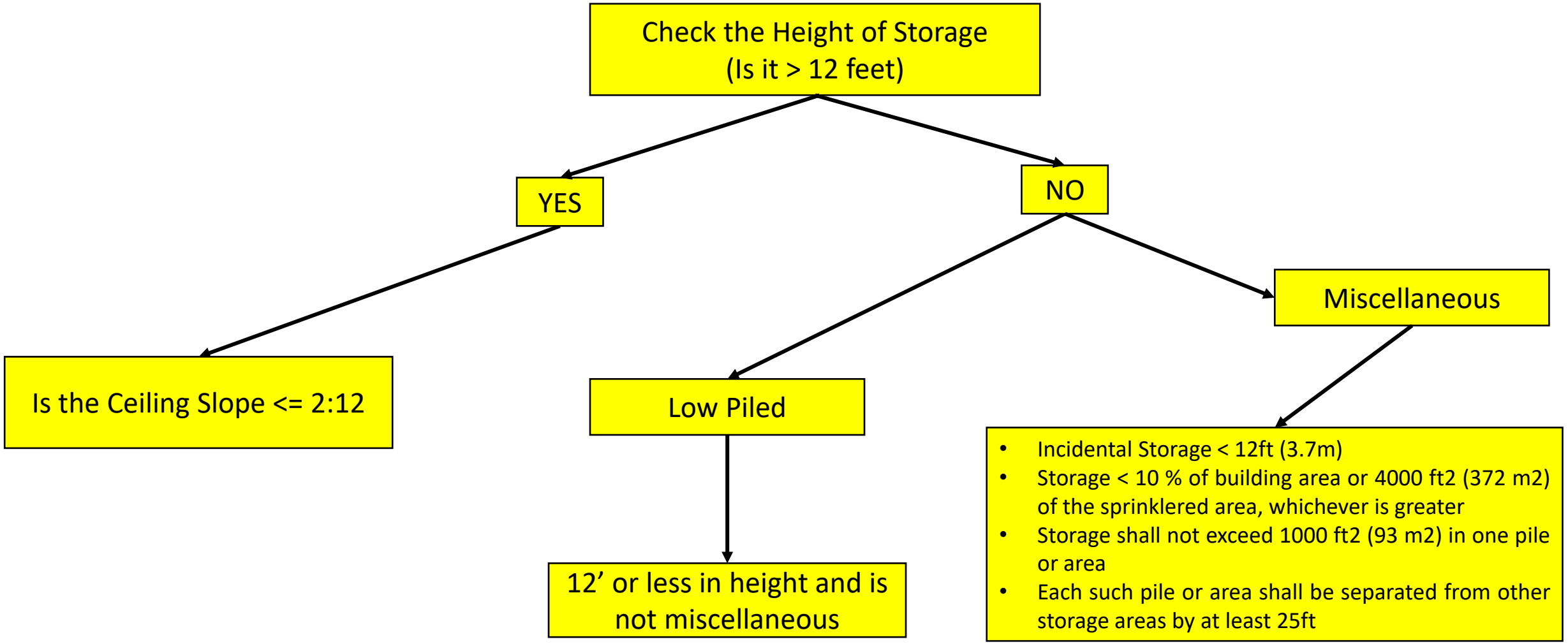
(3) The elevation of the bottom of the lowest steel *bar-joist* web inside the building

(4) 18" below the deflector of the sprinkler-heads

# How to Navigate through NFPA 13 for Storage Requirements ?

**FOR CLASS 1 TO 4 & GROUP B & C PLASTICS**

# How to Navigate through NFPA 13 for Storage Requirements ?



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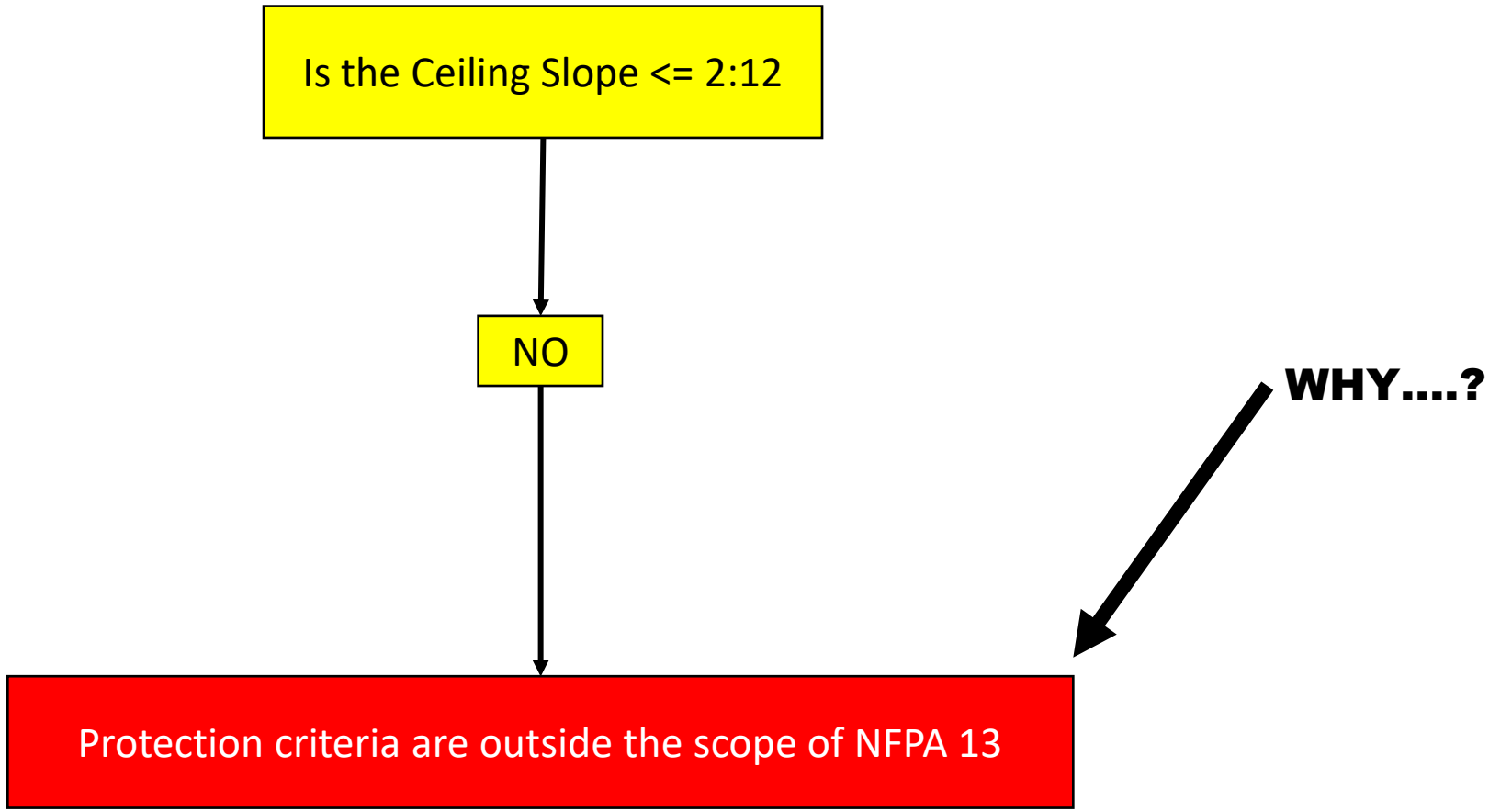


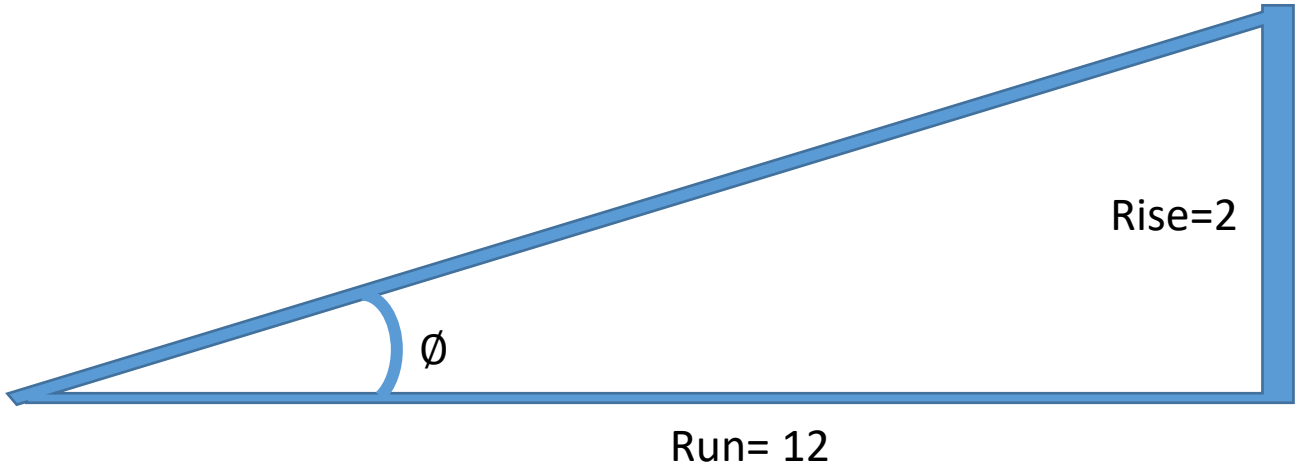
# Why Protection criteria for slope ceiling more than 2:12 are outside the scope of NFPA 13 ?

Firstly lets Understand the Slope of 2:12

$$\tan \emptyset = \frac{Opp\ side}{Adj\ Side}$$

$$\tan \emptyset = \frac{2}{12}$$

$$\emptyset = 9.42$$




Allowable Angle of inclination shall not be more than 9.42 degrees

# Why Protection criteria for slope ceiling more than 2:12 are outside the scope of NFPA 13 ?

According to a joint study Conducted by FM Global & FPRF on a numerical fire model called " FireFOAM" following conclusions were made on the effect of Ceiling slope on sprinkler activations and spray Transport.

Objectives of this study :

1. Evaluate sprinkler activation times and patterns from ceiling jet simulations
2. Evaluate effect of ceiling inclination on water mass flux distributions over a rack-storage commodity.
3. Understand the effect of sprinkler orientation

- two sprinkler orientations: deflector parallel-to-ceiling or parallel-to-floor

# Why Protection criteria for slope ceiling more than 2:12 are outside the scope of NFPA 13 ?

Spray Result :

- For <=18.4 degrees (deflector parallel-to-ceiling )
- Water from the sprinklers on the lower side is projected towards the fire region.

