



Sprinkler Selection for High-Piled Storage

(Participation Guide)



Course Summary

Explore the selection and application of automatic sprinklers for storage arrays where solid-pile, palletized, bin-box, shelf or rack storage commodity configurations exceed 12 feet. The course addresses the influence of various commodity and ceiling heights in sprinkler selection and system design. Learners should enter this program with the ability to apply NFPA 13 density/area design curves.

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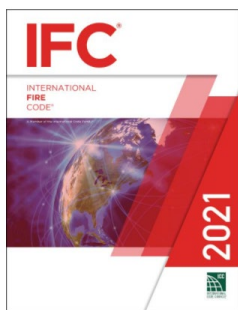
Module 1: High Piled Storage Requirements in the IFC

Objective: Understand high piled storage requirements in the IFC

1.1 Experience With High-Piled Storage Requirements in the IFC

Ask: “Can anyone share an experience you’ve had involving high-piled storage and coordination of the International Fire Code with NFPA 13?”

1.2 High-Piled Storage Requirements in the IFC



- ✓ Storage Layout Floor Plan
- ✓ General Fire Protection & Life Safety Requirements
- ✓ Fire Department Access roads
- ✓ Fire Department Access Doors

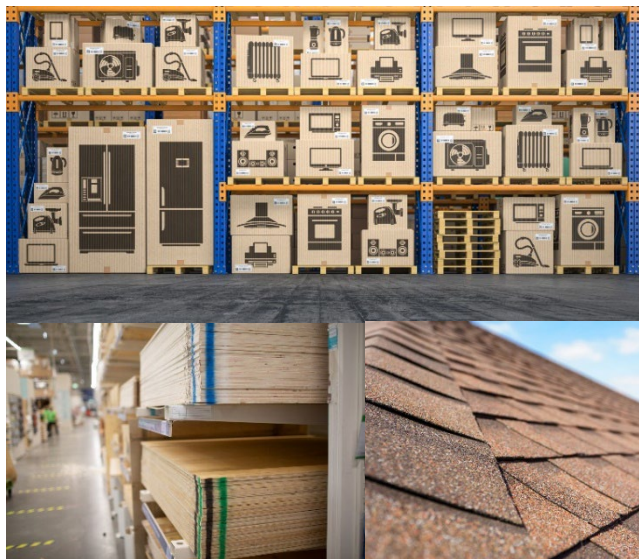
1. IFC applies to existing conditions and operations: no “grandfather clause”. Section 102.2.
2. High Piled Combustible Storage Requirements found in Ch 32



- ✓ What is the Commodity Classification?
- ✓ How is it stored?
- ✓ What is the height of the storage?
- ✓ Building height?
- ✓ What type of sprinkler is being used?
- ✓ Special Commodity?

1. Reorganization in 2019 Edition
2. Storage Chapters reorganized based upon sprinkler type
3. High pile storage requirements found in chapters 20-25.

IFC and NFPA 13 Alignment



1. The IFC Commodity classification closely aligns with NFPA 13
 - a. 2015-2018 editions: IFC modified commodity classifications to try to eliminate conflicting language.
 - b. Example: in 2015 IFC, classification of appliance storage, plywood and asphalt shingles were different in the IFC and NFPA 13



Storage

Group S-1 Examples (Moderate Hazard)

Combustible

- Furniture
- Lumber
- Bulk Storage of Tires

Group S-2 Examples (Low Hazard)

Non-combustible

- Food Products
- Metal Cabinets
- Washers & Dryers



Non-storage ("Occupancies")

- LH
- OH 1 & 2
- EH 1 & 2

Storage ("Commodities")

- Class I
- Class II
- Class III
- Class IV
- *Group C Plastics (Class III)*
- *Group B Plastics (Class IV)*
- Group A Plastics

1. Occupancy classifications means two different things. Building classification is based upon use, hazard classification is based on contents
2. A storage building can switch commodity classifications which can impact both IFC and NFPA 13 protection criteria.
 - a. What needs to be considered from a fire protection perspective when the commodity classification changes?
 - b. IFC considers this a Change of Occupancy.
 - i. Permit may be necessary. Even if permit is not required, IFC Chapter 32 can be applied since it's a retroactive requirement.

Conflicts

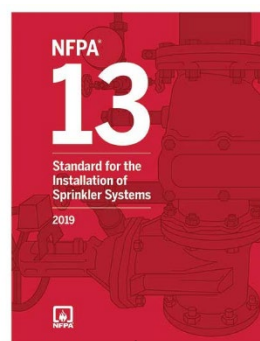
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2



3



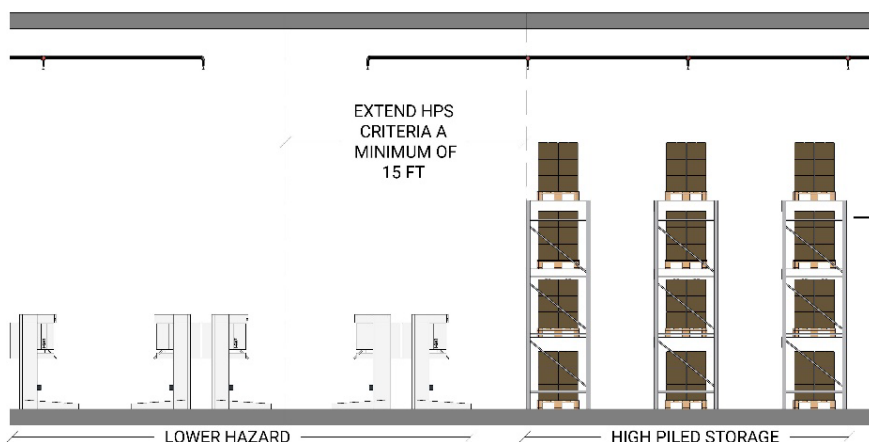
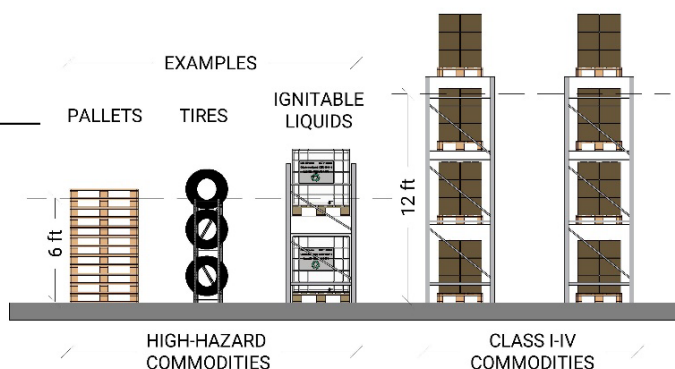
- Both IBC and IFC have sections stating: “where conflicts occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply”
 - For example the IFC and NFPA 13 Conflict regarding the monitoring of control valves. Since NFPA 13 is a referenced standard to the IFC and the IFC requirements are more stringent so the IFC wins.

IFC Chapter 32

IFC Chapter 32 applies to:

- a. Storage (Class I – IV) > 12 ft
- b. IFC uses the term “high-hazard”
 - i. High-piled storage requirements (Chapter 32) apply when storage exceeds 6 ft
 - ii. NFPA 13 requirements apply to storage over 5 ft

IFC CHAPTER 32



Chapter 32 requirements only apply to the high-piled storage area

- a. Requirements must extend to the lesser of:
 - i. 15 ft beyond the HP storage area, or full height wall

Smoke Vents



MECHANICAL SMOKE
REMOVAL SYSTEM (IFC 910.4)



SMOKE & HEAT VENTS (IFC 910.3)

1. NFPA 13- 20.6.5. Permits either manual or automatic roof vent with operating elements that have a higher temperature classification than the automatic sprinklers so that they don't open prior to the sprinklers. (ESFR exempt)
2. Table 3206.2 dictates when they are required

Storage Area Limits

3206.3.1. Size of high-piled storage area.

Include the footprint of the actual high-piled storage racks, shelves, or piles, and interior aisles and aisles around the perimeter (or to a wall) (Sprinklered – 44 inches wide minimum, open to the public 96 inches wide-3206.10.1)

Footnotes:

1. When automatic sprinklers are required for reasons other than those in Chapter 32, the portion of the sprinkler system protecting the high-piled storage area shall be designed and installed in accordance with Sections 3207 and 3208.
2. For aisles, see Section 3206.9.
3. Piles shall be separated by aisles complying with Section 3206.9.
4. For storage in excess of the height indicated, special fire protection shall be provided in accordance with Note g when required by the fire code official. See also Chapters 51 and 57 for special limitations for aerosols and flammable and combustible liquids, respectively.
5. Specific to exempting smoke/heat removal for ESFR and some CMSA

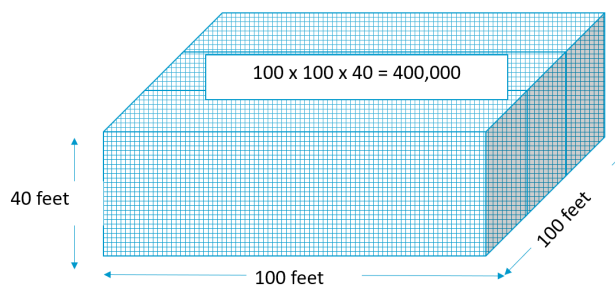
| Commodity Class | Size of High Piled Storage Area (square feet) | All Storage Areas | | | | Solid-Piled Storage, Shelf Storage and Palletized Storage | | |
|-----------------|--|-------------------------------------|---------------------------------|------------------------|------------------------|---|------------------------------------|---------------------|
| | | Automatic Fire Extinguishing System | Automatic Fire Detection System | Fire Dept Access Doors | Smoke and Heat Removal | Maximum Pile Dimension | Maximum Permissible Storage Height | Maximum Pile Volume |
| I – IV | 0-500 | NR | NR | NR | NR | NR | NR | NR |
| | 501 – 2,500 | NR | Yes | NR | NR | 120 | 40 | 100,000 |
| | 2501 – 12,000 Open to the Public | Yes | NR | NR | NR | 120 | 40 | 400,000 |
| | 2501 – 12,000 Not Open to the Public (Option 1) | Yes | NR | NR | NR | 120 | 40 | 400,000 |
| | 2501 – 12,000 Not Open to the Public (Option 2) | NR | Yes | Yes | Yes | 120 | 30 | 200,000 |
| | 12,000 – 20,000 | Yes | NR | Yes | Yes | 120 | 40 | 400,000 |
| | 20,001 – 500,000 | Yes | NR | Yes | Yes | 120 | 40 | 400,000 |
| | > 500,000 | Yes | NR | Yes | Yes | 120 | 40 | 400,000 |

| Commodity Class | Size of High Piled Storage Area (square feet) | All Storage Areas | | | | Solid-Piled Storage, Shelf Storage and Palletized Storage | | |
|-----------------|--|-------------------------------------|---------------------------------|------------------------|------------------------|---|------------------------------------|---------------------|
| | | Automatic Fire Extinguishing System | Automatic Fire Detection System | Fire Dept Access Doors | Smoke and Heat Removal | Maximum Pile Dimension | Maximum Permissible Storage Height | Maximum Pile Volume |
| High-Hazard | 0-500 | NR | NR | NR | NR | 60 | NR | NR |
| | 501 – 2,500 Open to the Public | Yes | NR | NR | NR | 60 | 30 | 400,000 |
| | 501 – 2,500 Not Open to the Public (Option 1) | Yes | NR | NR | NR | 60 | 30 | 400,000 |
| | 501 – 2,500 Not Open to the Public (Option 2) | NR | Yes | Yes | Yes | 60 | 20 | 200,000 |
| | 2,501 – 300,000 | Yes | NR | Yes | Yes | 60 | 30 | 400,000 |
| | 300,001 – 500,000 | Yes | NR | Yes | Yes | 60 | 30 | 400,000 |
| | | | | | | | | |

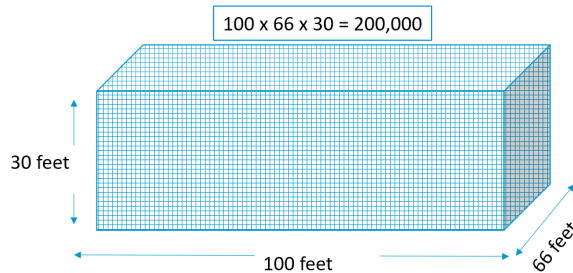
Storage Pile limits

| Solid-Piled Storage, Shelf Storage and Palletized Storage | | |
|---|------------------------------------|---------------------|
| Maximum Pile Dimension | Maximum Permissible Storage Height | Maximum Pile Volume |
| 120 | 40 | 400,000 |
| 120 | 40 | 400,000 |
| 120 | 30 | 200,000 |

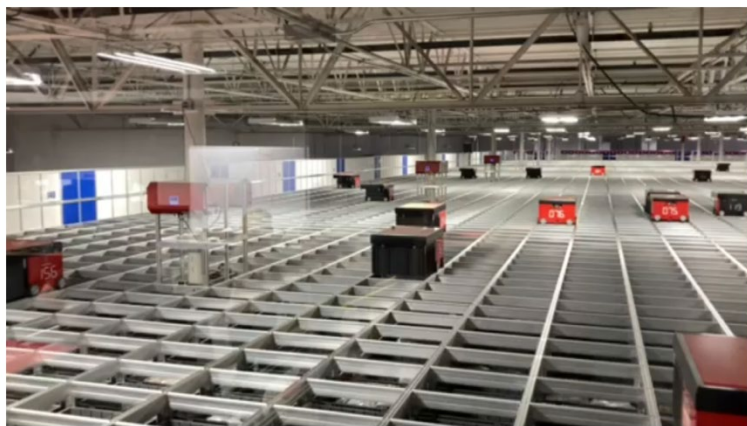
Option 1 – Sprinklered



Option 2- Not sprinklered



Automated Storage

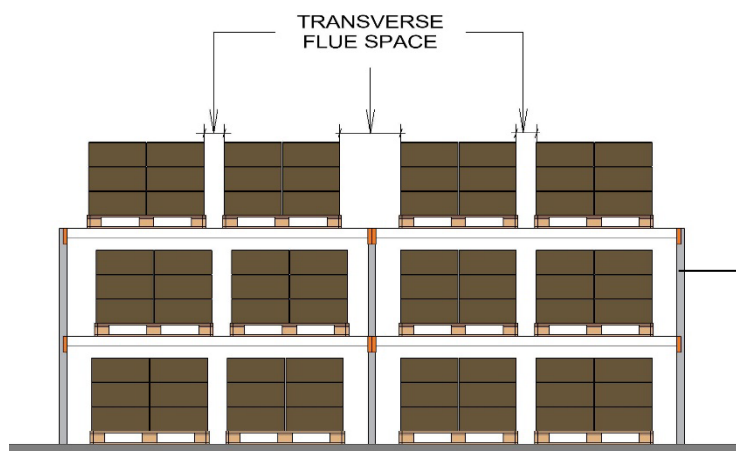


1. Known as Automated Storage and Retrieval System (ASRS)
2. No specific design criteria in NFPA 13
3. IFC requires shutdown upon:
 - a. Waterflow and/or fire alarm activation, and
 - b. Manual means

IFC Inspection, Testing and Maintenance (ITM)



1. Fire protection system maintenance
 - a. See IFC Section 901
2. Storage layout plan must include the following:
 - a. Location, dimensions, rack layout
 - b. Design storage height
 - c. Type(s) and location(s) of commodities
 - d. Commodity clearance requirements
 - e. Aisle dimensions
 - f. Location of FD access doors
 - g. Location of sprinkler control valves
3. Layout must be reviewed annually by AHJ
4. Fire code official can require a visual method of determining maximum storage height
5. Required flue space maintained



1.3 Module 1 Assessment

Complete the [assessment](#).

Assessment QR Code



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Module 2: Application of High Piled Storage

Objective: Understand when requirements for high piled storage come into effect

2.1 Module 2 Survey

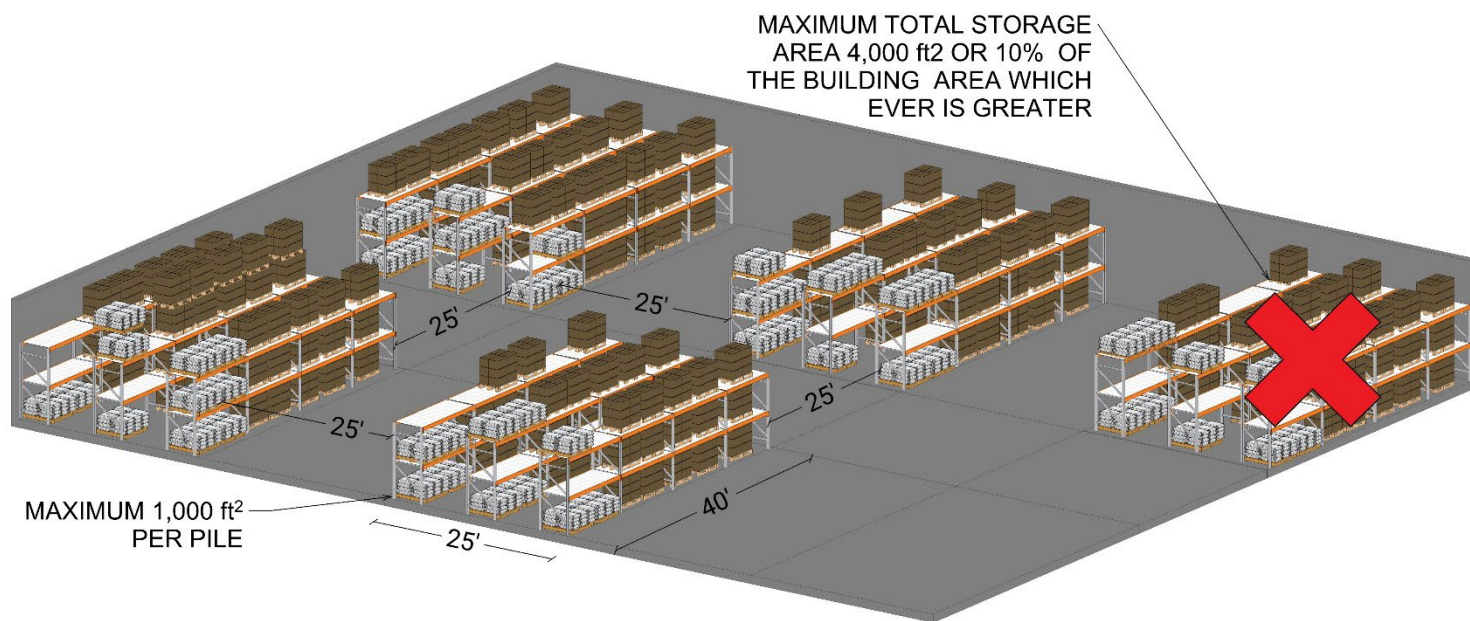
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Survey QR Code



2.2 The General Process to Develop Protection Criteria for Storage Applications

Miscellaneous Storage

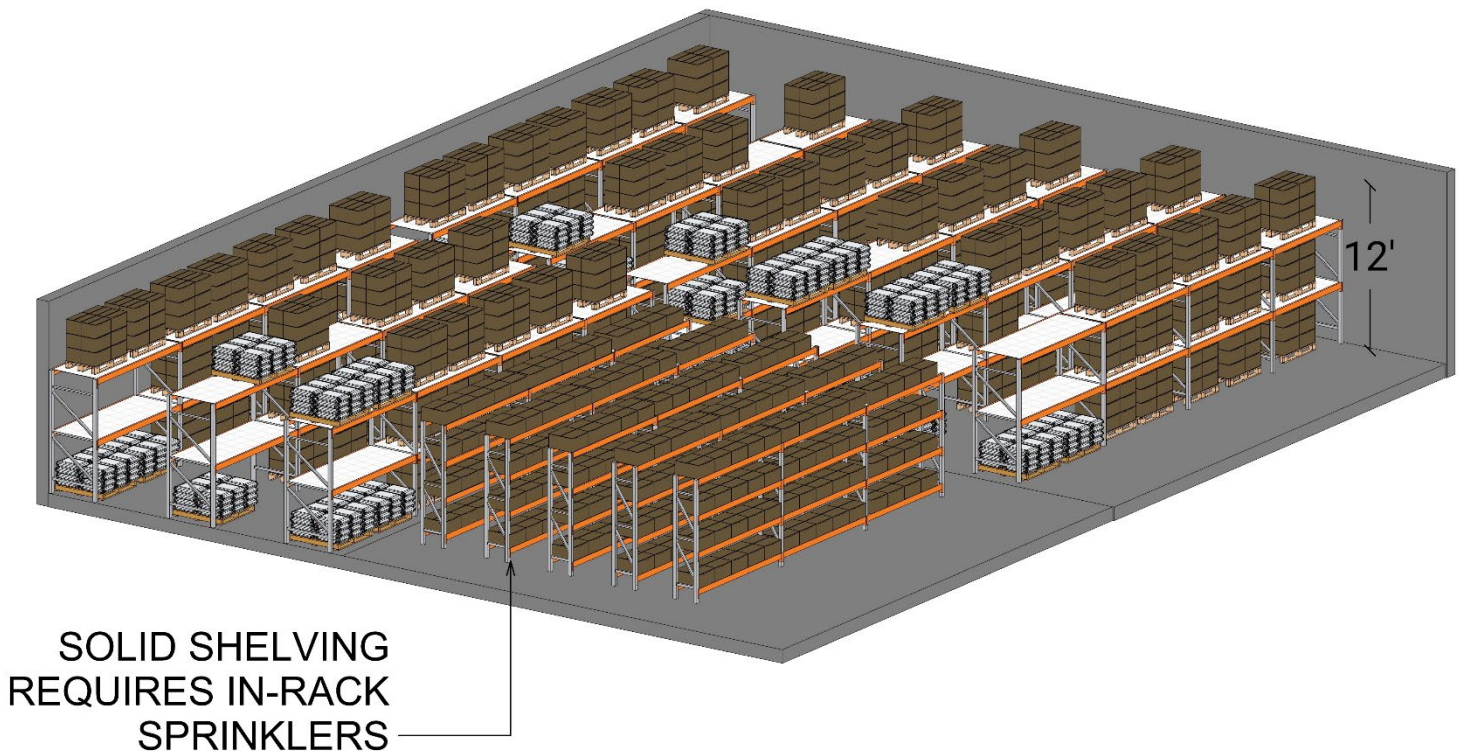


Miscellaneous Storage Limits (4.3.1.4)

- a. **Miscellaneous Storage:** Miscellaneous storage is a concept that applies to buildings in which storage constitutes only part of the building's use, such as the back room of a mercantile facility. Limitations are imposed on the amount and arrangement of storage that are permitted
- b. **Miscellaneous Storage limits:**
 - i. Storage area limits (4.3.1.4.1)

1. Miscellaneous Storage shall not constitute more than 10 percent of the building area or 4000 ft² of the sprinklered area which ever is greater
- ii. Pile area limits (4.3.1.4.2)
 1. Miscellaneous storage shall not exceed 1000 ft² in one pile or area.
- iii. Separation requirements (4.3.1.4.3)
 1. Miscellaneous storage shall be separated from other storage piles or areas by at least 25 ft.
- iv. Miscellaneous Tire Storage (4.3.1.6)
 1. Area limit (4.3.1.6.1)
 - a. Miscellaneous tire storage shall not exceed 2000 ft²
 2. Storage arrangement (4.3.1.6.2)
 - a. Miscellaneous tire storage piles on tread, regardless of storage method, shall not exceed 25 ft in the direction of the wheel holes.

Low-Piled Storage



Low-Piled Storage Limits (5.3.1.5)

- a. **Low-Piled Storage:** Low piled storage is a situation where the storage can be the primary purpose of the facility or storage areas are not limited, this criteria is simply based on the height of the storage.
- v. Low-piled storage is essential storage that does not meet the criteria for miscellaneous storage but is less than 12 feet for class I-IV commodities and 5

feet for group A plastics. The design criteria is the same however for low pile storage on shelves in-rack sprinklers are required.

b. Describe Low-Piled Storage Limits:

- vi. Height Limit for Class I-IV Storage (4.3.1.5.1)
 - 1. For storage of Class I-IV commodities Low-piled storage is limited to 12 ft in height
- vii. Height Limit for Group A plastics (4.3.1.5.2)
 - 1. For storage of group A plastics low-piled storage is limited to 5 ft.
- viii. In-rack requirements
 - 1. For low piled storage arrangements that do not meet miscellaneous storage requirements in-rack sprinklers need to be provided for solid shelf storage.

Protection Criteria for Miscellaneous and Low-Pile Storage (4.3.1.7)

- a. The criteria for Misc. and Low-Pile Storage will not be covered, this course will only cover High Piled storage in detail, the purpose of defining Misc. and Low-piled storage is to define what is not covered by chapters 20-25.

2.3 Module Assessment

Complete the [assessment](#).

Assessment QR Code



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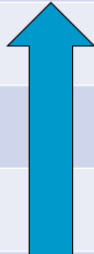
Module 3: General Requirements – Commodity Classification
Objective: Understand the storage commodity classes

3.1 Conversation Quiz

Complete [the survey](#).

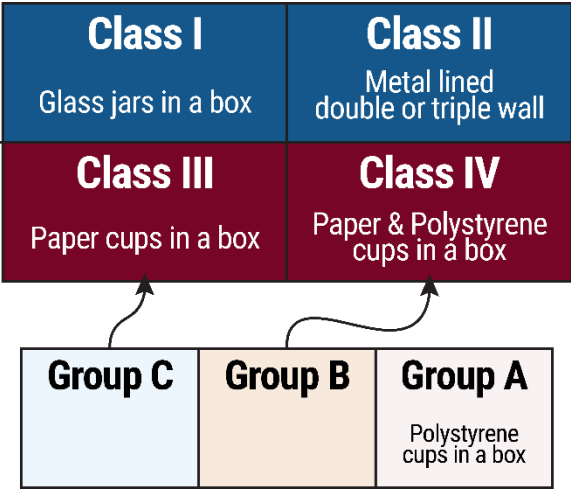


3.2 How to Identify Storage Commodity Class

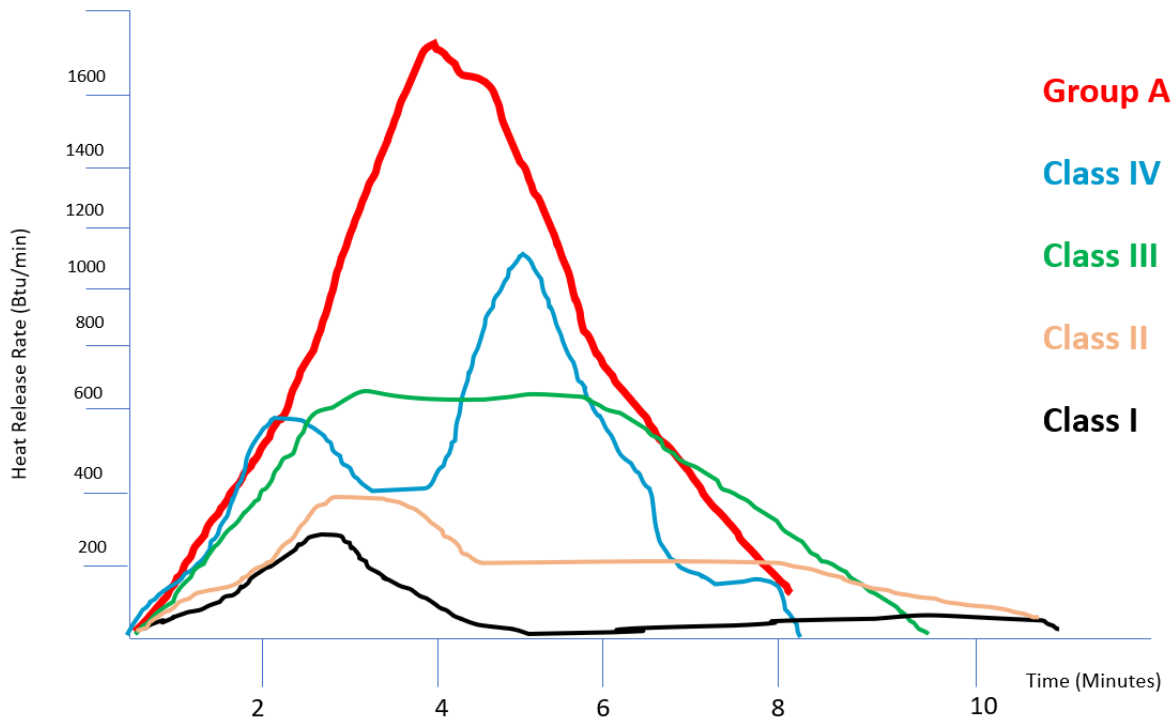
| Commodity Class | Fire Hazard Ranking |
|---|--|
| Special or High-Hazards: Tires, Rolled paper, Group A plastics, Flammable/Combustible liquids, Aerosols | Highest Fire Hazard |
| Class IV Commodity |  |
| Class III Commodity | |
| Class II Commodity | |
| Class I Commodity | |
| | Lowest Fire Hazard |