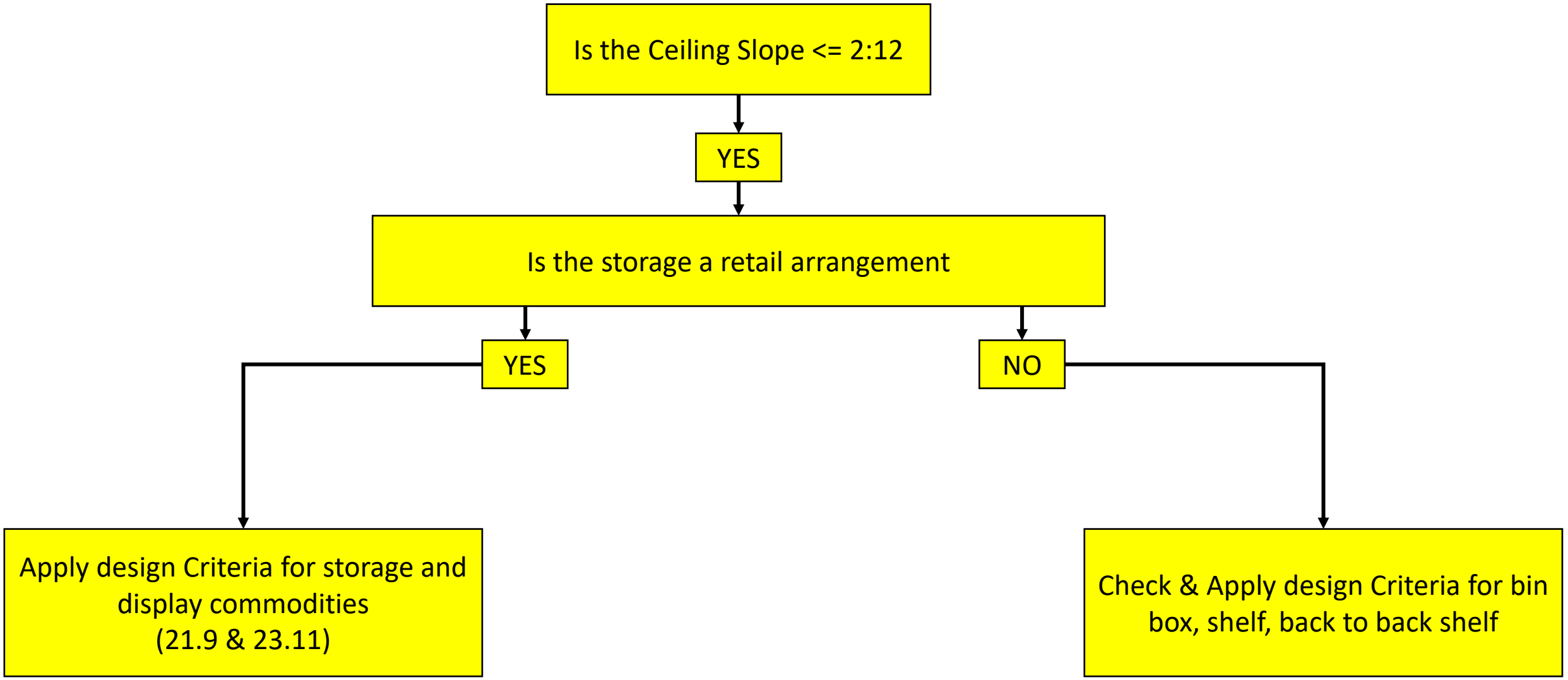
# Why Protection criteria for slope ceiling more than 2:12 are outside the scope of NFPA 13 ?

Spray Result :

For 33.7 inclination

- low spray density on the fire region due to highly skewed activation pattern
- *water flux to fire region reduced by 54-76% as compared to horizontal ceiling*

# How to Navigate through NFPA 13 for Storage Requirements ?



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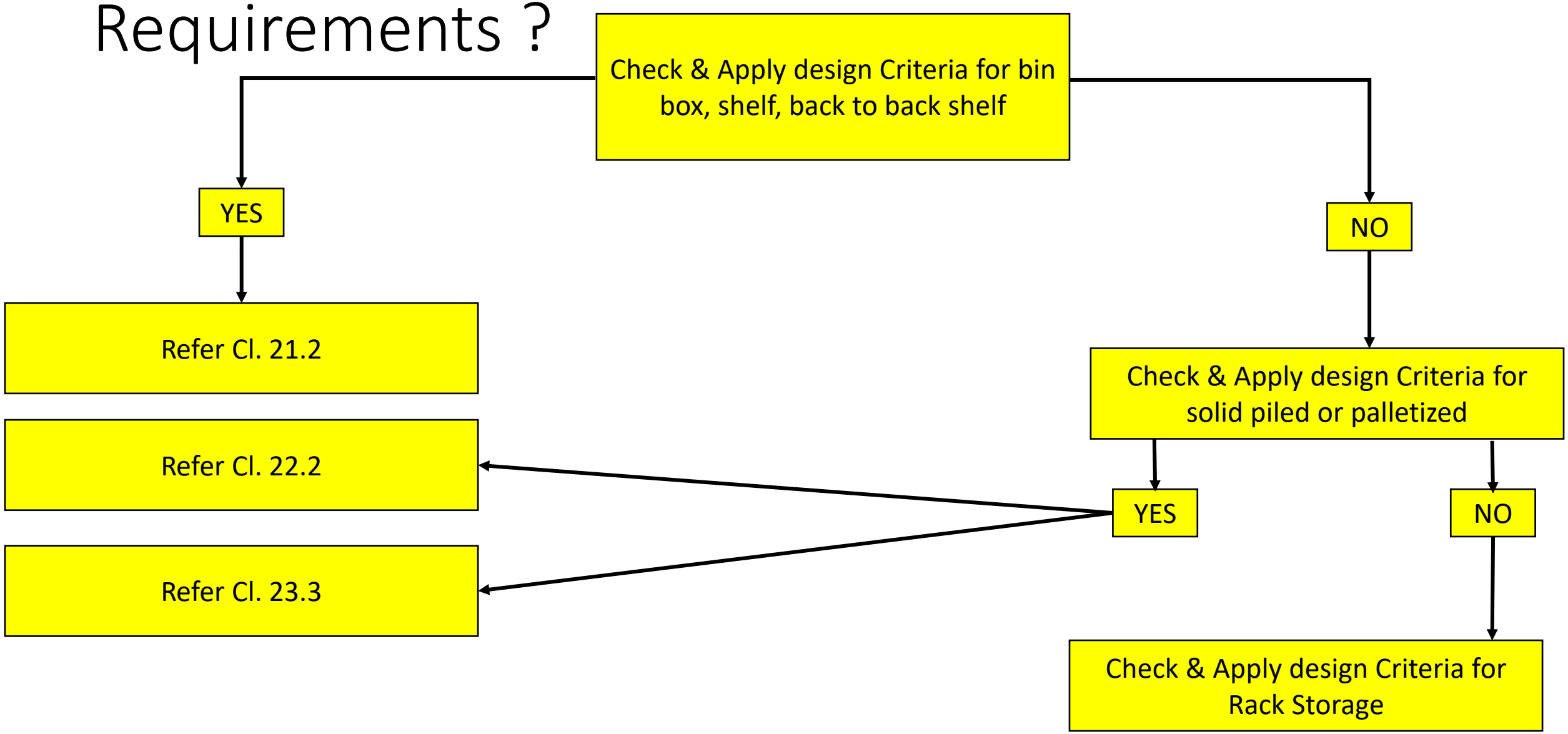

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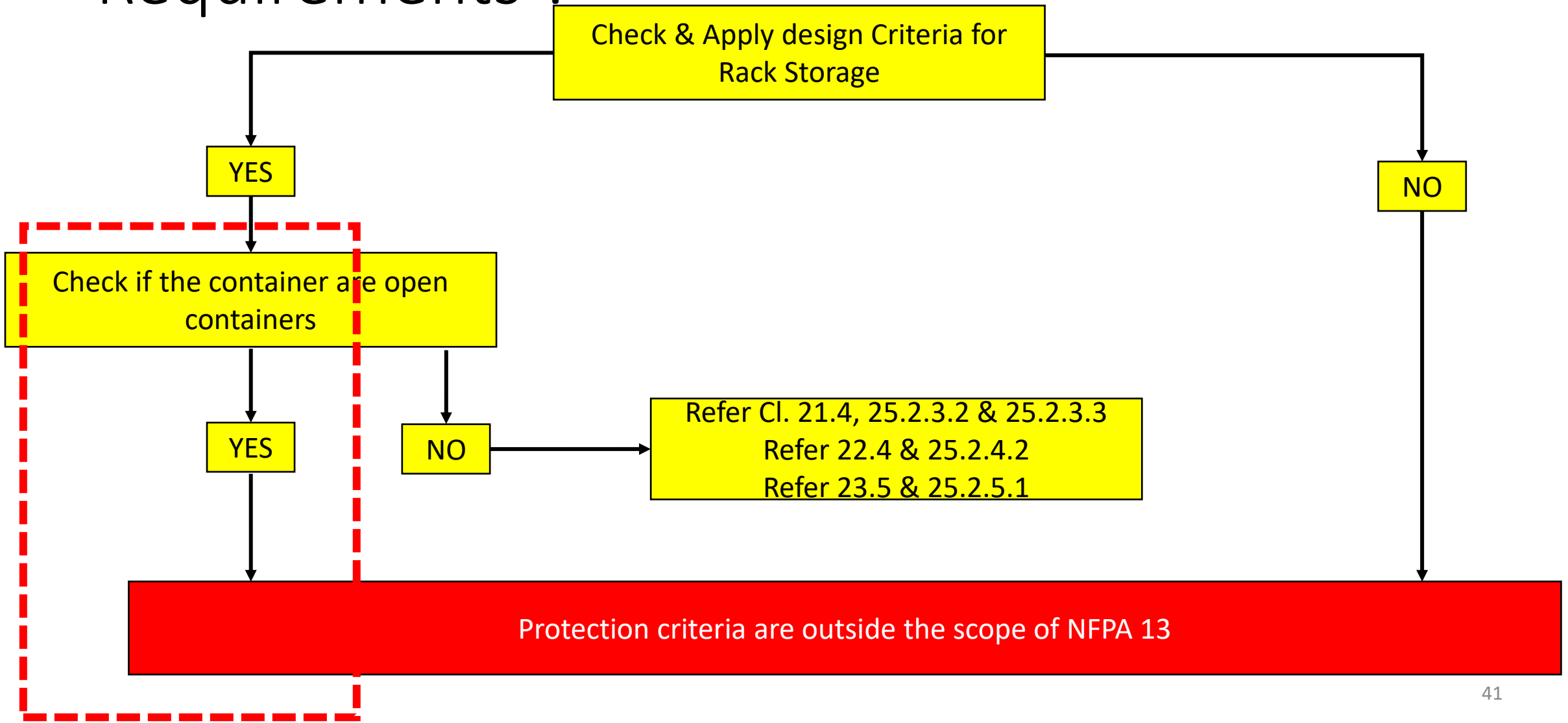
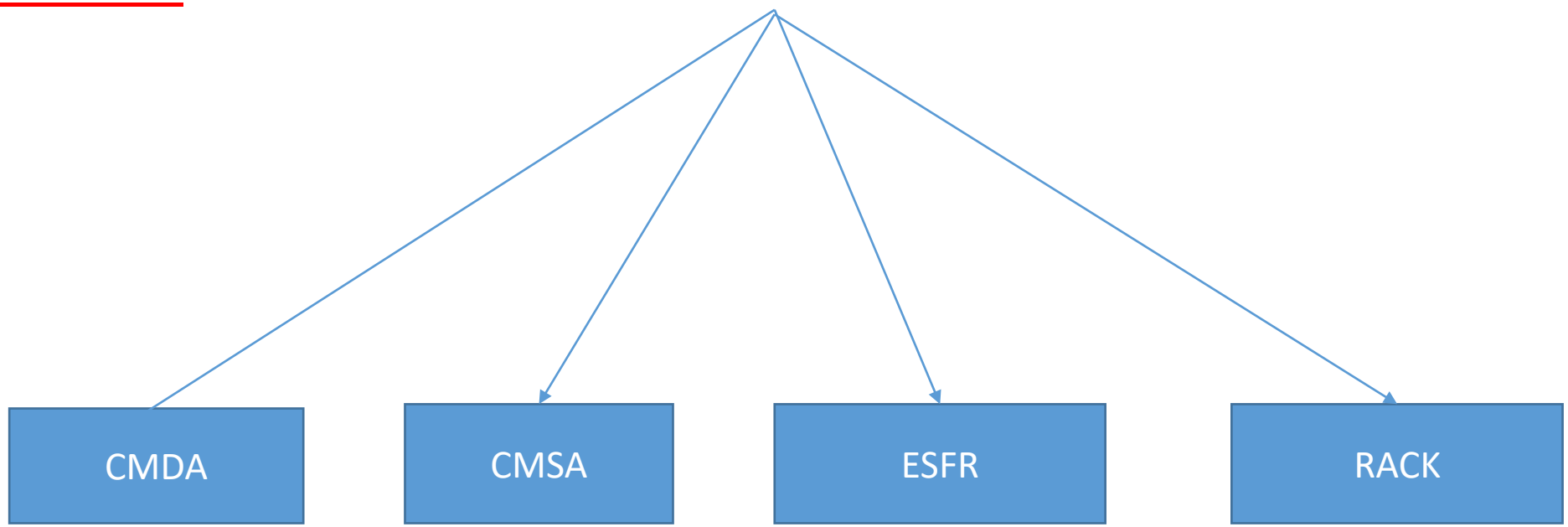