Non-Combustible

Combustible



Product: In general, Class I and Class II commodities are non-combustible and Class III and IV commodities are combustible. While there is separate criteria for group A plastics, there is none for group B or C plastics, because Group C plastics have similar burn characteristics to Class III commodities and Group B plastics have similar burn characteristics as Class IV commodities.



Heat Rate Example

The higher a commodity's heat of combustion the higher the commodity classification. The higher a commodity's classification the more difficult this material is to control and extinguish when it is involved in fire.

The 3 Ps: The following "P's" will go into the development of the commodity classification.

- i. **Product (item being stored):** Coffee mugs, engine blocks, plywood panels, wristwatches, toilet paper
- ii. **Packing materials around the item:** Cardboard boxes with dividers, steel containers, shrink wrap, boxes with foam "peanuts"
- iii. **Pallets or Containers:** Pallets, bins or storage method. Wood or plastic pallets, plastic, cardboard or paper bin boxes, crates, wooden spools

Packaging: The packaging of the commodity can affect the classification in a few ways

1. By adding to the fire load
2. By preventing water from reaching the hazard
3. By either providing or not providing support which would either keep the commodity together or allow it to fall apart.

Items regarding the packaging that need to be considered:

- a. **Cartoned.** Defined by NFPA 13 as a method of storage consisting of corrugated cardboard or paperboard containers fully enclosing the commodity.

- b. **Encapsulated:** Defined by NFPA 13 as 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.
NOTE: Pallet loads wrapped only on the sides is not considered encapsulated, it must cover the sides including the top.
- c. **Free-flowing plastic materials:** Defined by NFPA 13 as those plastics that fallout of their containers during a fire, fill flue spaces, and create a smothering effect on the fire, Examples include: powder, pellets, flakes, or random-packed small objects.

Pallets: Commodity classifications suggested in NFPA 13 assume all pallets are wood or metal, when plastic pallets are used commodity classification must be increased unless the pallets are listed, or the commodity stored is a group A plastic.

Unreinforced plastic pallets

Classification shall be increased by one class, and must have permanent symbol marking them.

Reinforced plastic pallets

Classification shall be increased by two classes

Listed Pallets:

Per section 20.3.2.4 no increase in commodity class is required for listed pallets that have demonstrated the fire hazard is equal to or less than wood pallets.

Slave Pallets

Slave pallets do not change the commodity class however, where solid, flat-bottom, combustible pallets are used for rack storage of class I-IV Commodities up to 25 feet in height an increase of 20% density shall apply (unless in-rack sprinklers are provided), *this only applies to CMDA sprinklers*



Class I Commodity:

A noncombustible product that meets one of the following criteria:

- Placed directly on wood 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



Class II Commodity:

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.

Class III Commodity:

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

- Shall be permitted to contain a limited amount (5 percent or less by weight of nonexpanded plastic or 5 percent or less by volume of expanded plastic) of Group A or Group B plastics. Shrink-wrapped or paper-wrapped as a unit load with or without pallets
- Class III commodities containing a mix of both Group A expanded and nonexpanded plastics shall comply with Figure 20.4.3.3(a) where they are within cartons, boxes, or crates or with Figure 20.4.3.3(b) where they are exposed.



Class IV Commodity:

A product, with or without pallets, that meets one of the following criteria:

| | |
|---|--|
| Constructed partially or totally of Group B plastics | Consists of free-flowing Group A plastic materials |
| Cartoned, or within a wooden container, that contains greater than 5 percent and up to 15 percent by weight of Group A nonexpanded plastic | Cartoned, or within a wooden container, that contains greater than 5 percent and up to 25 percent by volume of expanded Group A plastics |
| Cartoned, or within a wooden container, that contains a mix of Group A expanded and nonexpanded plastics and complies with Figure 20.4.3.3(a) | |



Plastics are divided into groups and sub-groups

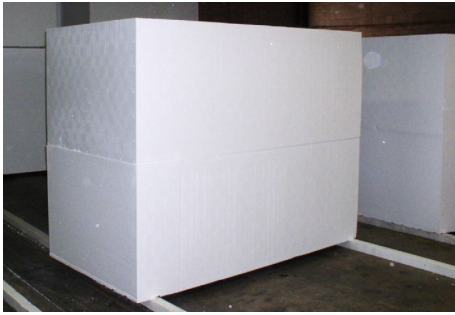
| Relative Fire Severity |
|---------------------------------|
| Group A <i>Expanded</i> Plastic |
| Group A <i>Unexpanded</i> |
| Group A <i>Free Flowing</i> |
| Group B |
| Group C |



Remember: Group C is considered Class III, and Group B is considered Class IV.

Group A Expanded:

Generally, a low-density product commonly called “foam plastics” such as polystyrene foam coffee cups, polystyrene foam packaging material, and polyethylene and polypropylene foam sheeting packaging material. Expanded plastics have a cellular structure made up of many small air pockets and voids. The pockets increase the available surface area and promote rapid ignition and flame spread, both vertical and horizontal.



Group A Unexpanded:

Unexpanded plastics have a higher density when compared to expanded plastics and may or may not have rigidity. They are a solid material and can include goods such as toys, tote bins and containers. In comparison to expanded plastics, unexpanded plastics are less hazardous, because of the reduced surface area even though the heat of combustion is generally the same because this value is influenced by the resin formulation.



Group A Free Flowing:

Very small plastic items such as bottle caps, hypodermic needle plungers, granular or flake plastics or powdered plastics. They burn less severely when compared to expanded or unexpanded plastics. When a container holding free-flowing plastics fails under fire exposure, the goods begin to spill from the container. In rack storage, the items begin to fill the rack flue spaces and slow the spread of a fire. Because of this, free-flowing plastics are classified as a Class IV commodity in IFC Section 3203.5.

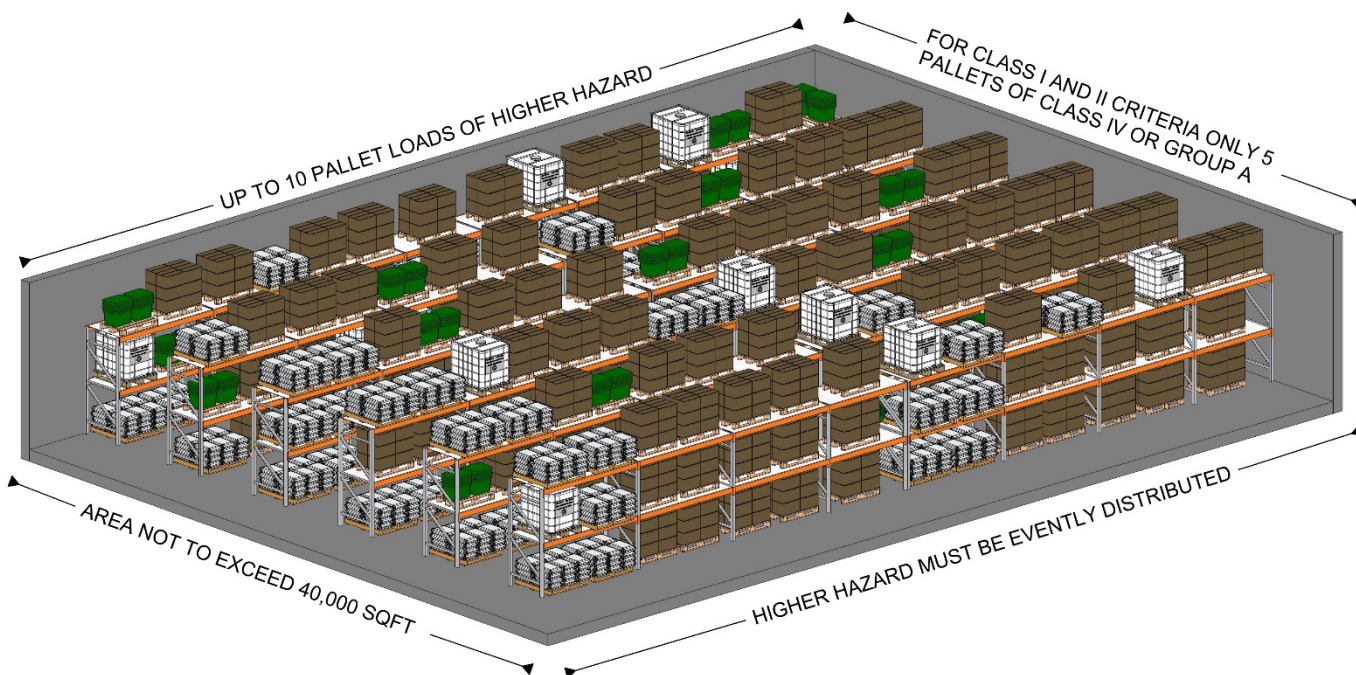


Rubber Tire Storage/Paper Storage:

Rubber Tires and Rolled Paper have a category of their own. They do not fit into the commodity classification and have stand-alone criteria.



Mixed Commodities Criteria



- Up to 10 pallet loads of a higher hazard commodity shall be permitted to be present in an area not exceeding 40,000 sqft
- The higher hazard commodity class 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.

3.3 Module assessment

Assessment QR Code

Complete the [survey](#).



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Module 4: General Storage Requirements – Storage Arrangement

Objective: Understand the different storage arrangement options

4.1 Storage arrangement knowledge check

Slide 1: Conversation Questions:

- a. Provide one example of a high-piled storage project you've worked on. What was the commodity and how was it being stored?

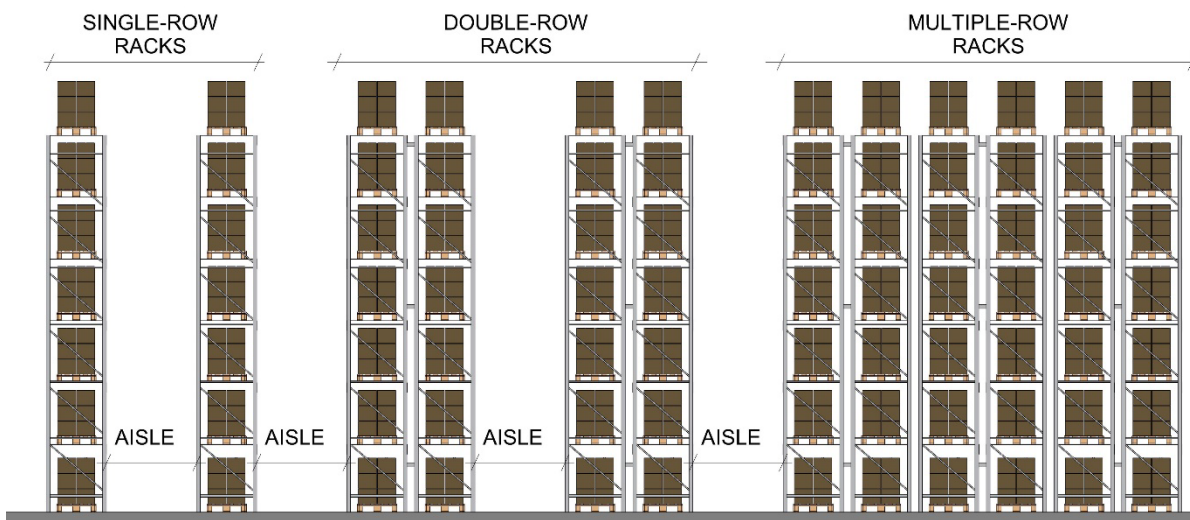
4.2 Understanding the different storage arrangement options

Rack Storage

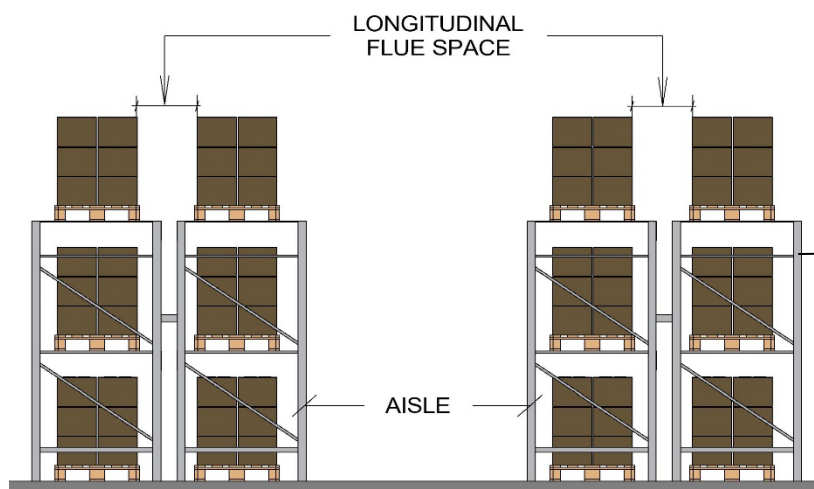


1. **What is Rack Storage?** Rack Storage is a general term for a storage structure that has any combination of vertical, horizontal, and diagonal members that supports stored material. Many variables found in racks will affect the design of high piled storage sprinklers.
2. **Open Rack Storage:** Racks 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 or with shelves having a wire mesh, slatted surface, or other material with openings representing at least 50% of the shelf area including the horizontal area of rack members and where the flue spaces are maintained.

Rack Arrangements

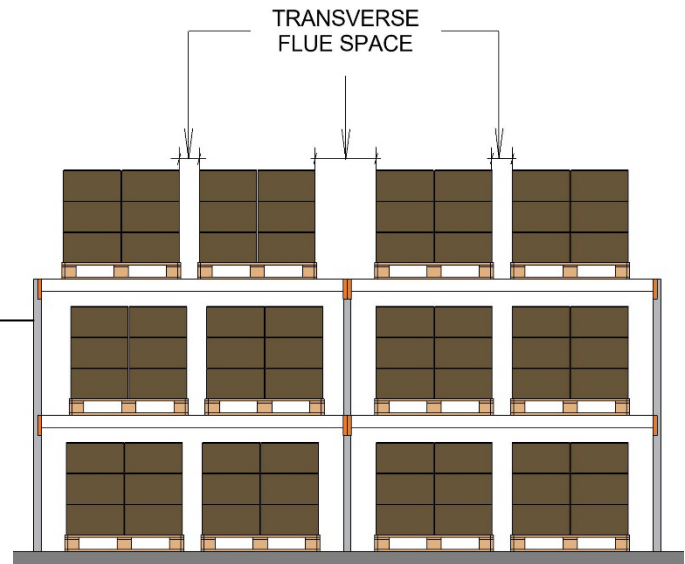


- **Single-Row Rack:** Racks that have no longitudinal flue space and that have a depth of 6 feet with aisles having a width of at least 3.5 feet between loads on racks. **3.3.191**
- **Double-Row Racks:** Racks less than or equal to 12 feet in depth, or single-row racks placed back to back having an aggregate depth of up to 12 feet with aisles have an aisle width of at least 3.5 feet between loads on a rack. **3.3.56.**
- **Multi-Row Racks:** Racks greater than 12 feet in depth or single- or double-row racks separated by aisles less than 3.5 feet in wide having an overall width greater than 12 feet. **3.3.127**
- **Aisle Width:** The horizontal distance between the face of the loads in racks under consideration **3.3.4**



Longitudinal flue space: The space between rows of storage perpendicular to the direction of loading with a width not exceeding 24 in. (600 mm) between storage. **3.3.116**

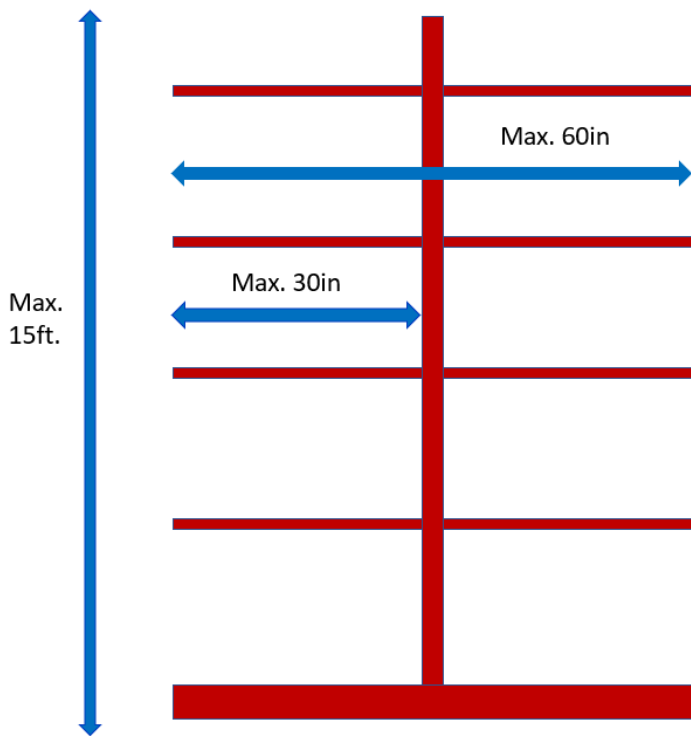
Transverse Flue Space:
The space between rows of storage parallel to the direction of loading **3.3.220**



Shelf Storage



3.3.188 Shelf Storage. Storage on structures up to an including 30 inches deep and separated by aisles at least 30 inches deep.



Back-to-Back Shelf Storage. Two solid or perforated shelves up to 30 inches in depth each, not exceeding a total of 60 inches, separated by a longitudinal barrier such as plywood, particleboard, sheet metal, or equivalent with a maximum of $\frac{1}{4}$ inch diameter penetration, and no longitudinal flue space and a maximum storage height of 15 feet. (this is your typical grocery store arrangement). **3.3.12**



3.5.201. Solid-Piled Storage.
Storage of commodities stacked on each other



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



Bin Box Storage. Storage in a five-sided wood, metal, or cardboard box with open face on the aisles in which boxes are self-supporting.

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 arrays

OPEN TOP CONTAINERS ARE NOT CONSIDERED BIN BOX STORAGE



4.3 Module Assessment

Complete the [assessment](#).

Assessment QR Code



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Module 5: General Storage Requirements - Storage Height and Common Criteria

- Objectives:**
1. Evaluate the storage and building height.
 2. Identify and understand common protection criteria
 3. Understand the specific requirements for idle wood pallets

5.1 Conversation Quiz

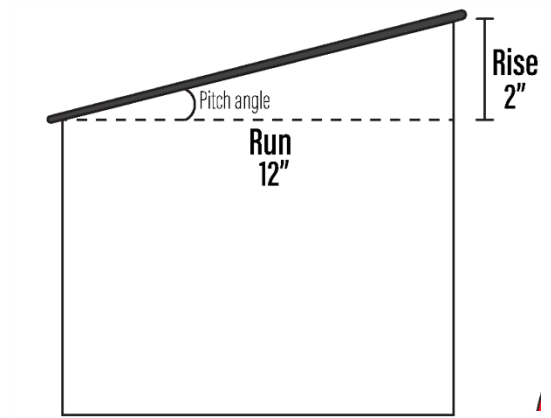
Complete [this survey](#).



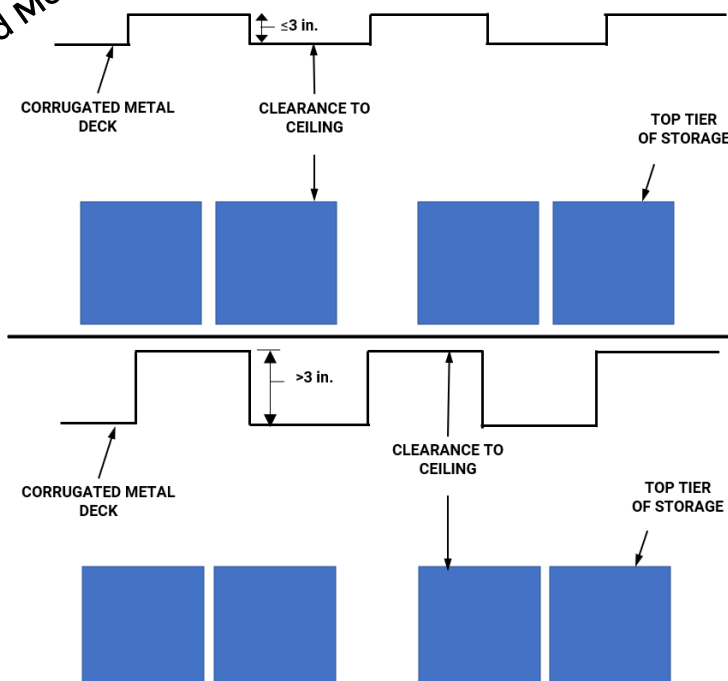
5.2 Storage and Building Height

Ceiling Slope

The Ceiling slope over the storage area shall not exceed a slope of 2 in 12 (16.7 percent)



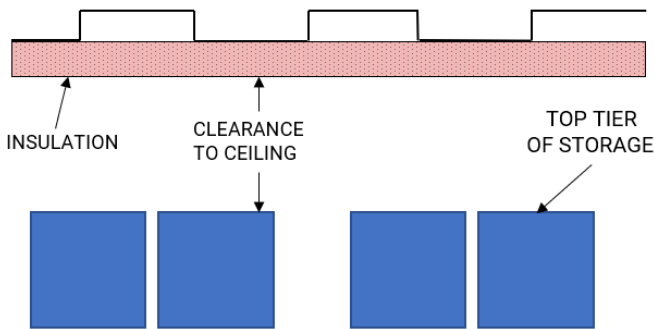
Corrugated Metal Decking



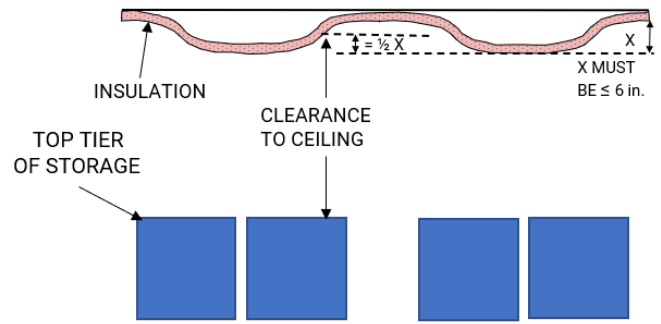
CORRUGATED
DECK 3 INCHES
OR LESS IN
DEPTH

CORRUGATED
DECK GREATER
THAN 3 INCHES
IN DEPTH

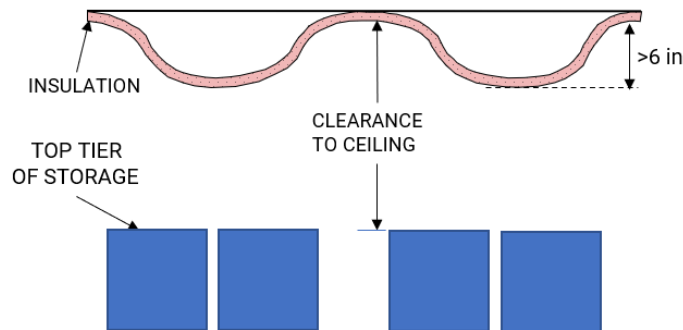
Insulated Ceiling



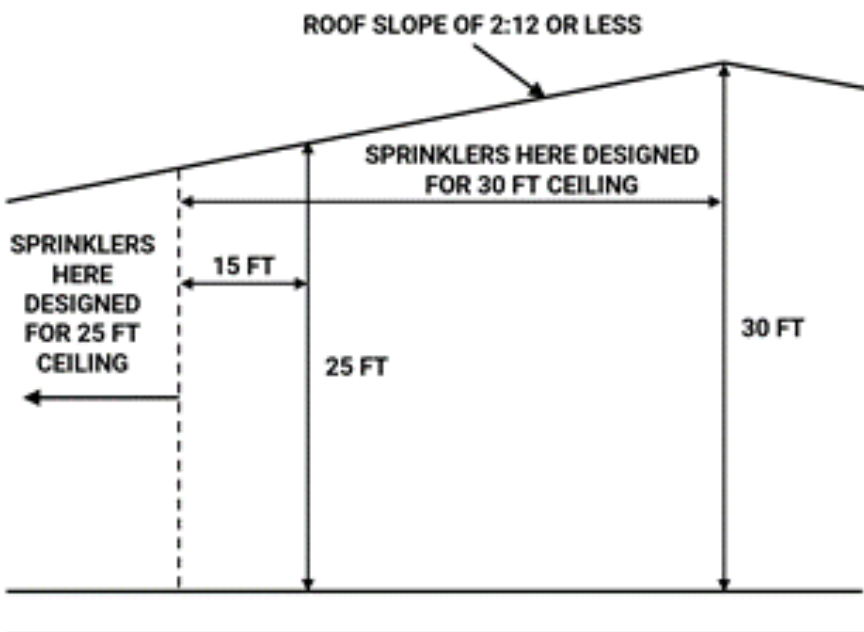
INSULATION TIGHT TO CEILING



INSULATION SAGGING 6 INCHES



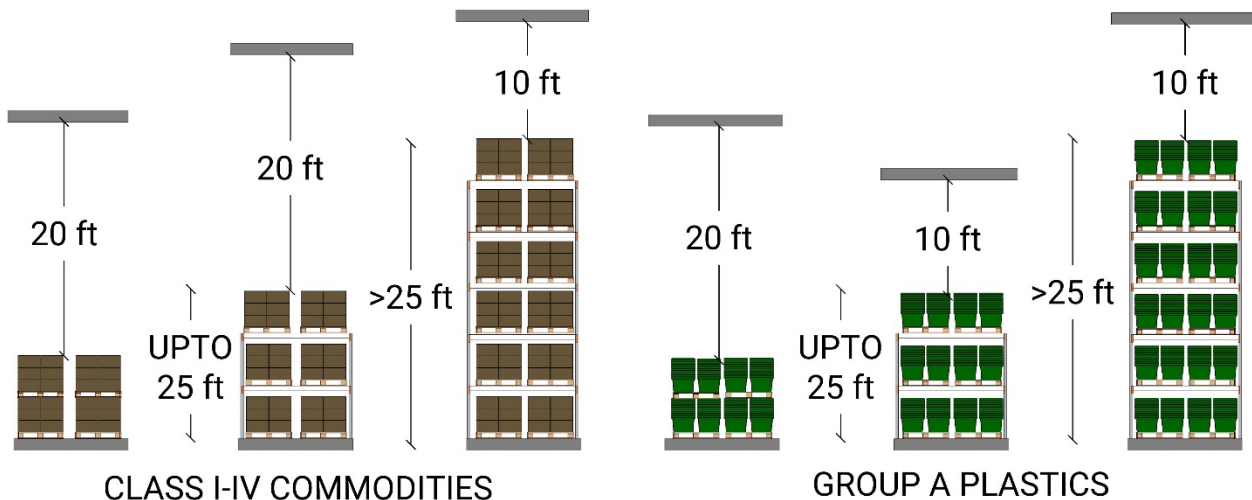
INSULATION SAGGING MORE THAN 6 INCHES



Change in Ceiling Height

When the ceiling height changes, or when the ceiling is sloped, either a baffle needs to be provided at the ceiling height change or the criteria the lower ceiling height needs to be followed 15 ft from that point.