# Why NFPA 13 Does Not Permit Open-Top Containers ?

Loss experience and large-scale fire tests indicate a greater hazard with open-top combustible (paper, cardboard, or wood) containers. *The major factor appears to be the capture and retention of ceiling sprinkler discharge within the open-top container* and less water flow down the flue and aisle faces. This does not apply to open-top containers with mesh sides.

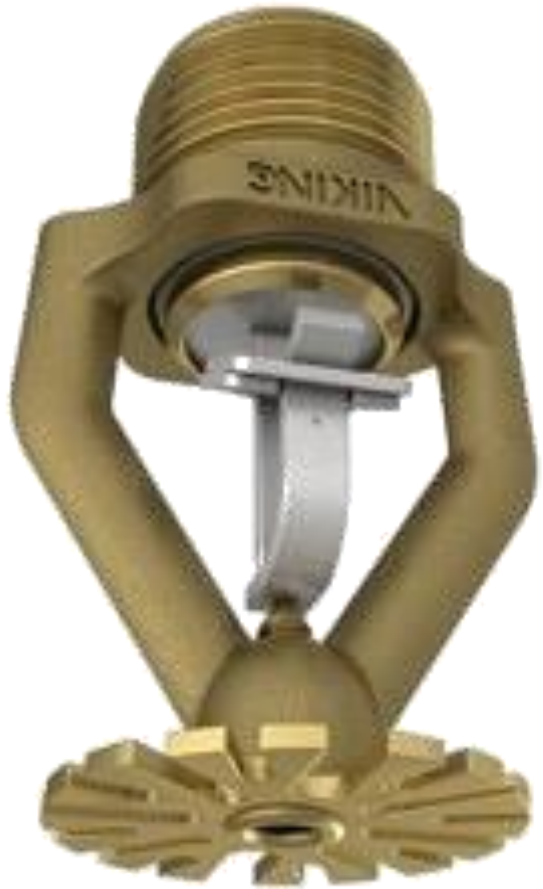
# Sprinkler Selection

- A precise design approach is necessary to meet the challenges of these occupancies, an effort that includes using **storage fire sprinklers.**



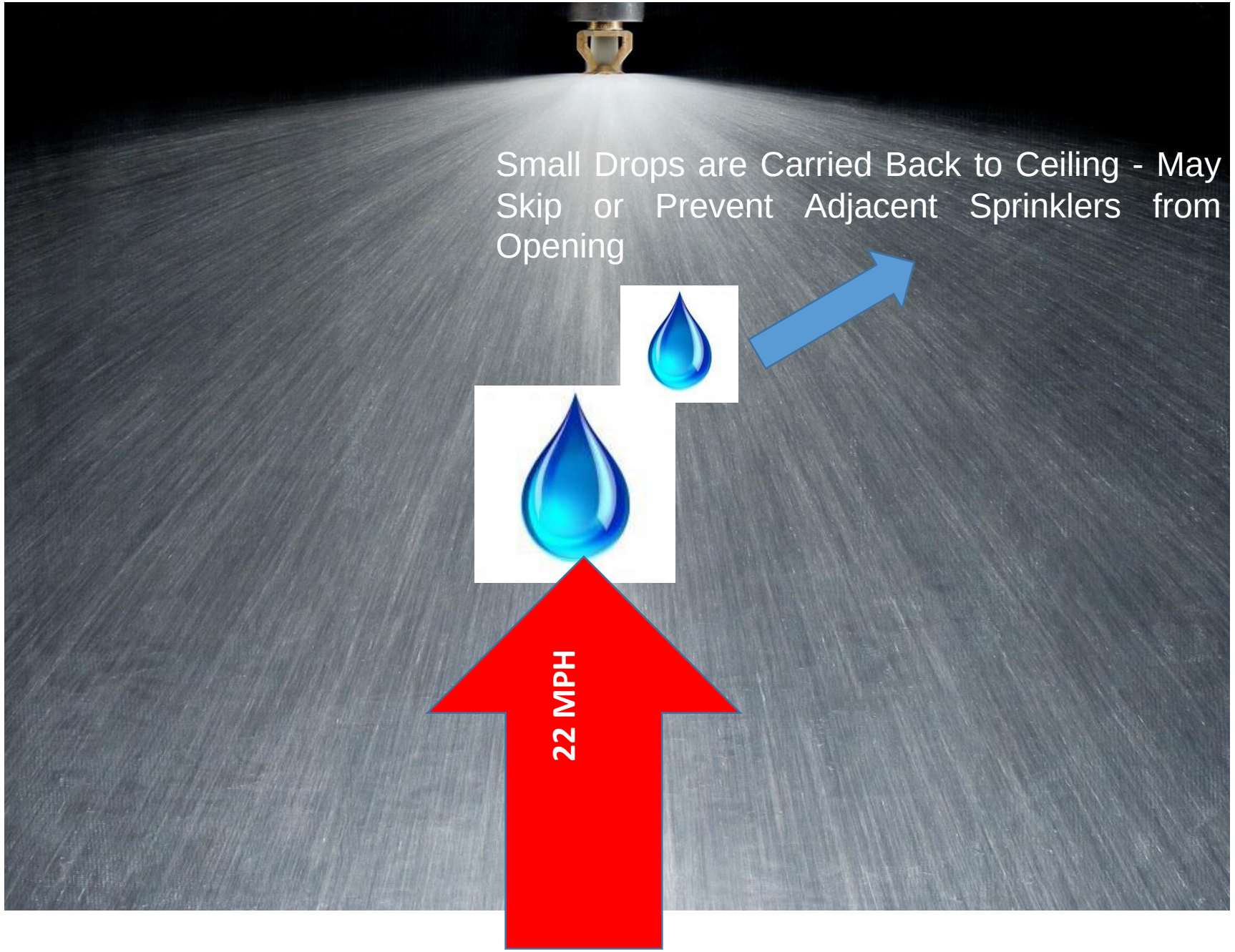
**Standard Commercial**
**VK3521**
**K=8**

**CMDA**
**VK377**
**K=11.2**



**CMSA**
**VK592**
**K=19.6**

**ESFR**
**VK500**
**K=14**


Small Drops are Carried Back to Ceiling - May Skip or Prevent Adjacent Sprinklers from Opening
22 MPH

# *CMDA: control-mode density area sprinklers*

- The “control-mode” in a control mode density area (CMDA) sprinkler refers to the fact that these heads provide wetting and cooling to control a fire until first responders can arrive. “Density-area” refers to how CMDA systems are designed.
- A set of density-area curves specifies the amount of water flow required for a given area. The system and its water source are engineered based on them to provide the necessary flow and pressure.

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# *CMDA: control-mode density area sprinklers*

- Does that mean **CMDA sprinklers are almost identical to average fire sprinklers** ?
- Yes in Both Shape and Functions
- The two things separating a CMDA sprinkler from a regular sprinkler are **larger K-factors** and **higher temperature ratings**.

# *CMSA: Control-mode special application sprinklers*

- Like CMDA sprinklers, control-mode special application (CMSA) sprinklers are designed for “control” functions: wetting and cooling to prevent fire spread. And like most storage sprinklers, CMSA sprinklers usually have large K-factors. However, they differ from CMDA sprinklers in two ways.

# *CMSA: Control-mode special application sprinklers*

1. CMSA sprinklers have unique sprinkler deflectors that produce different water droplet sizes and spray patterns. This makes CMSA sprinklers suited to “special applications;” in other words, high-challenge storage occupancies. The unique deflector also requires the sprinklers to carry a different listing.
2. CMSA sprinklers don’t use the design concepts employed by CMDA sprinklers. No density/area curves are involved. Instead, different variables are analyzed to calculate the necessary flow and pressure for a given system

# *ESFR: Early-suppression fast response sprinklers*

- Unique among fire sprinklers, early-suppression fast-response (ESFR) sprinklers provide **fire suppression** instead of **fire control**. The goal of ESFR sprinklers isn't preventing fire spread until firefighters can fully extinguish it. Rather, they are meant to **activate quickly** and **attack a fire directly.** The idea is that early fire suppression requires less total water, allows less fire spread, and ultimately makes sprinkler systems less expensive