Storage Clearance from Ceiling



These distances shown reflect the requirements for CMDA sprinkler protection, the distances for CMSA or ESFR are reflected in the design tables found in their respective chapters. When these clearances are exceeded the following criteria applies which is shown in table 20.6.4.3:

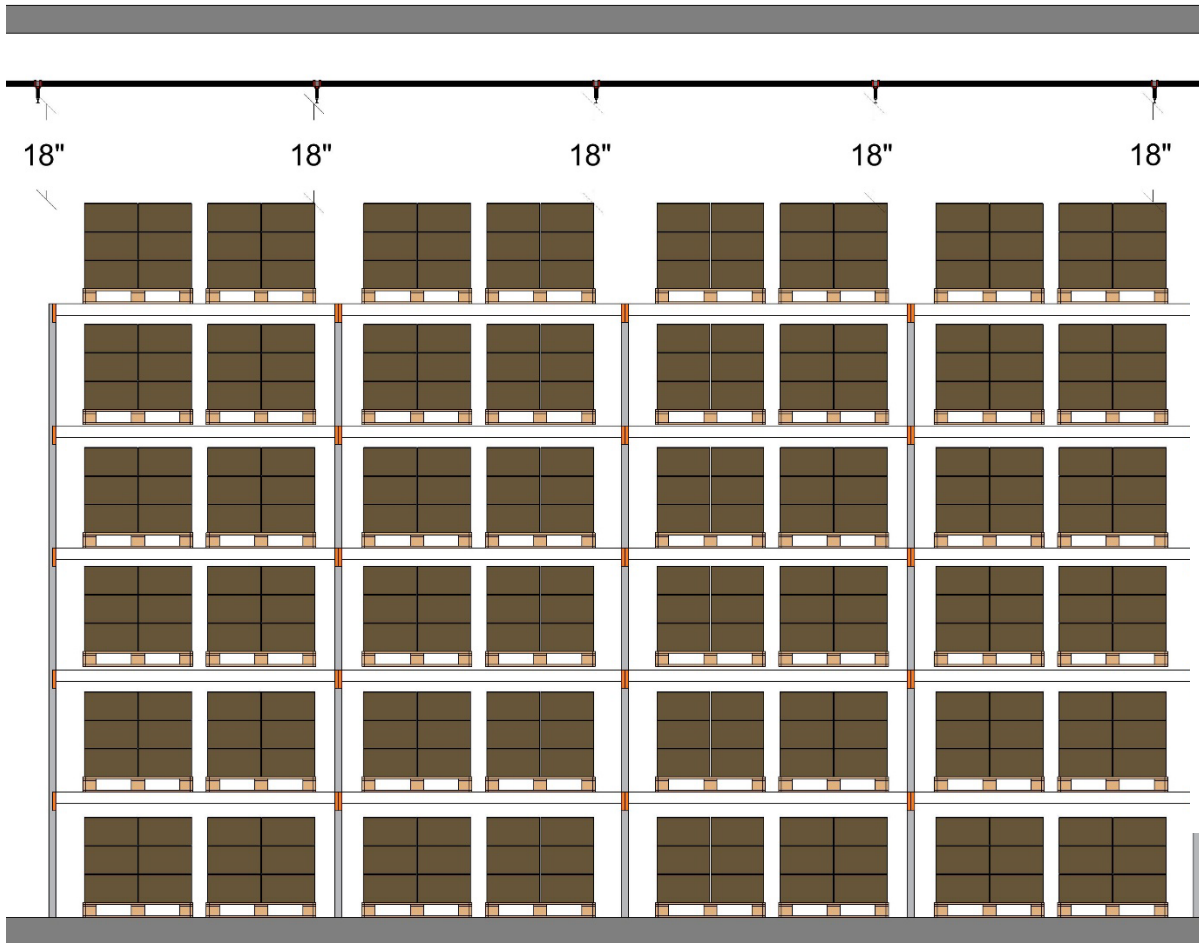
CRITERIA WHEN MAXIMUM CEILING CLEARANCE IS EXCEEDED FOR CLASS I-IV COMMODITIES

| Storage Configuration | Where the clearance to the ceiling exceeds | Protection is based upon the storage height that would result in a clearance to the ceiling of... | In-Rack Sprinklers |
|--|--|---|---|
| Palletized, solid-piled, bin box, shelf, or back-to-back shelf storage | 20 ft | 20 ft | N/A |
| Rack storage up to and including 25 ft in height | 20 ft | 20 ft | Permitted as alternative to presumed clearance of 20 ft |
| Rack Storage over 25 ft in height | 10 ft | 10 ft | Permitted as alternative to presumed clearance of 10 ft |

CRITERIA WHEN MAXIMUM CEILING CLEARANCE IS EXCEEDED FOR GROUP A PLASTICS AND TIRES

| Storage Configuration | Where the clearance to the ceiling exceeds | Protection is based upon the storage height that would result in a clearance to the ceiling of... | In-Rack Sprinklers |
|--|--|---|---|
| General Storage | 20 ft | 20 ft | N/A |
| Rack storage up to and including 25 ft in height | 20 ft | 20 ft | Permitted as alternative to presumed clearance of 10 ft |
| Rack Storage over 25 ft in height | 10 ft | 10 ft | Required |

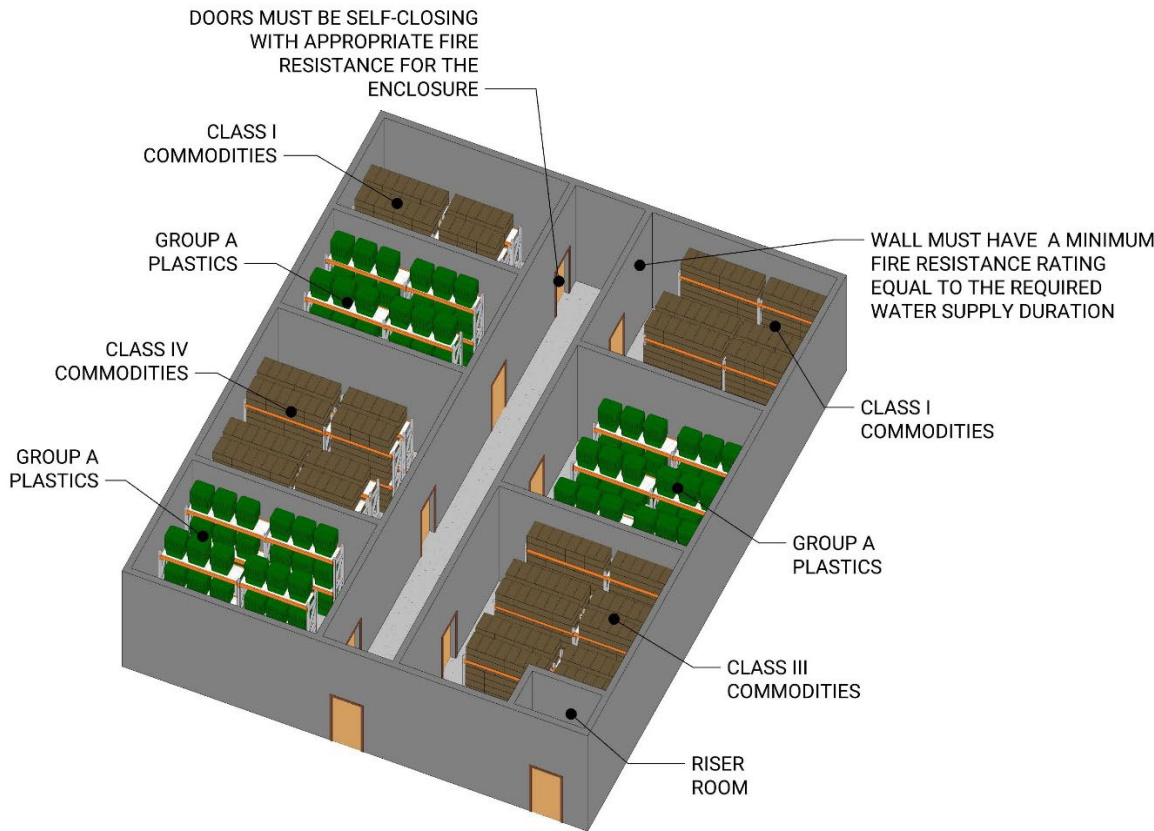
Storage Clearance from Sprinkler Deflector



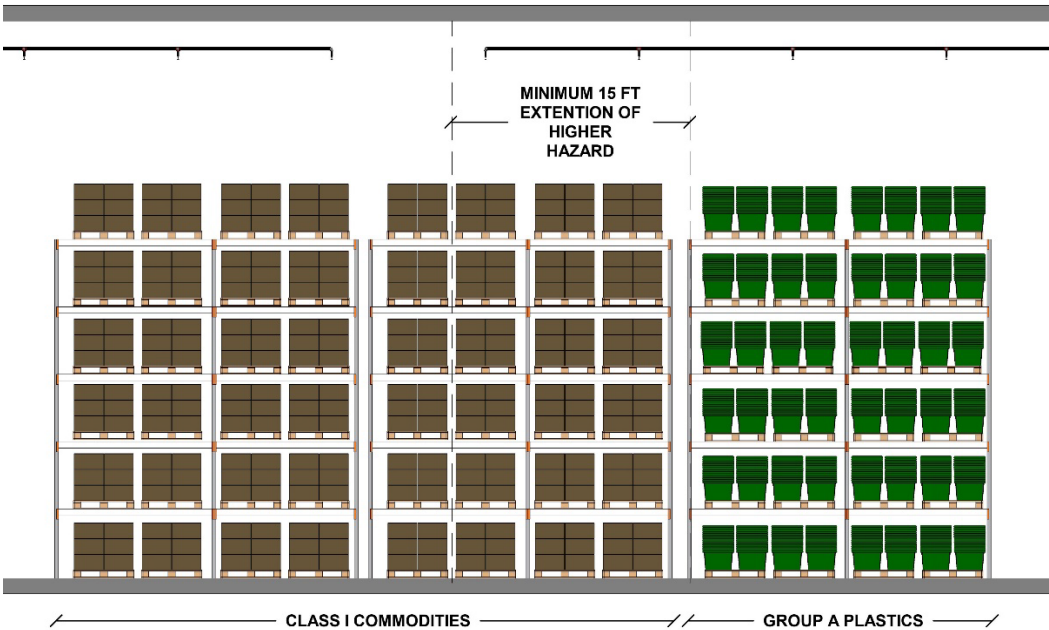
For CMDA Sprinkler protection the minimum distance from sprinklers to storage is 18 inches. The purpose of this minimum distance is to allow for the sprinkler spray pattern to fully develop