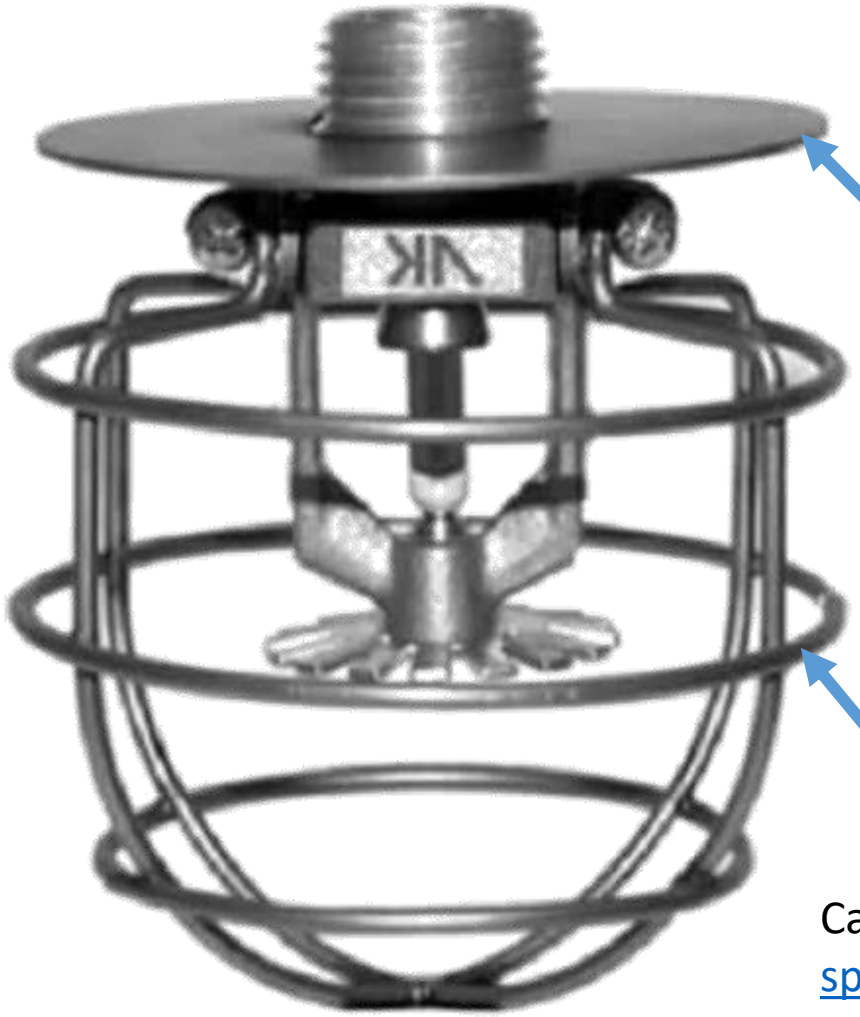
# *ESFR: Early-suppression fast response sprinklers*

- ESFR sprinklers have large K-factors and feature uniquely designed deflectors meant to produce large, high-momentum droplets that won't evaporate before penetrating a fire plume. Another major distinguishing characteristic of ESFR sprinklers is fast-response elements designed to operate sooner than standard sprinkler elements.

# *In-rack fire sprinklers*

- In-rack sprinklers work just like their name suggests: sprinkler risers and branch pipes are installed with storage racks to put sprinklers **as close to potential fires as possible**. Of course, doing so creates unique infrastructure challenges for warehouses—storage racks become more permanent when plumbing is involved. But it solves the issues posed by height and obstruction.
- Various ESFR and Control Mode ceiling level sprinklers introduced since 1980 have led to ceiling-only protection dominating the storage sprinkler market. But as storage buildings have evolved, the limitations of ceiling-only sprinkler protection have become apparent

# *In-rack fire sprinklers*



Water Shield - Protect in-rack sprinklers from the spray of other sprinklers.

*Water from a ceiling-level sprinkler head (or another in-rack head) could cool the heat-sensitive element of sprinklers near it, preventing them from operating as designed.*

Cage Guard - Protect sprinklers from heavy loads and machinery moving around them

# Why In Rack Sprinklers ?

There are situations where tests have determined that ceiling sprinklers—no matter how large the K-factor or water pressure—can't provide adequate control or suppression. Extremely flammable commodities, high ceilings, high-piled storage, and obstructions to water are common culprits. In these cases, **in-rack fire sprinklers** are necessary.

# Why In Rack Sprinklers ?

- Location matters. Being located closer to a rack storage fire gives in-rack sprinklers an advantage over ceiling sprinklers in terms of both activation and delivering water to the burning commodity. Thus, in-rack sprinklers have the potential to activate when a fire is smaller and requires less water to control.
- A key feature of in-rack sprinklers is that they do not depend on the configuration of the building enclosure. The tallest current listing for an ESFR sprinkler without in-rack sprinklers is 48 ft. There are typically no limits on building height with in-rack sprinklers

# Why In Rack Sprinklers ?

Two of the biggest challenges with ESFR sprinklers which do not affect in-rack sprinklers:

(1) Sloped ceilings and

(2) Complicated ESFR obstruction rules.

# Limits of Ceiling Only Sprinkler

1. Height :

The original ESFR sprinkler had a Nominal K-factor of 14.0 gpm/psi1/2 and was designed with a discharge pressure of 50 psi to protect Cartoned Unexpanded Group A plastics stored up to 25 ft. high under ceilings up to 30 ft. in height

# Limits of Ceiling Only Sprinkler

What Does NFPA 13 say ?

- NFPA 13 limits K14.0 ESFR sprinklers to ceiling heights of 35 ft. when protecting rack storage, unless in-rack sprinklers are provided.

- Ceiling-only design criteria to protect rack storage under ceilings up to 45 ft. tall are available with larger orifice K22.4 and K25.2 ESFR sprinklers. Specific application criteria are also available for certain ESFR sprinklers under ceiling heights up to 48 ft.

# Limits of Ceiling Only Sprinkler

## Limitations of ESFR as a Ceiling Only Sprinkler

- To be effective, an ESFR sprinkler must operate early in the development of a storage fire. Even with a very sensitive operating element, ceiling-only ESFR sprinklers are challenged to activate prior to a fire spreading across an aisle as ceiling heights increase beyond 45 ft. The design criteria available for ESFR sprinklers under a 48 ft. ceiling require minimum 6 ft. or 8 ft. aisles. For storage buildings taller than 48 ft., in-rack sprinklers are likely to be required.

- Modern distribution facilities using either multi-level work platforms (pick modules) or automated storage and retrieval systems often gain efficiency by increasing the building height beyond the limits of ceiling-only sprinkler systems.

# Limits of Ceiling Only Sprinkler

## 2. Water Demand :

Even if not required by height, the efficiency of ceiling sprinklers decreases with height. As ceiling heights increase, the water demand required for ceiling-only sprinkler systems also increases

# Limits of Ceiling Only Sprinkler

Water Demand :

| Ceiling Height (ft) | Sprinkler | Basic Sprinkler Water Demand (gpm) |
|---|---|---|
| 30 | K25.2 EC | 828 |
| 35 | K25.2 EC | 1275 |
| 40 | K16.8 ESFR | 1454 |
| 45 | K22.4 ESFR | 1700 |
| 48 | K28.0 ESFR Specific Application | 1987 |

# Limits of Ceiling Only Sprinkler

## 2. Water Demand :

Previous Table illustrates how the efficiency of ceiling-only sprinkler protection decreases with ceiling height above 30 ft. Increasing the ceiling height by just 5 ft., 17%, from 30 ft. to 35 ft. increases the basic sprinkler water demand by more than 50%. Increasing the ceiling height by 60%, from 30 ft. to 48 ft., increases the basic sprinkler water demand by 140%. Thus, even in buildings that could be protected with ceiling sprinklers, ceiling-only sprinkler protection may not be the most efficient use of water.

# Limits of Ceiling Only Sprinkler

## 3. More Hazardous Commodity:

- The discussion so far has referenced protection criteria for Cartoned Unexpanded Group A plastics. More hazardous commodities such as tires, Exposed Group A plastics, and aerosols present an increased challenge to a sprinkler system.

- These commodities typically require in-rack sprinklers to be provided at lower storage heights than would be required for a Cartoned Unexpanded Group A plastic commodity.

# Limits of Ceiling Only Sprinkler

## 3. More Hazardous Commodity:

- For example, NFPA 13 limits storage of rubber tires on racks to 35 ft. of storage under a 40 ft. ceiling with ESFR sprinkler protection at the ceiling. The criterion requires more than 2,600 gpm of basic sprinkler water demand from K25.2 ESFR sprinklers.
- Thus, while ceiling-only criteria are available for storage of Cartoned Unexpanded Group A plastics under ceilings up to 48 ft. tall, other commodities have lower ceiling height limits for ceiling-only protection. Even when ceiling-only protection options are available, the water demand or other required features may make the installation of in-rack sprinklers preferable.

# Overview of FM Data Sheet 8-9

## 2.3 Protection

### 2.3.1 General

2.3.1.1 When determining the fire protection options for a storage facility, consider all the protection options the water supply can support. This approach will help maximize operational flexibility when considering potential future commodity changes and/or storage arrangements.

# Recommended Ceiling only Sprinklers

**2.3.3.2 K-Factors, Nominal Temperature Rating, RTI Rating, and the Orientation of Ceiling-Level Storage Sprinklers**

2.3.3.2.1 Use only FM Approved sprinklers listed in the *Approval Guide* under the heading of Storage Sprinklers (Ceiling-Level) for any ceiling-level sprinkler options in this data sheet.

Currently, FM Approved ceiling-level Storage sprinklers have K-factor values ranging from 11.2 (160) to 33.6 (480). See Appendix A for a definition of K-factor as well as the units used for its indicated value.

Note that the following sprinklers are not FM Approved as ceiling-level Storage sprinklers:

- K8.0 (K115) and smaller
- On-Off type sprinklers
- ECLH type sprinklers
- ECOH type sprinklers

# Ceiling-Level Sprinkler System Design Criteria

- Table 7: Ceiling-Level Protection Guidelines for Class 1, 2 and 3 Commodities in Open-Frame Rack Storage Arrangements
- Table 8: Ceiling-Level Protection Guidelines for Class 4 and Cartoned Unexpanded Plastic Commodities in Open-Frame Rack Storage Arrangements
- Table 9: Ceiling-Level Protection Guidelines for Cartoned Expanded Plastic Commodities in Open-Frame Rack Storage Arrangements
- Table 10: Ceiling-Level Protection Guidelines for Uncartoned Unexpanded Plastic Commodities in Open-Frame Rack Storage Arrangements
- Table 11: Ceiling-Level Protection Guidelines for Uncartoned Expanded Plastic Commodities in Open-Frame Rack Storage Arrangements