5.3 Common Protection Criteria

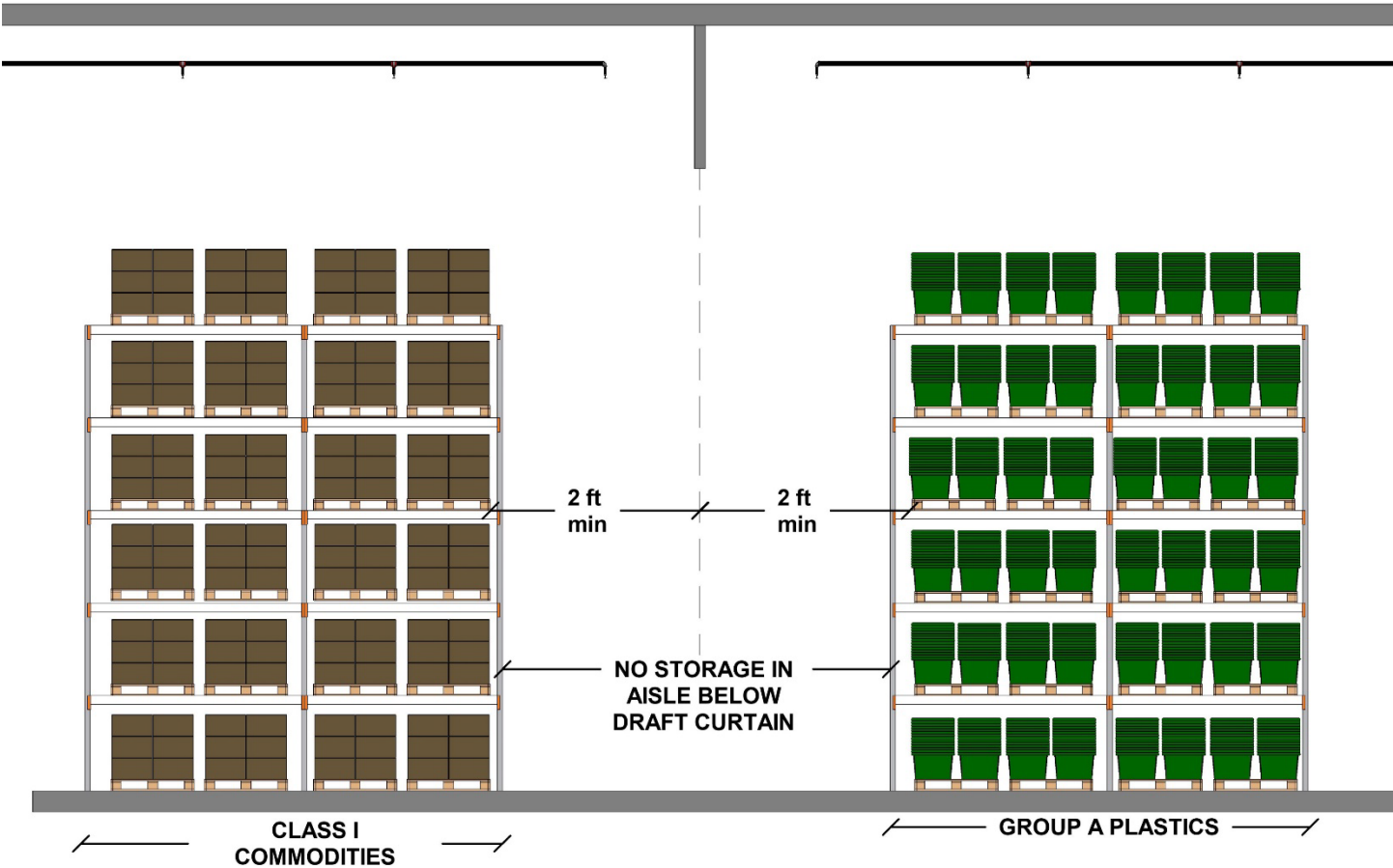
Room Design Method



Adjacent Hazards Method 1

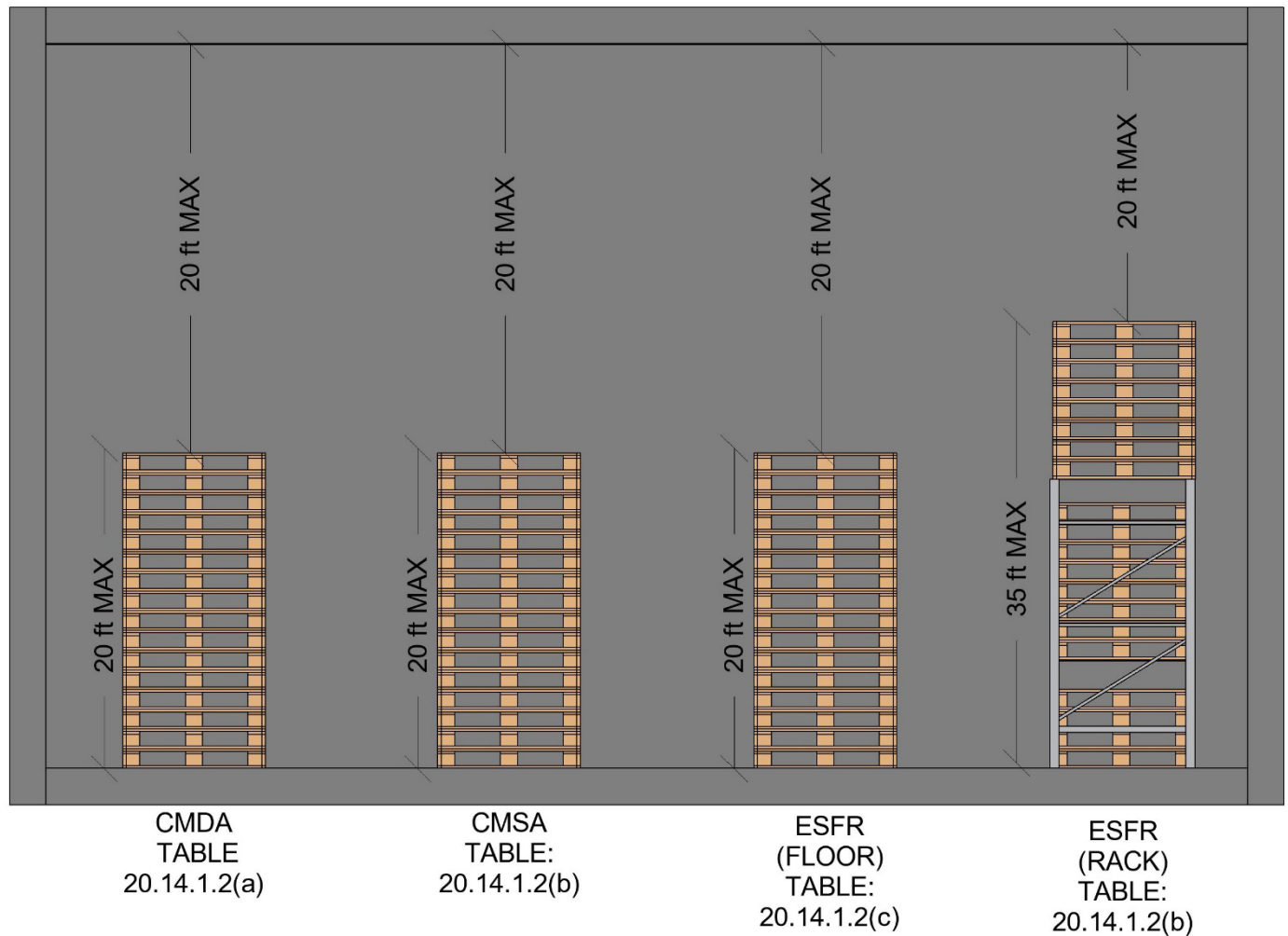


Adjacent Hazards Method 2



5.4 Module Assessment

Idle Wood Pallets



Complete the [assessment](#).



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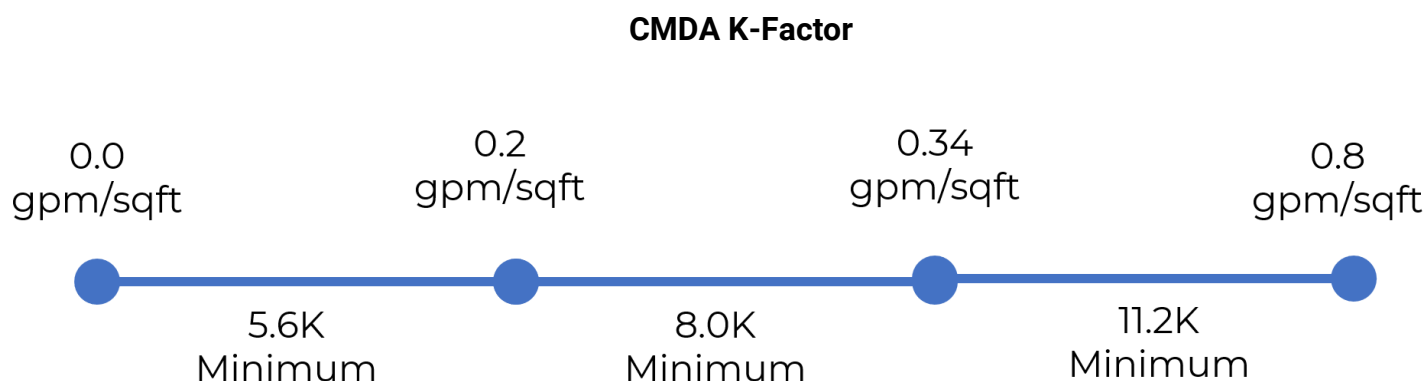
Module 6: Control Mode Density Application (CMDA) Sprinklers

Objective: Understand the protection of high piled storage using control mode density area sprinklers

6.1 Definition of CMDA

What does CMDA Stand for and what does it mean?

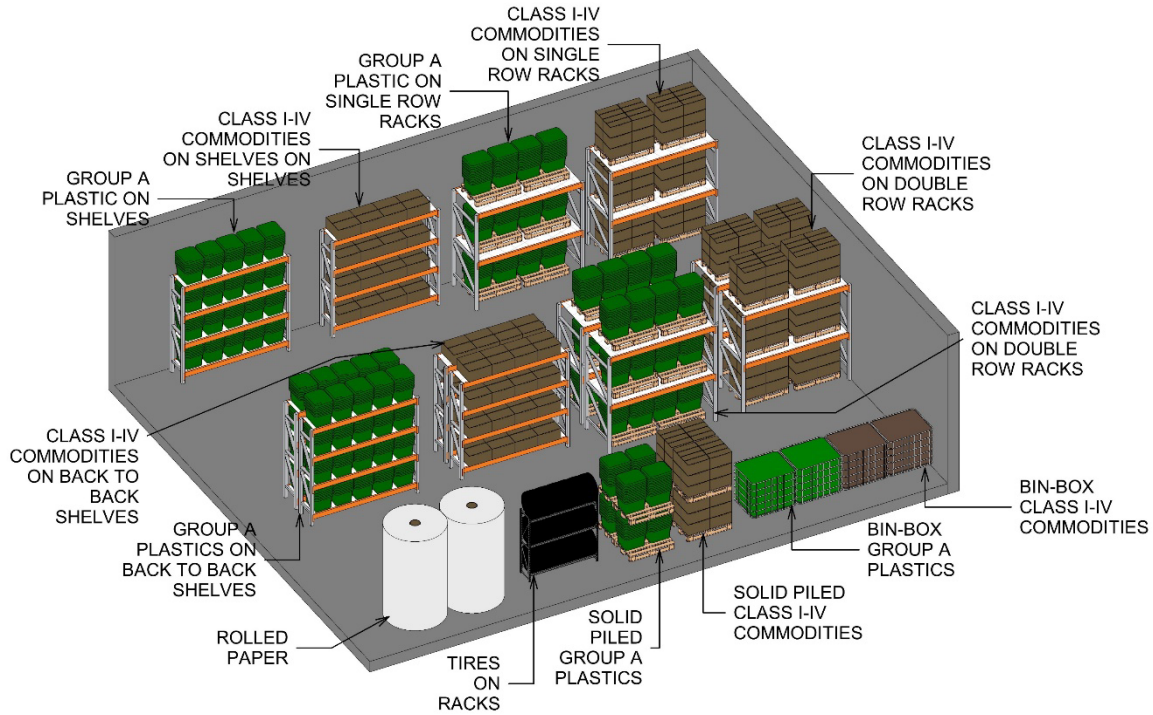
6.2 Control Mode Density Area (CMDA) Sprinklers



K Factors: Fire tests have demonstrated that sprinklers with K factors of 5.6 and below are not effective to protect high challenge fires therefore any density above 0.2 gpm/sqft requires a k-factor larger than 5.6.

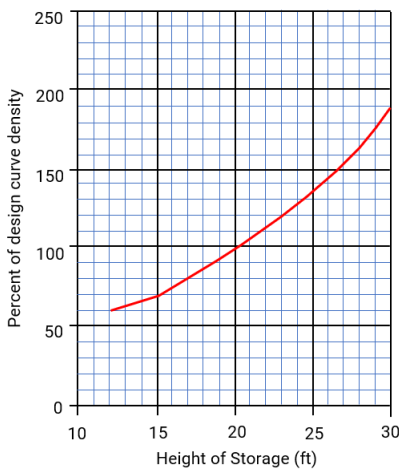
- 0.2 gpm/ft² or less – K-5.6 or larger is acceptable.
- 0.2 gpm/sqft to 0.34 gpm/sqft – K-8.0 or larger is acceptable
- Greater than 0.34 gpm/sqft – K-11.2 or larger is acceptable.

CMDA Application

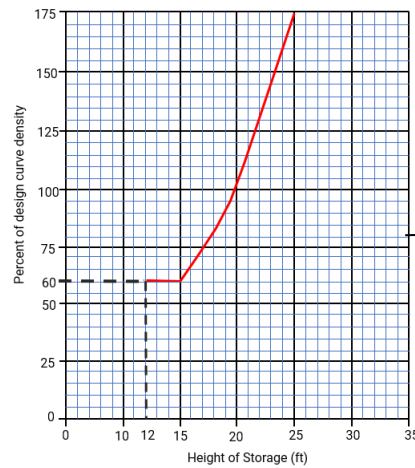


DESIGN AREA REDUCTION

Class I-IV – Paletized, Bin Box, Shelf, Back-to-Back Storage. Figure 21.2.2.3



Class I-IV– Rack Storage. Figure 21.4.1.4.1

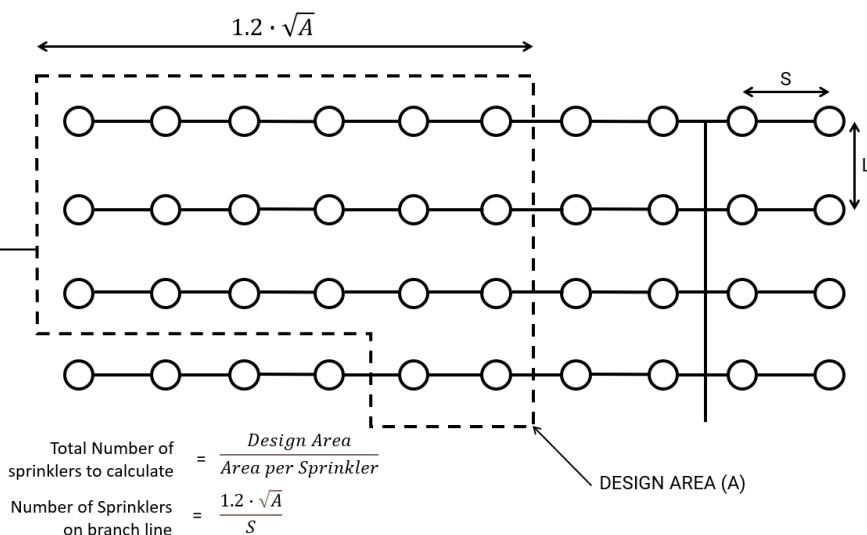


For storage of class I-IV commodities the design density can be reduced based on the storage height. This reduction is allowed because lower storage arrays will require less flow to control the fire. Minimum density is .15 gpm/sqft for storage

Other adjustments such as a 30% increase in the design area for dry systems also applies to CMDA sprinklers.