# Ceiling-Level Sprinkler System Design Criteria

*Table 7. Ceiling-Level Protection Guidelines for Class 1, 2 and 3 Commodities in Open-Frame Rack Storage Arrangements*

| Protection of Class 1, 2 and 3 Commodities in Open-Frame Storage Racks; No. of AS @ psi (bar) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Max. Ceiling Height, ft (m) | Wet System, 160°F (70°C) Nominally Rated, Pendent Sprinklers | | | | | | | | | | Wet System, 160°F (70°C) Nominally Rated, Upright Sprinklers | | | | | | | Dry System, 280°F (140°C) Nominally Rated, Upright Sprinklers | | |
| | Quick Response | | | | | | Standard Response | | | | Quick Response | | | | Standard Response | | | Standard Response | | |
| | K11.2 (K160) | K14.0 (K200) | K16.8 (K240) | K22.4 (K320) | K25.2 (K360) | K25.2EC (K360EC) | K11.2 (K160) | K14.0 (K200) | K19.6 (K280) | K25.2 (K360) | K11.2 (K160) | K14.0 (K200) | K16.8 (K240) | K25.2EC (K360EC) | K11.2 (K160) | K16.8 (K240) | K25.2 (K360) | K11.2 (K160) | K16.8 (K240) | K25.2 (K360) |
| 10 (3.0) | 12 @ 7 (0.5) | 9 @ 7 (0.5) | 9 @ 7 (0.5) | 9 @ 20 (1.4) | 9 @ 20 (1.4) | 6 @ 20 (1.4) | 12 @ 7 (0.5) | 9 @ 7 (0.5) | 9 @ 16 (1.1) | 9 @ 7 (0.5) | 12 @ 7 (0.5) | 9 @ 7 (0.5) | 9 @ 7 (0.5) | 6 @ 20 (1.4) | 12 @ 7 (0.5) | 9 @ 7 (0.5) | 9 @ 7 (0.5) | 16 @ 7 (0.5) | 16 @ 7 (0.5) | 16 @ 7 (0.5) |
| 20 (6.0) | 12 @ 10 (0.7) | 12 @ 7 (0.5) | 12 @ 7 (0.5) | 9 @ 20 (1.4) | 9 @ 20 (1.4) | 6 @ 20 (1.4) | 12 @ 10 (0.7) | 12 @ 7 (0.5) | 9 @ 16 (1.1) | 9 @ 10 (0.7) | 12 @ 10 (0.7) | 12 @ 7 (0.5) | 12 @ 7 (0.5) | 6 @ 20 (1.4) | 12 @ 10 (0.7) | 12 @ 7 (0.5) | 12 @ 7 (0.5) | 16 @ 10 (0.7) | 16 @ 7 (0.5) | 16 @ 7 (0.5) |
| 25 (7.5) | 15 @ 16 (1.1) | 12 @ 16 (1.1) | 12 @ 11 (0.8) | 9 @ 20 (1.4) | 9 @ 20 (1.4) | 6 @ 22 (1.5) | 15 @ 16 (1.1) | 15 @ 10 (0.7) | 9 @ 16 (1.1) | 9 @ 10 (0.7) | 15 @ 16 (1.1) | 12 @ 16 (1.1) | 12 @ 11 (0.8) | 6 @ 22 (1.5) | 15 @ 16 (1.1) | 15 @ 7 (0.5) | 10 @ 20 (1.4) | 20 @ 16 (1.1) | 20 @ 7 (0.5) | 20 @ 7 (0.5) |
| 30 (9.0) | 18 @ 50 (3.5) | 12 @ 50 (3.5) | 12 @ 35 (2.4) | 9 @ 20 (1.4) | 9 @ 20 (1.4) | 6 @ 30 (2.1) | 18 @ 50 (3.5) | 18 @ 32 (2.2) | 9 @ 16 (1.1) | 9 @ 10 (0.7) | 18 @ 50 (3.5) | 12 @ 50 (3.5) | 12 @ 35 (2.4) | 6 @ 30 (2.1) | 18 @ 50 (3.5) | 18 @ 22 (1.5) | 12 @ 20 (1.4) | 25 @ 50 (3.5) | 25 @ 22 (1.5) | 25 @ 10 (0.7) |
| 35 (10.5) | | 12 @ 75 (5.2) | 12 @ 52 (3.6) | 12 @ 29 (2.0) | 12 @ 23 (1.6) | 6 @ 60 (4.1)[a] | | | 15 @ 25 (1.7) | 9 @ 30 (2.1) | | | | 8 @ 40 (2.8) | | | | See Section 2.3.6.1 | | |
| 40 (12.0) | | 12 @ 75 (5.2) | 12 @ 52 (3.6) | 9 @ 50 (3.5) | @ 40 (2.8) | | | | | 9 @ 30 (2.1) | | | | | | | | | | |

[a] An acceptable alternative design is 8 @ 40 (2 ) when a 12 ft (3.6 m) maximum linear spacing is used

The ceiling-level protection options highlighted in green represent those for which the hose stream demand is 250 gpm (950 L/min) and the duration is 1 hour. These highlighted options have the potential result in less fire, smoke, and water damage than other acceptable options and thus may, from a sustainability standpoint, be preferable

# Ceiling-Level Sprinkler System Design Criteria

The design guidelines for ceiling-level Storage sprinklers are based on five main attributes assigned to a sprinkler. They are:

1) K-Factor (orifice size)
2) Orientation (pendent or upright)
3) Response time index rating (quick-response or standard-response)
4) Nominal temperature rating
5) Sprinkler spacing (standard or extended-coverage)

*Once the commodity hazard, storage arrangement, and peak ceiling height for the protected area is known, the protection design options for the sprinkler system can be determined using the appropriate protection table in combination with the five sprinkler attributes*

# In-Rack Sprinklers (IRAS)

### 2.3.4 In-Rack Sprinklers (IRAS)

#### 2.3.4.1 General

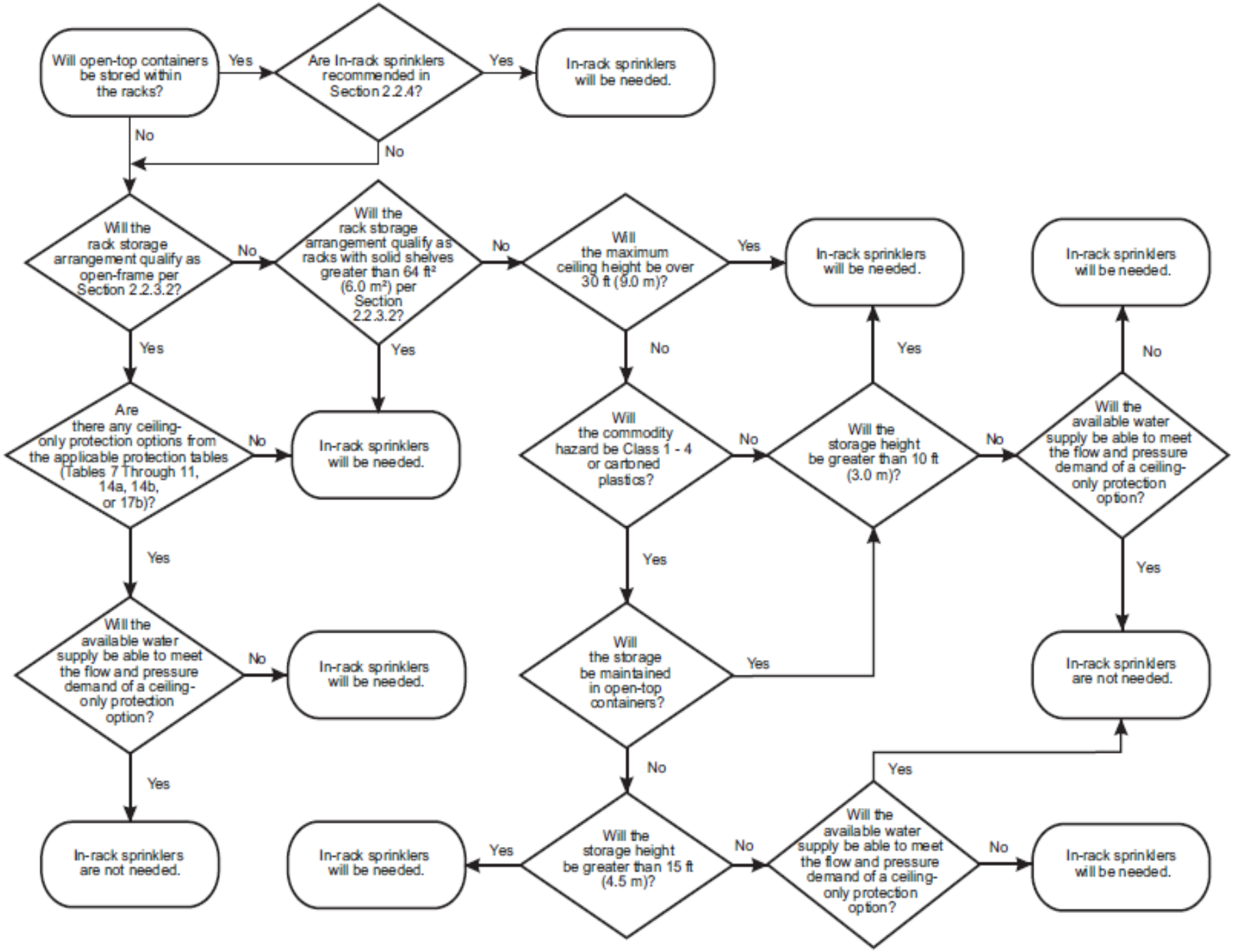
Protection options for rack storage arrangements are based on ceiling-only sprinkler systems, or a combination of ceiling-level and in-rack sprinkler systems. When in-rack sprinklers are needed, they can be used in combination with any of the ceiling sprinklers listed in the protection tables indicated for rack storage.

# In-Rack Sprinklers (IRAS)

**2.3.4.2 When In-Rack Sprinklers are Needed**

The need for in-rack sprinklers is dependent on several parameters, including commodity hazard, ceiling height, available water supply, the presence of solid shelves or open-top containers, and the width and location of flue spaces. See Section 2.2.3.2 to determine if the storage racks meet the guidelines to be treated as open-frame racking. Use Figure 3 to determine when in-rack sprinklers are recommended.

# FM Global Data Sheet 8-9
# (Flowchart for evaluating the need for in-rack sprinklers)


Will open-top containers be stored within the racks?
Yes
Are In-rack sprinklers recommended in Section 2.2.4?
Yes
In-rack sprinklers will be needed.
No
No
Will the rack storage arrangement qualify as open-frame per Section 2.2.3.2?
No
Will the rack storage arrangement qualify as racks with solid shelves greater than 64 ft² (6.0 m²) per Section 2.2.3.2?
No
Will the maximum ceiling height be over 30 ft (9.0 m)?
Yes
In-rack sprinklers will be needed.
In-rack sprinklers will be needed.
Yes
Yes
No
No
Are there any ceiling-only protection options from the applicable protection tables (Tables 7 Through 11, 14a, 14b, or 17b)?
No
In-rack sprinklers will be needed.
Will the commodity hazard be Class 1 - 4 or cartoned plastics?
No
Will the storage height be greater than 10 ft (3.0 m)?
No
Will the available water supply be able to meet the flow and pressure demand of a ceiling-only protection option?
Yes
Yes
Yes
Yes
Will the available water supply be able to meet the flow and pressure demand of a ceiling-only protection option?
No
In-rack sprinklers will be needed.
Will the storage be maintained in open-top containers?
Yes
In-rack sprinklers are not needed.
Yes
No
In-rack sprinklers are not needed.
In-rack sprinklers will be needed.
Yes
Will the storage height be greater than 15 ft (4.5 m)?
No
Will the available water supply be able to meet the flow and pressure demand of a ceiling-only protection option?
No
In-rack sprinklers will be needed.

| Where In-Racks Become Mandatory Based on Ceiling Height – FM 8-9 | | |
|---|---|---|
| Chapter | Commodity | Building Height |
| Tables 7 - 11 | Class I – IV and Cartoned Unexpanded Plastic | >45 ft (13.7 m) |
| | Cartoned and Uncartoned Expanded Plastic | >40 ft (12.1 m) |

# FM Global vs NFPA

- FM has eliminated all names of storage sprinklers such as ESFR, CMSA and CMDA, NFPA still uses the names to differentiate the rules
- FM has banned K5.6 (K80) and K8.0 (K115) from ceiling protection of storage, NFPA restricts the use but not a ban
- FM has banned 286 degree (high temperature) sprinklers from wet systems
- FM has eliminated density and area from design considerations, NFPA still highly dependent on density curves
- FM has eliminated storage height from design consideration of ceiling only protection, storage height and clearance a significant design consideration in NFPA
- FM and NFPA now recognize ceiling only designs with as few as 6 sprinklers in the hydraulic demand

# Selecting FM Standards

- 1.5 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.
- 1.5.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.
- 1.5.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

**When NFPA is the referenced code by law, Section 1.5 is used to submit a FM design.**

# NFPA 13 and FM 8-9 Starting Points

## • NFPA 13

// Commodity Class
- Building Height
- Storage
  - Arrangement - Palletized or Rack
  - Height
    - From floor
    - Clearance to Ceiling
- Sprinkler System
  - Wet
    - ESFR
    - CMSA
    - CMDA
    - Special
  - Dry
    - CMSA
    - CMDA
    - Special

## • FM 8-9

// Commodity Class
- Building Height
- Storage
  - Arrangement - Palletized or Rack
- Sprinkler System
  - Wet
    - Pendent QR or SR
    - Upright QR or SR
  - Dry
    - Upright 280$^0$F (140C)

# 45 ft (13,7 m) Ceiling Recommendation Rack Storage With No In-Rack Sprinklers

- Model ESFR-25
  - K-Factor 25.2 (360)
- NFPA/FM Global Exceptions
  - No Solid Shelves
  - Open-top containers
  - Uncartoned Unexpanded Plastic
  - Cartoned or Uncartoned Expanded Plastic

# 40 ft (12,2 m) Ceiling Recommendation Rack Storage With No In-Rack Sprinklers

- Model ESFR-25
  - K-Factor 25.2 (360)
- NFPA/FM Global Exceptions
  - No Solid Shelves
  - Open Top containers
- NFPA Exceptions
  - Cartoned or Uncartoned Expanded Plastic
- Other available options include Model ESFR-17 Pendent and Model ESFR-1

# 35 ft (10,5 m) Ceiling Recommendation Rack Storage With No In-Rack Sprinklers

- Model EC-25
  - K-Factor 25.2 (360)
- NFPA Exceptions
  - No Solid Shelves
  - No Open Top containers
  - Cartoned or Uncartoned Expanded Plastic
- FM Global Exceptions
  - No Solid Shelves
  - Open Top containers
  - Uncartoned Unexpanded Plastic
  - Cartoned or Uncartoned Expanded Plastic
- Other available options include Model ESFR-25, Model ESFR-17 Pendent, Model ESFR-17 Upright and Model ESFR-1

# Specific Application Listing Tyco Model ESFR-25

- Provide ceiling-only protection up to a
  - **48 ft (14.6 m) Ceiling**
  - **43 ft (13.1 m) Storage**
- Eliminates need for in-rack sprinklers NFPA 13
- Lower pressure provides flexibility wh compared to other listed sprinklers
- 10-Year Limited Warranty

tyco

Worldwide Contacts | www.tyco-fire.com

**Model ESFR-25**
**Early Suppression, Fast Response Pendent Sprinklers**
**25.2 K-factor**

**General Description**

The TYCO Model ESFR-25 Pendent Sprinklers are Early Suppression, Fast Response Sprinklers* having a nominal K-factor of 25.2. (Refer to Figure 1.) They are suppression-mode sprinklers that are especially advantageous as a means of eliminating the use of in-rack sprinklers when protecting high-piled storage.

The Model ESFR-25 Sprinklers are primarily used for ceiling-only sprinkler protection of (but not limited to) the following storage applications:

- Most encapsulated or non-encapsulated common materials including cartoned, unexpanded plastics.
- Uncartoned (exposed) expanded plastics in accordance with NFPA 13 and FM Global standards.
- Some storage arrangements of rubber tires, roll paper, flammable liquids, aerosols, and automotive components.

For more specific criteria, refer to Table 1 as well as the applicable design standard.

The Model ESFR-25 Pendent Sprinklers provide the system designer with hydraulic and sprinkler placement options not presently available to the traditional ESFR sprinklers having nominal K-factors of 14.0 and 16.8. In particular, the Model ESFR-25 Sprinkler has been designed to operate at substantially lower end head pressure, as compared to ESFR Sprinklers having nominal K-factors of 14.0 and 16.8. This feature offers flexibility when sizing system piping, as well as possibly reducing or eliminating the need for a system fire pump.

Also, Model ESFR-25 Sprinklers permit use of a maximum deflector-to-ceiling distance of 18 inches (450 mm) versus 14 inches (356 mm). Additionally, a storage arrangement of 40 ft. (12.2 m) with a ceiling height of 45 ft. (13.7 m) does not require in-rack sprinklers as do other ESFR Sprinklers having nominal K-factors of 14.0 and 16.8.

The Model ESFR-25 Sprinklers are listed by Underwriters Laboratories (UL) for specific applications with a maximum storage height of 43 ft. (13.1 m) with a maximum ceiling height of 48 ft. (14.6 m) without the requirement for in-rack sprinklers. Refer to the Specific Application Listing (UL) for the design criteria.

Applications for the TYCO ESFR Sprinklers are expanding beyond currently recognized installation standards. For information on research fire tests (e.g., with flammable liquids and aerosols) that may be acceptable to an authority having jurisdiction, contact the Technical Services department.

**IMPORTANT**

*Always refer to Technical Data Sheet TFP700 for the "INSTALLER WARNING" that provides cautions with respect to handling and installation of sprinkler systems and components. Improper handling and installation can permanently damage a sprinkler system or its components and cause the sprinkler to fail to operate in a fire situation or cause it to operate prematurely.*

**NOTICE**

*The Model ESFR-25 Sprinklers described herein must be installed and maintained in compliance with this document, as well as with the applicable standards of the National Fire Protection Association, in addition to the standards of any authority having jurisdiction (e.g., FM Global). Failure to do so may impair the performance of these devices.*

*The owner is responsible for maintaining their fire protection system and devices in proper operating condition. The installing contractor or sprinkler manufacturer should be contacted with any questions.*

*In all cases, the appropriate NFPA or FM installation standard, or other applicable standard, must be referenced to ensure applicability and to obtain complete installation guidelines. The general guidelines in this data sheet are not intended to provide complete installation criteria.*

**Sprinkler Identification Number (SIN)**

TY9226

TY9226 is a re-designation for C9226, G8441, and S8010.

**Technical Data**

**Approvals**
UL and C-UL Listed
FM and VdS Approved
LPCB Approved (094b/01 and 094b/02)
NYC under MEA 358-01-E
CE Certified (DoP 11.03/05)

**Maximum Working Pressure**
175 psi (12.1 bar)

**Pipe Thread Connections**
1 inch NPT
ISO 7-R1

**Discharge Coefficient**
K = 25.2 GPM/psi$^{1/2}$
(362.9 LPM/bar$^{1/2}$)

**Temperature Ratings**
165°F (74°C)
214°F (101°C)

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# Specific Application Listing Tyco Model ESFR-25 – Key Design Criteria

- Temperature rating: 212˚ F (100˚ C)
- Deflector to top of storage: ≥ 36 in (914 mm)
- Deflector to ceiling distance 6 – 14 in (152 – 356 mm)
- Sprinkler system design: NFPA 13 for ESFR Sprinkler based on 45 PSI (3.1 bar)
- Minimum aisle width: 8 ft (2,4 m)

# Chapter- 25
# Protection of Rack Storage using In rack Sprinklers

# Single Row Rack

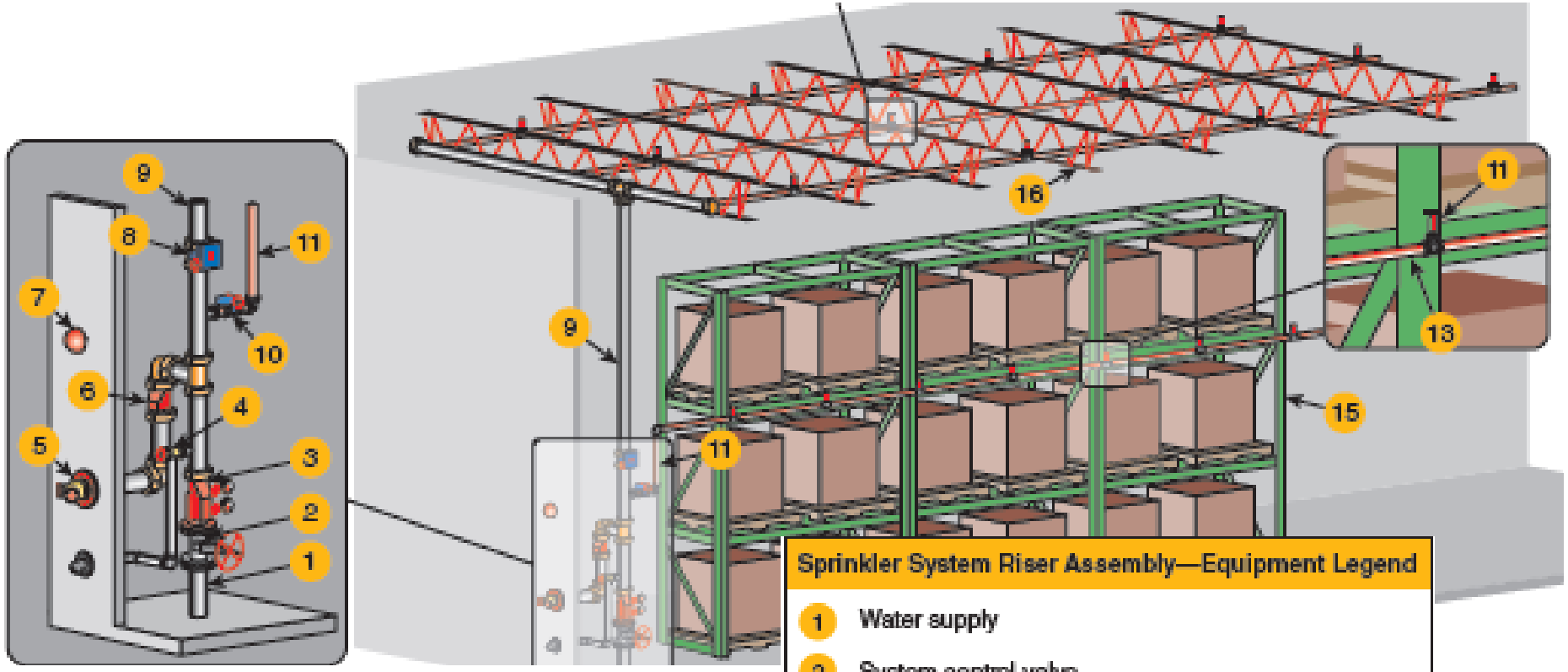
Racks that have no longitudinal flue space and that have a width up to 6ft (1.8m) with aisles at least 3.5ft (1.1m) from other storage.

# Double Row Rack

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 Rack


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).