DESIGN AREA SHAPE

- 1 The number of sprinklers in the design area is found by dividing the required design area by the total coverage area per sprinkler.
- 2 The design area must have a minimum length along the branch line. This width is 1.2 times the square



6.3 Module Assessment

Complete the [assessment](#).

Assessment QR Code



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Module 7: Control Mode Specific Application (CMSA) Sprinklers

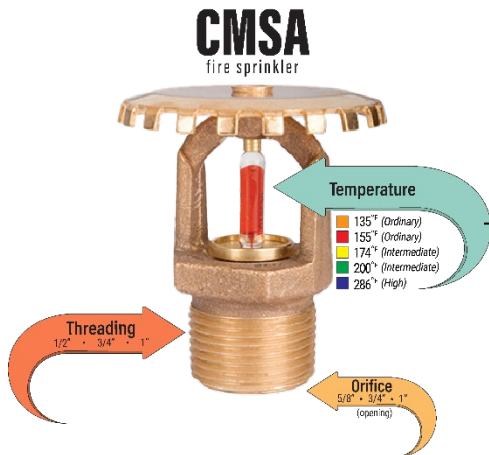
- Objective:**
1. Define and describe CMSA Sprinklers
 2. Identify the application and limitations of CMSA sprinklers

7.1 Conversation Quiz

[Complete the survey](#)



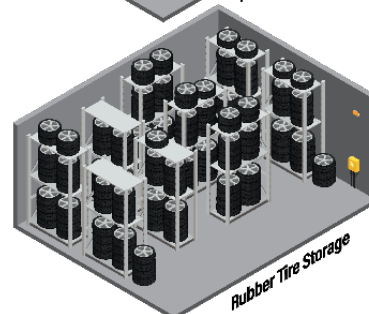
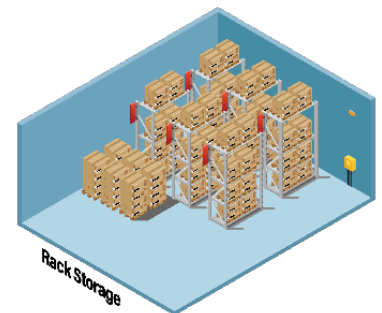
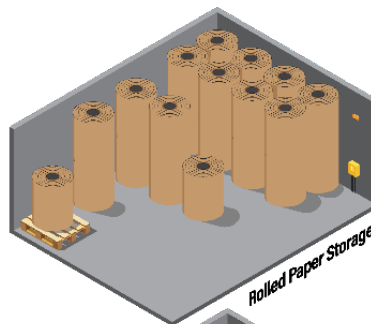
7.2 Define and describe CMSA Sprinklers



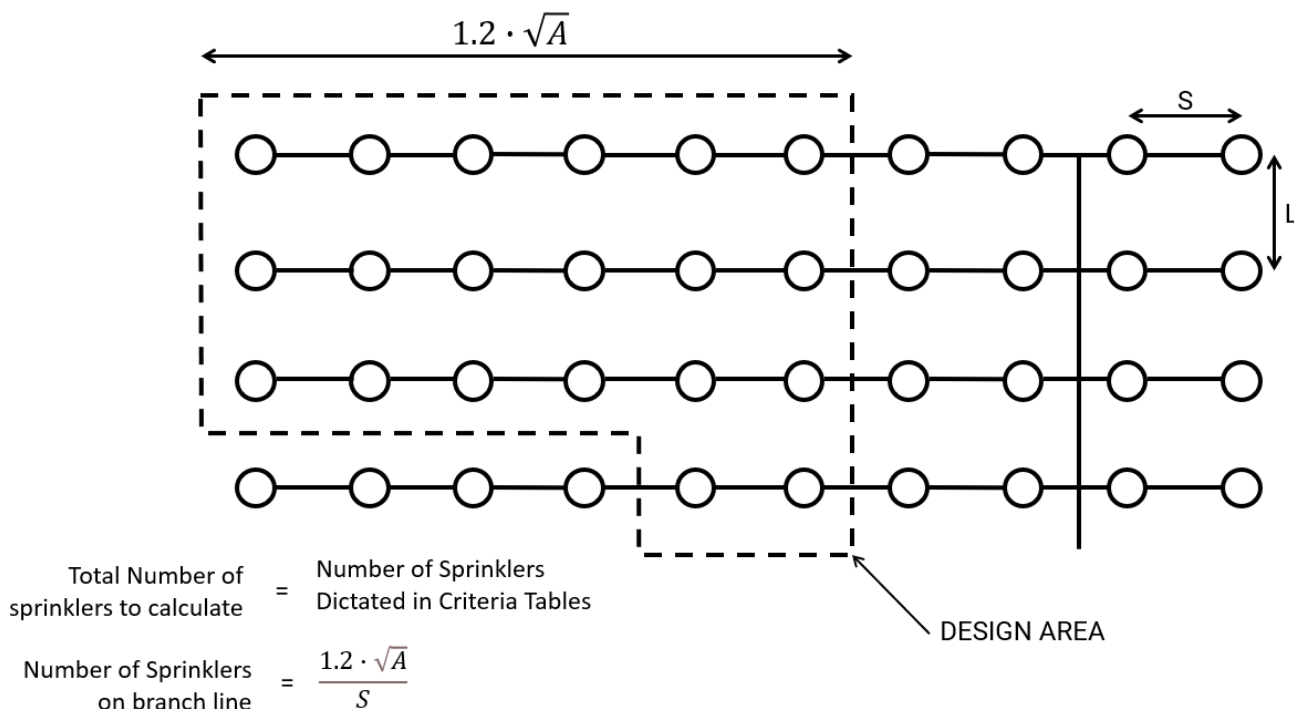
1. Is capable of producing characteristic large water droplets
2. Listed for its capability to provide fire control of specific high-challenge fire hazards.
3. CMSA sprinklers is to control the fire not suppress the fire. The large drops created by these sprinklers allows the water to better penetrate the greater heat created by storage fires and reach the hazard before evaporating.
4. Per section 7.2.2.5 indicates the minimum K-factor for an CMSA sprinkler is 11.2

7.3 Identify the application and limitations of CMSA Sprinklers

1. High piled storage of:
 - a. Class I-IV commodities
 - b. Group A Plastics
 - c. Rubber tires
2. Rolled Paper storage
3. OH1, OH2
4. Not permitted to protect solid-shelf racks unless in-rack sprinklers are used



Design Area



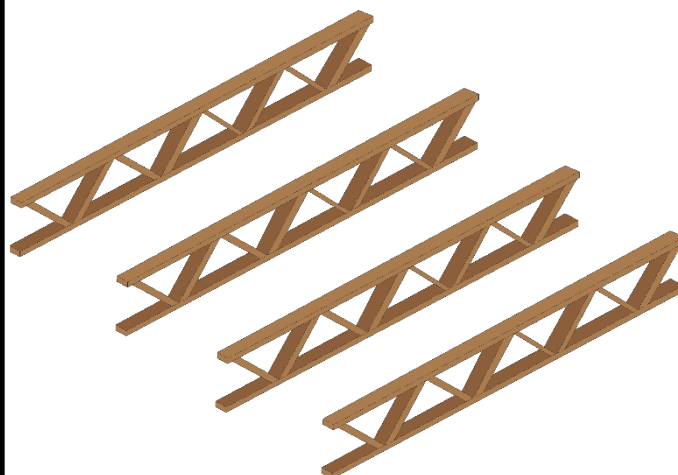
$A = (\text{Number of Sprinklers Flowing}) \times (\text{Maximum Allowable area per sprinkler, not actual area per sprinkler})$

1. Number of sprinklers flowing
 - a. Rather than using density/area approach, design is based on specific number of design sprinklers in Tables 22.2 through 22.7.
2. Calculating flow
 - a. The minimum pressure for each sprinkler is provided, we can determine the flow using the equation $Q = k\sqrt{P}$
3. Determine design area shape
 - a. Per section 27.2.4.3.1 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. 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, not the actual area per sprinkler. For example the sprinklers may be spaced at 120 sqft per sprinkler however the design area size for this purpose is the maximum allowable therefore if NFPA 13 allows for 130 sqft, the area (A) will equal 130 multiplied by the number of sprinklers in the remote area.

Wood Joist Construction

| Sprinkler K Factor | Minimum Operating Pressure |
|--------------------|----------------------------|
| K = 11.2 | 50 |
| K = 16.8 | 22 |
| K = 19.6 or larger | Refer to Table 22.4 |
| K = 11.2 or 16.8 * | Refer to Table 22.4 |

*Where each joist channel is fully separated with material equal to the joist material to its full depth at intervals not exceeding 20 feet creating draft stops.



7.3 CMSA Design Criteria Assessment

Complete the [assessment](#).

Assessment QR Code



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Module 8: Control Mode Specific Application (CMSA) installation Requirements

Objective: Understand the installation requirements specific to CMSA sprinklers

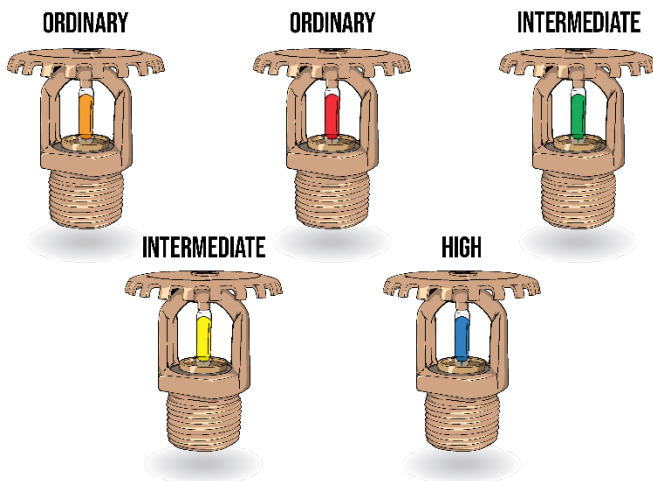
8.1 Conversation Quiz

Complete the following [survey](#)



8.2 CMSA installation Requirements

Temperature Ratings



1. Intermediate and High Temp sprinklers shall be installed in areas as required by 9.4.2 (13.2.3.2)
2. Storage occupancies Ordinary, intermediate, or high temp sprinklers shall be used in wet pipe systems.
3. Storage occupancies in which dry-pipe system is installed CMSA sprinklers shall be high temperature-rated sprinklers

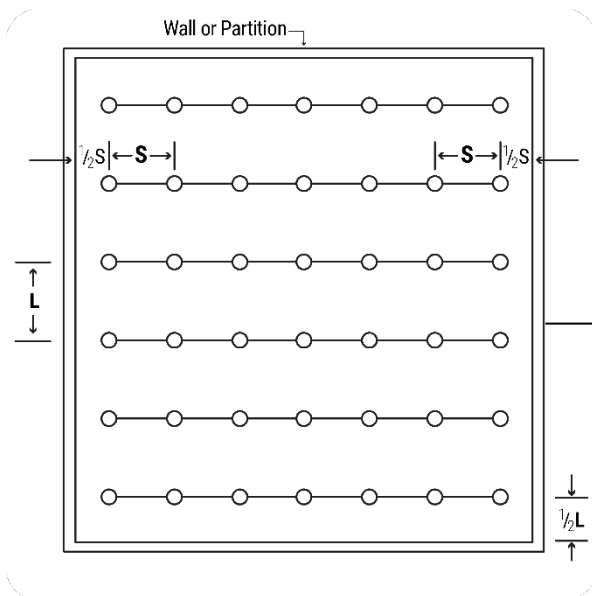
Maximum Coverage Area

While Protection areas beyond 100 sqft are allowed it is common practice to limit the design to 100 sqft, test involve spacing beyond 100 sqft are limited