## Sprinkler System & Building—Legend

12 Ceiling/overhead fire sprinklers

13 In-rack fire sprinkler(s)

14 Branch line(s)

15 Rack structure

16 Roof support structure

## Sprinkler System Riser Assembly—Equipment Legend

1 Water supply

2 System control valve

3 System check valve

4 Main drain valve

5 Fire department connection

6 Check valve

7 Local waterflow alarm

8 Control valve for ceiling/overhead sprinklers

9 Feed main to ceiling/overhead sprinklers

10 Control valve for in-rack sprinklers

11 Feed main to in-rack sprinklers

# 3 Basic Questions:

- What is stored? ( Classification of Commodities)
- How is it stored? (Storage Arrangements)
- How high is it stored?

✓ < 12 feet

✓ < = 25 feet

✓ > 25 feet

# Fire Control Vs Fire Suppression

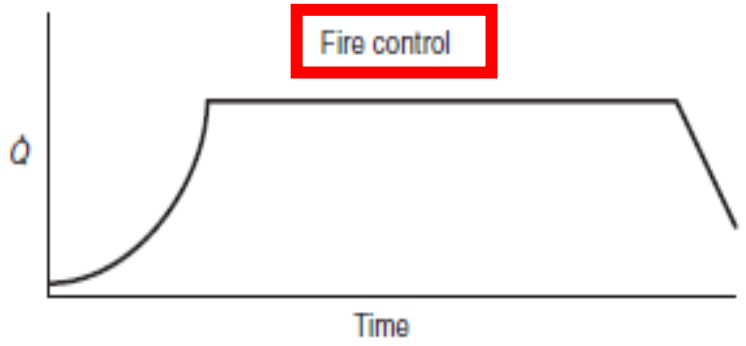



**FIGURE 16.1.9** Representation of Fire Control by Sprinklers; Heat Release Rate ($\dot{Q}$) Versus Time

Vs

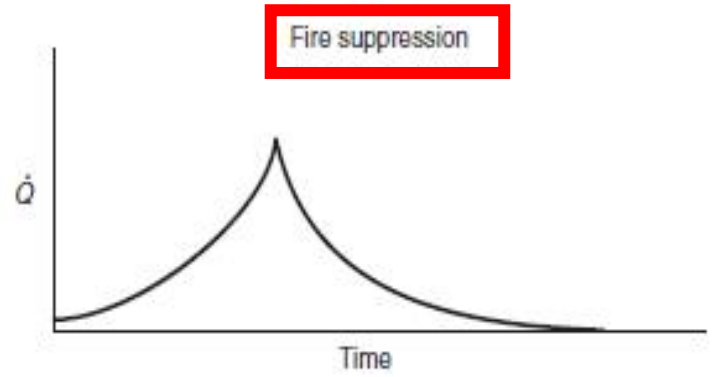



**FIGURE 16.1.11** Representation of Fire Suppression by Sprinklers, Heat Release Rate ($\dot{Q}$) Versus Time

# Requirement of In Rack Sprinklers

*Depends upon*

- Type of commodity (Type 1 to 4 and plastics)
- Height of the rack ( Over 12’ & upto 25’ / Over 25’) with different aisle widths
- Arrangement of Rack (Single, Double & multiple rows)

**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)**

| Storage Height | Commodity Class | Encapsulated | Aisle Width* | | No. of In-Rack Sprinkler Levels | Appropriate Figure and Curves | | |
|---|---|---|---|---|---|---|---|---|
| | | | ft | m | | Figure | Curves | Apply Figure 25.2.3.2.4.1 |
| Over 12 ft (3.7 m) and up to and including 20 ft (6.1 m) | I | No | 4 | 1.2 | 1 Level | 25.2.3.2.3.1(a) | C and D | Yes |
| | | | 8 | 2.4 | | | A and B | |
| | | Yes | 4 | 1.2 | | 25.2.3.2.3.1(e) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | II | No | 4 | 1.2 | | 25.2.3.2.3.1(b) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | | Yes | 4 | 1.2 | | 25.2.3.2.3.1(e) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | III | No | 4 | 1.2 | | 25.2.3.2.3.1(c) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | | Yes | 4 | 1.2 | | 25.2.3.2.3.1(f) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | IV | No | 4 | 1.2 | | 25.2.3.2.3.1(d) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | | Yes | 4 | 1.2 | | 25.2.3.2.3.1(g) | C and D | |

# Example : 1

- Type of Commodity : Class 4, Encapsulated
- Storage Height : 21 feet
- Building Height : 30 feet
- Type of Rack Arrangement : Double row with Aisle width 4 foot
- Type of Sprinkler System : Wet Type

Determine Requirement of in rack sprinklers

**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)**

| Storage Height | Commodity Class | Encapsulated | Aisle Width ft | Aisle Width m | No. of In-Rack Sprinkler Levels | Appropriate Figure and Curves: Figure | Curves | Apply Figure 25.2.3.2.4.1 |
|---|---|---|---|---|---|---|---|---|
| Over 12 ft (3.7 m) and up to and including 20 ft (6.1 m) | I | No | 4 | 1.2 | 1 Level | 25.2.3.2.3.1(a) | C and D | Yes |
| | | | 8 | 2.4 | | | A and B | |
| | | Yes | 4 | 1.2 | | 25.2.3.2.3.1(e) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | II | No | 4 | 1.2 | | 25.2.3.2.3.1(b) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | | Yes | 4 | 1.2 | | 25.2.3.2.3.1(e) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | III | No | 4 | 1.2 | | 25.2.3.2.3.1(c) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | | Yes | 4 | 1.2 | | 25.2.3.2.3.1(f) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | IV | No | 4 | 1.2 | | 25.2.3.2.3.1(d) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | | Yes | 4 | 1.2 | | 25.2.3.2.3.1(g) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| Over 20 ft (6.1 m) and up to and including 22 ft (6.7 m) | I | No | 4 | 1.2 | 1 Level | 25.2.3.2.3.1(a) | C and D | No |
| | | | 8 | 2.4 | | | A and B | |
| | | Yes | 4 | 1.2 | | 25.2.3.2.3.1(e) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | II | No | 4 | 1.2 | | 25.2.3.2.3.1(b) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | | Yes | 4 | 1.2 | | 25.2.3.2.3.1(e) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | III | No | 4 | 1.2 | | 25.2.3.2.3.1(c) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | | Yes | 4 | 1.2 | | 25.2.3.2.3.1(f) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | IV | No | 4 | 1.2 | | 25.2.3.2.3.1(d) | C and D | |
| | | | 8 | 2.4 | | | A and B | |
| | | Yes | 4 | 1.2 | | 25.2.3.2.3.1(g) | C and D | |
| | | | 8 | 2.4 | | | A and B | |

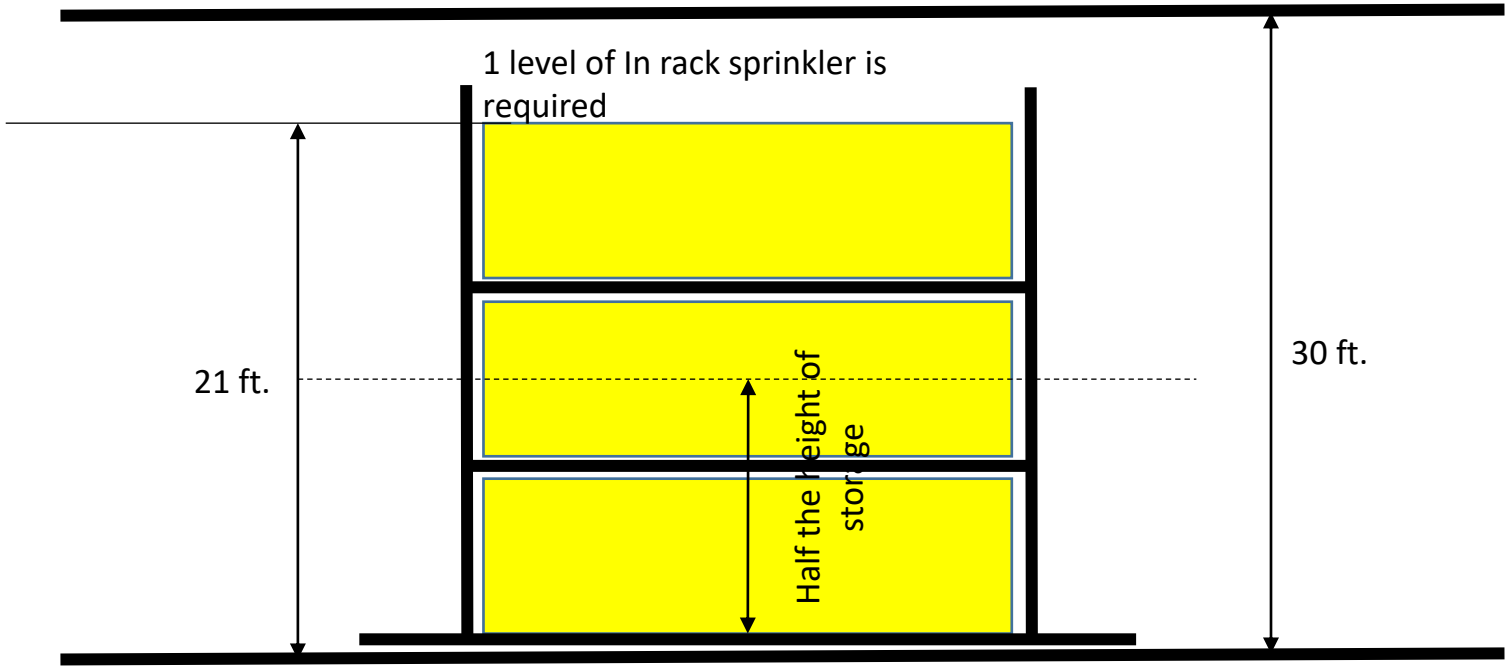
**Option-01**

**With CMDA Sprinklers**

**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**

| Storage Arrangement | Commodity Class | Maximum Storage Height | | Maximum Ceiling/ Roof Height | | K-Factor/ Orientation | Type of System | No. of Ceiling Sprinklers in the Design | No. of Required Levels of In-Rack Sprinklers | Minimum Ceiling Sprinkler Operating Pressure | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ft | m | ft | m | | | | | psi | bar |
| Single-, double-, and multiple-row racks (no open-top containers) | I or II | 30 | 9.1 | 35 | 11 | 11.2 (160) Upright | Wet | 20 | One level | 25 | 1.7 |
| | | | | | | | Dry | 30 | One level | 25 | 1.7 |
| | | | | | | 16.8 (240) Upright | Wet | 20 | One level | 15 | 1 |
| | | | | | | | Dry | 30 | One level | 15 | 1 |
| | III | 25 | 7.6 | 30 | 9.1 | 11.2 (160) Upright | Wet | 15 | One level | 25 | 1.7 |
| | | | | | | | Dry | 25 | One level | 25 | 1.7 |
| | | | | | | 16.8 (240) Upright | Dry | 25 | One level | 15 | 1 |
| | | | | 35 | 11 | 11.2 (160) Upright | Wet | 15 | One level | 25 | 1.7 |
| | | | | | | | Dry | 25 | One level | 25 | 1.7 |
| | | | | | | 16.8 (240) Upright | Wet | 15 | One level | 15 | 1 |
| | | | | | | | Dry | 25 | One level | 15 | 1 |
| | IV | 25 | 7.6 | 30 | 9.1 | 11.2 (160) Upright | Wet | 15 | One level | 50 | 3.4 |
| | | | | 35 | 11 | 11.2 (160) Upright | Wet | [illegible] | One level | 50 | 3.4 |
| | | | | | | | | 15 | One level | 75 | 5.2 |
| | | | | | | 16.8 (240) [illegible] | Wet | 20 | One level | 22 | 1.5 |
| | | | | | | | | 15 | One level | 35 | 2.4 |

# Example-1


1 level of In rack sprinkler is required
21 ft.
30 ft.
Half the height of storage

# Example : 2

- Type of Commodity : Class 4, Encapsulated
- Storage Height : 18 feet
- Building Height : 23 feet
- Type of Rack Arrangement : Multiple row Rack with Aisle 15 feet deep
- Aisle Width : 6 feet
- Type of Sprinkler System : Wet Type

Determine Requirement 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)**

| Storage Height | Commodity Class | Encapsulated | No. of In-Rack Sprinkler Levels | Appropriate Figure and Curves | | |
|---|---|---|---|---|---|---|
| | | | | Figure | Apply Figure 25.2.3.2.4.1 | Density Multiplier |
| Over 12 ft (3.7 m) and up to and including 15 ft (4.6 m) | I | No | 1 Level | 25.2.3.2.3.1(a) | Yes | 1.0 |
| | | Yes | | | | 1.25 |
| | II | No | | 25.2.3.2.3.1(b) | | 1.0 |
| | | Yes | | | | 1.25 |
| | III | No | | 25.2.3.2.3.1(c) | | 1.0 |
| | | Yes | | | | 1.25 |
| | IV | No | | 25.2.3.2.3.1(d) | | 1.0 |
| | | Yes | | | | 1.5 |
| Over 15 ft (4.6 m) and up to and including 20 ft (6.1 m) | I | No | 1 Level | 25.2.3.2.3.1(a) | Yes | 1.0 |
| | | Yes | | | | 1.25 |
| | II | No | | 25.2.3.2.3.1(b) | | 1.0 |
| | | Yes | | | | 1.25 |
| | III | No | | 25.2.3.2.3.1(c) | | 1.0 |
| | | Yes | | | | 1.25 |
| | IV | No | | 25.2.3.2.3.1(d) | | 1.0 |
| | | Yes | | | | 1.5 |
| Over 20 ft (6.1 m) and up to and including 25 ft (7.6 m) | I | No | 1 Level | 25.2.3.2.3.1(a) | No | 1.0 |
| | | Yes | | | | 1.25 |
| | II | No | | 25.2.3.2.3.1(b) | | 1.0 |
| | | Yes | | | | 1.25 |
| | III | No | | 25.2.3.2.3.1(c) | | 1.0 |
| | | Yes | | | | 1.25 |
| | IV | No | 2 Levels | 25.2.3.2.3.1(d) | | 1.0 |
| | | Yes | 2 Levels | | | 1.5 |

# Example : 5

- Type of Commodity : Class 4, Encapsulated
- Storage Height : 25 feet
- Building Height : 42 feet
- Type of Rack Arrangement : Double row Rack
- ESFR K = 16.8 pendant sprinkler at the ceiling.

Determine Requirement of in rack sprinklers

**Table 25.2.5.1.1 ESFR Ceiling-Level Sprinkler Design Criteria for Rack Storage of Class I Through Class IV and Group A Plastic Commodities (Encapsulated and Nonencapsulated) Supplemented with In-Rack Sprinklers**

| Storage Arrangement | Commodity Class | Maximum Storage Height | | Maximum Ceiling/ Roof Height | | K-Factor | Orientation | No. of Ceiling Sprinklers in the Design | No. of Required Levels of In-Rack Sprinklers | Minimum Ceiling Sprinkler Operating Pressure | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ft | m | ft | m | | | | | psi | bar |
| Single-, double-, and multiple-row racks (no open-top containers) | Class I, II, III or IV, encapsulated or nonencapsulated, cartoned nonexpanded and exposed nonexpanded plastics | 25 | 7.6 | 45 | 14 | 14.0 (200) | Pendent | 12 | One level | 90 | 6.2 |
| | | | | | | 16.8 (240) | Pendent | 12 | One level | 63 | 4.3 |

# COMPARISON SUMMARY

| Parameter | ESFR | IRAS |
|---|---|---|
| Fire Suppression capability | Yes | NO( It Control) |
| Effect of Obstruction | Highly Affected hence Obstruction rule shall be followed during installation | No Effects |
| Clearance from Ceiling | As applicable | Not Applicable |
| Effect of Building Height | Applicable | Not Applicable |
| Response Time | Fast Response However might get delayed if encounter an obstruction | Increased proximity to equipment for fast acting fire suppression |
| Sprinkler Head Water Discharge | 100 GPM | 60 GPM |
| Effect of Type of Commodity Storage | Each type of ESFR sprinkler head can protect a different set of commodities. | Not Applicable |
| Cost of Installation | 30% to 50% less than IRAS however it also depends upon water supply cost as well | Higher |

# Tank Sizing

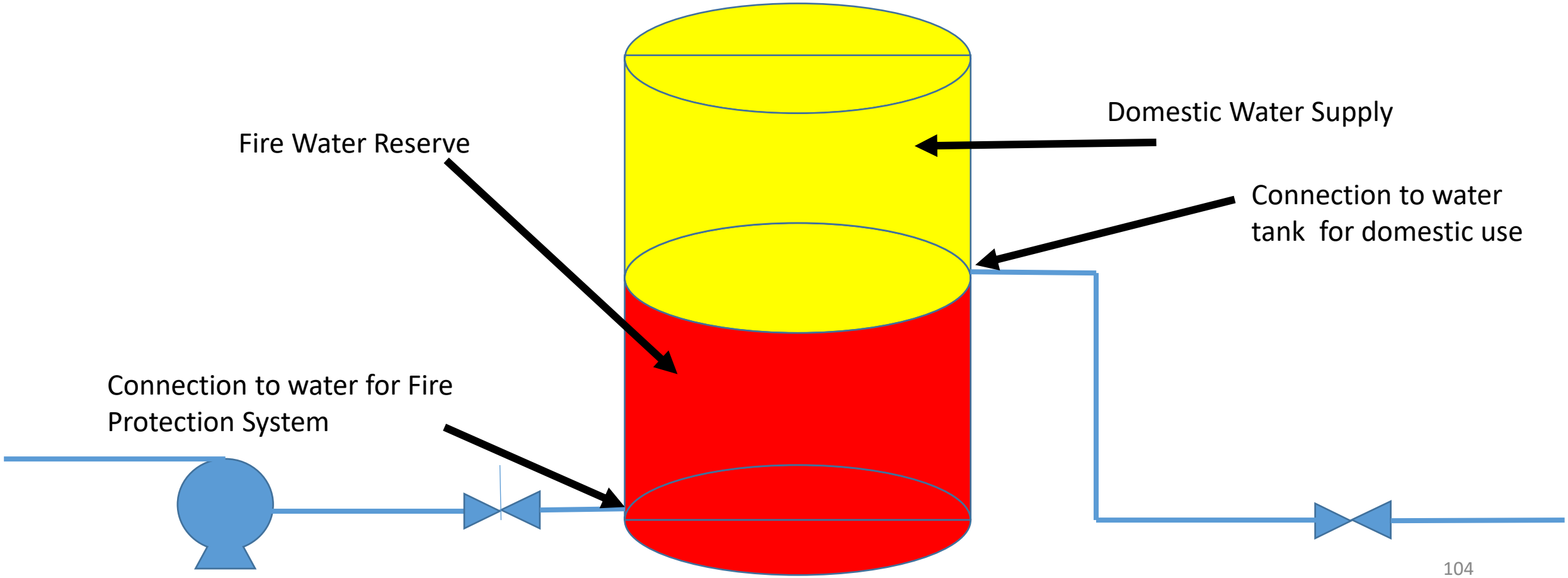
Cl. 20.12.2.1 - Tanks shall be sized to supply the equipment that they serve.

Tank Size = Sprinkler Demand + (Internal + External Hose ) Demand

Its not same as that of Standpipe System, this is only for manual fire fighting by the fire fighters along with sprinkler operation

Check if its required at site else as per local AHJ

# **Tank Sizing -** Serve both domestic and fire protection uses



# Q1 : Can ESFR systems protect all types of rack storage?

No.

- There is no one ESFR system available to protect all types of rack storage, rather there are several types of ESFR sprinkler heads and required water pressures, with each one of them to be applied in specific storage scenarios. It should also be noted that ESFR systems cannot be applied to open top containers. However, since the concern with open top containers relates to these containers retaining the water (like a reservoir) and not allowing the water to flow down to the lowest levels of a rack, there is no harm if open top containers are used in the lowest level of the rack (at or near the floor)

## Q2 : Once an ESFR system is installed, can any business move in and store however they want?

# No.

- Each type of ESFR sprinkler head can protect a different set of commodities. For example, based on the NFPA 13 standard, K-25 ESFR cannot protect cartoned expanded plastics, such as products that have >25% by volume of foam packaging in a cardboard box (FM Global Loss Prevention Data Sheet DS 8-9 does offer K-25 ESFR options for protecting cartoned expanded plastics.
- These FM protection schemes, however, need to be applied as alternative means of protection criteria to NFPA 13). For building owners or in warehouses, where the types of storage fluctuates, the best return for your ESFR dollar is the K-17 ESFR head, which protects a large variety of products, but still requires comparatively low water pressures.

# Q3 : Are there instances where in-rack sprinklers are required, even when the building is equipped with an ESFR system?

Yes.

- There are several instances where in-rack sprinklers are required with an ESFR system. For example, in cases where solid shelves are proposed in the racks, in-racks sprinklers will be required. Additionally, close attention must be paid to the ESFR tables in NFPA 13, especially Tables 16.2.3.1, 16.3.3.1, 17.2.3.1, and 17.3.3.1 for ceiling heights greater than 40 feet. Many of the ESFR options in these tables require in-rack sprinklers.

# Q4 : Can I store products which are not protected by the ceiling level ESFR?

## Yes

There may be circumstances that an existing ceiling level ESFR sprinkler system cannot protect some of the products stored in a warehouse. This is often the case if the ESFR system was specified for Class I-IV commodities, but some of the products stored in the racks are of higher hazard, e.g. rack storage of exposed Group A plastics. In these cases, new protection schemes prescribed in the 2016 edition of NFPA 13 allow the existing ceiling level protection to remain unchanged while protecting the racks with the higher hazard commodities with an ‘alternative protection’ scheme, see Sections 16.1.2.4 (Class I-IV) and 17.1.2.9 (Plastics and Rubber) for more detail. These Alternative Protection schemes applied to only a few racks (with the higher hazard) can be very cost effective in these situations. These schemes can also be used in combination with solid shelves on these ‘alternatively protected’ racks, but in these cases will require in-rack sprinklers at every level.

# Q5: Can ESFR sprinkler systems be used with solid shelving?

## Yes

one of the biggest changes since the release of NFPA 13 2013 Edition and the protection of commodities on racks with ESFR is the allowance for ESFR sprinklers in combination with solid shelving! ESFR sprinkler are now allowed to protect racks with solid shelving if in-rack sprinkler protection is installed