Minimum coverage area: 80 sq ft

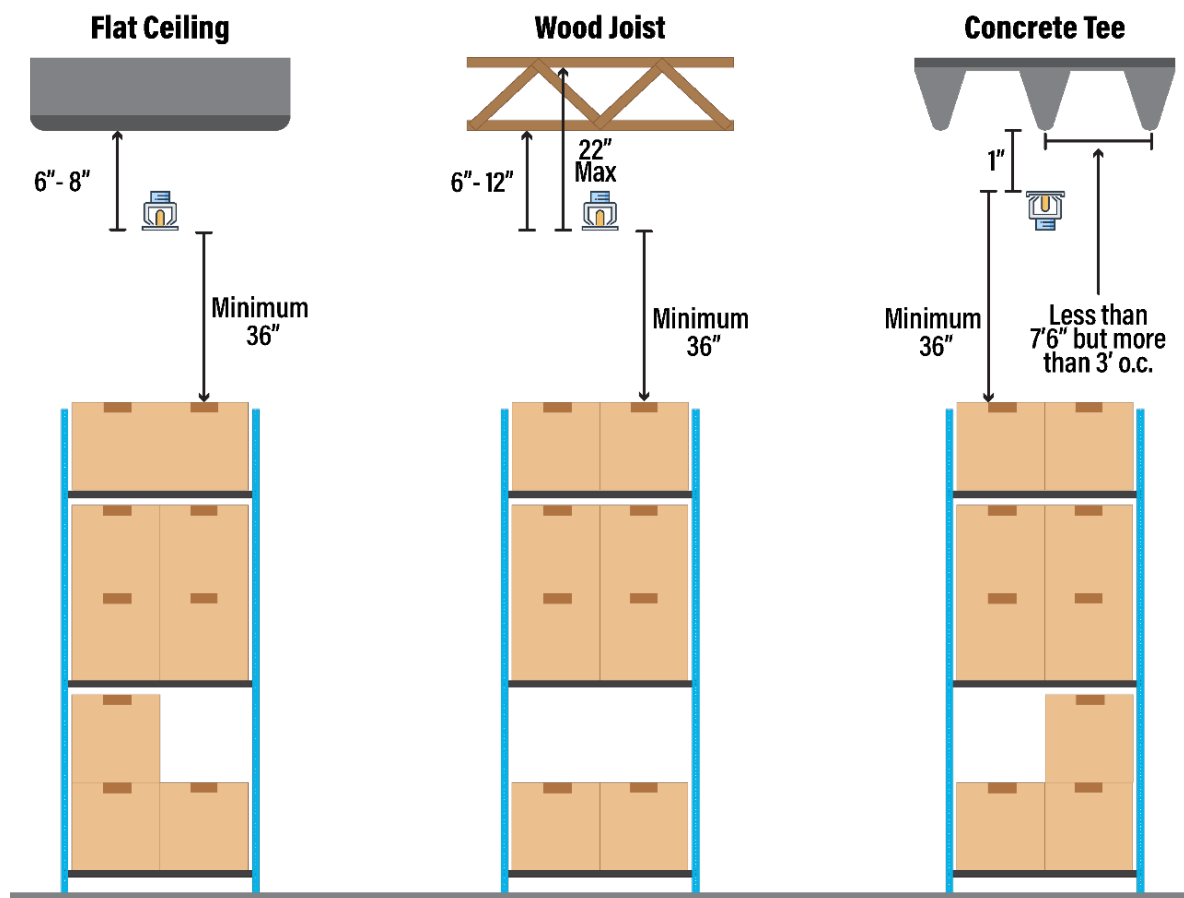
| Construction Type | Protection Area | Maximum Spacing |
|---|-----------------|-----------------|
| Noncombustible | 130 sqft | 12 ft |
| Combustible Unobstructed | 130 sqft | 12 ft |
| Combustible Obstructed | 100 sqft | 10 ft |
| Rack Storage: All Construction Unobstructed and Noncombustible Obstructed | 100 sqft | 12 ft |

Sprinkler spacing

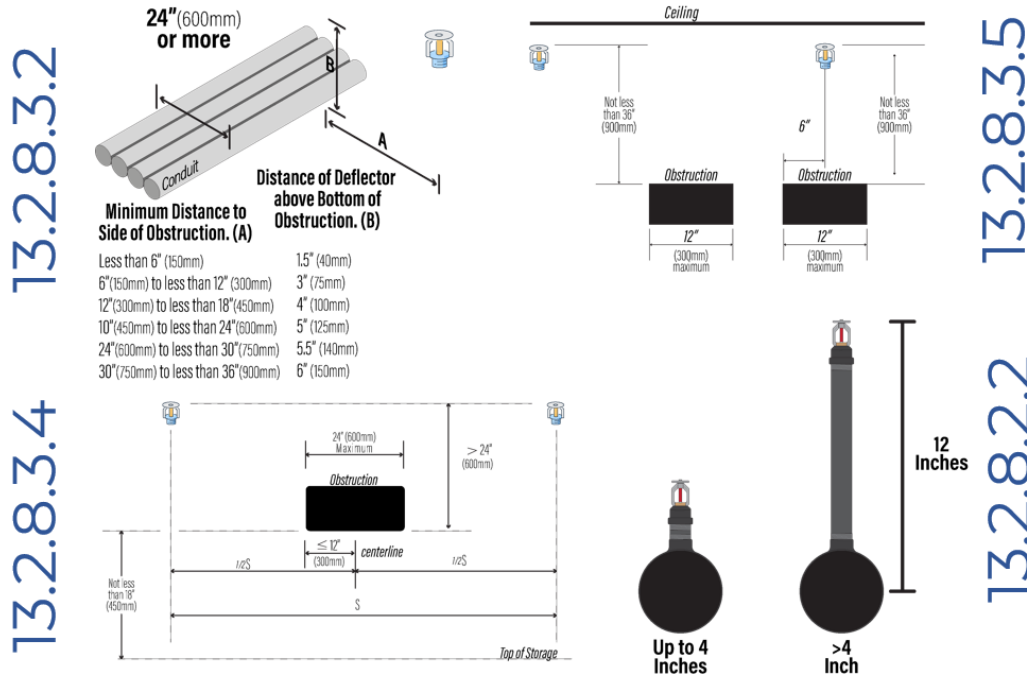


1. Unobstructed Construction: maximum of 12 feet between sprinklers
2. Obstructed Construction: Maximum of 10 feet between sprinklers
3. Maximum distance to wall: $\frac{1}{2}$ allowable distance between sprinklers
4. Minimum distance to walls: 4 inches
5. Minimum distance between sprinklers: 8 ft

CMSA Deflector Distance to the Ceiling



CMSA Obstruction



- 13.2.8.3.2: Special rules for continuous obstructions completely below the sprinklers that are more than 24 inches wide
- 13.2.8.3.4: Special rules for continuous obstructions completely below sprinklers
- 13.2.8.3.5: Special rules for continuous obstructions directly below and parallel to branch line.
- Branch Lines Larger than 4 inch
 - Offset sprinkler 12 inches horizontally from branch line, or
 - Install sprinklers on a sprig 12 inches above the centerline of branch lines greater than 4 inches. (measure 12 inches from deflector to centerline of pipe)

8.2 CMSA installation Requirements

complete the [assessment](#).



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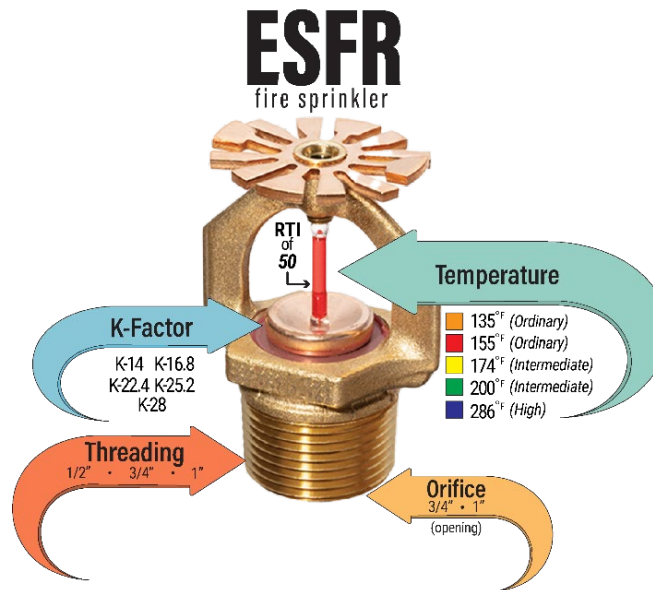
Module 9: ESFR Design Criteria

- Objective:**
1. Define and Describe ESFR Sprinklers
 2. Understand the design criteria for storage protection using ESFR Sprinklers

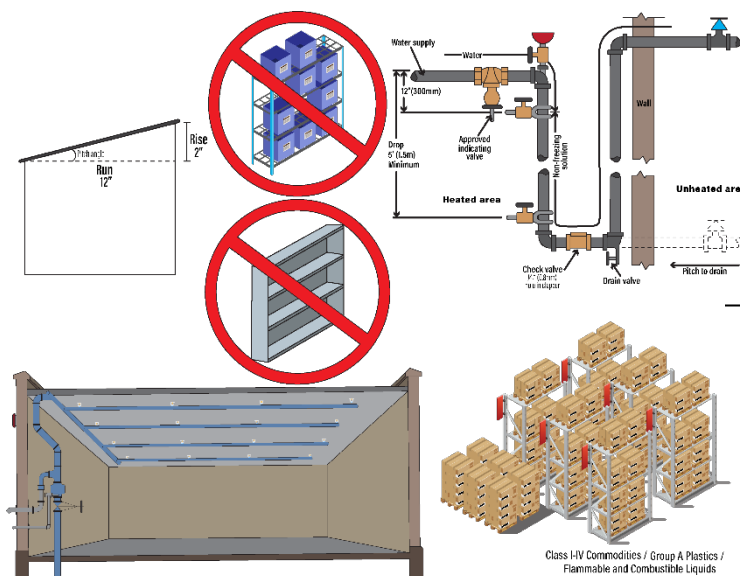
9.1 Conversation

"What is the primary different between an ESFR sprinkler And CMDA/CMSA Sprinkler?"

9.2 Define and Describe ESFR Sprinklers



ESFR Applications and Limitations

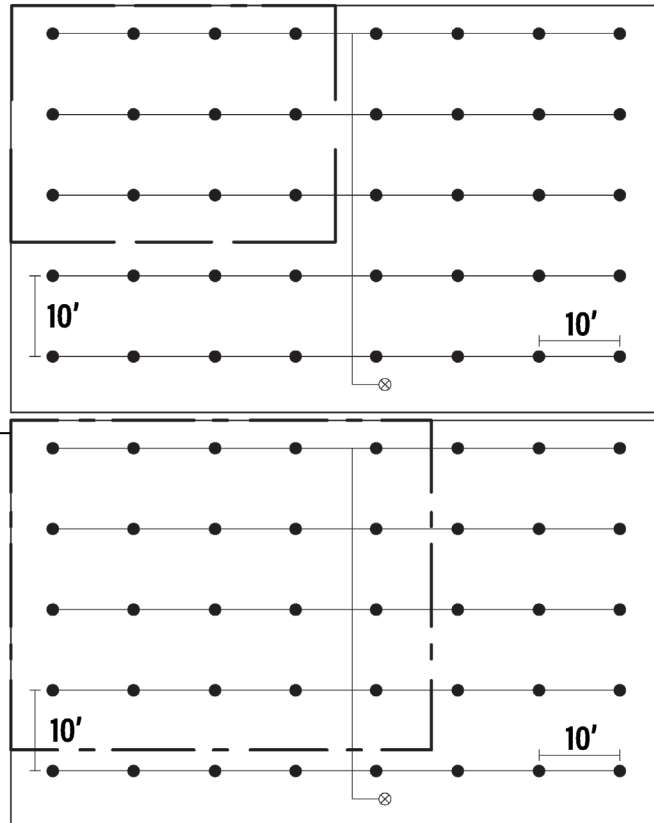


1. OH1, OH2, any storage arrangement for OH1, OH2, EH1, EH2
2. High piled storage of:
 - a. Class I-IV commodities
 - b. Group A Plastics
 - c. Rubber tires
 - d. Rolled Paper storage
 - e. Plastic Motor Vehicle Components
 - f. High Bay Record Storage
3. Wet systems only
4. No Open top containers (unless in the bottom tier of a rack)
5. No solid shelves

9.3 Understand the Design Criteria for Storage Protection Using ESFR Sprinklers

ESFR Design Area

1. Per section 27.2.4.4: for ESFR sprinkler the design area shall consist of the most hydraulically demanding area of 12 sprinklers, consisting of 4 sprinklers on each of three branch lines, unless other specific numbers of design sprinklers are required in other sections of this standard.
2. Where protecting rubber tires in a laced array, calculate 20 sprinklers (5 sprinklers on 4 branch lines)



ESFR Design Area -Most Criteria

12 Sprinklers
3 Branch Lines
4 Sprinklers per Branch Line

ESFR Design Area -Rubber Tires

20 Sprinklers
4 Branch Lines
5 Sprinklers per Branch Line

9.4 ESFR Design Criteria Assessment

Complete the [assessment](#).



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Module 10: Early Suppression Fast Response (ESFR) Installation Requirements

Objective: Understand the installation requirements for ESFR Sprinklers

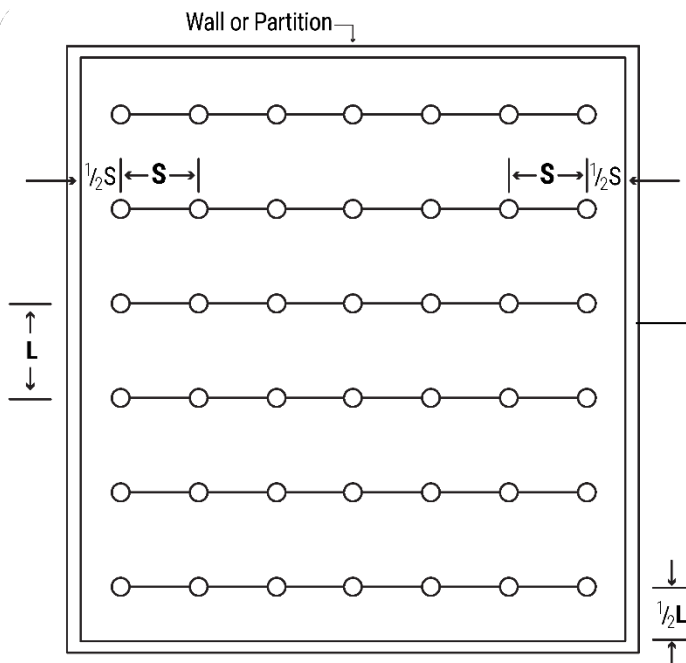
10.1 Conversation Quiz

Complete the [survey](#).



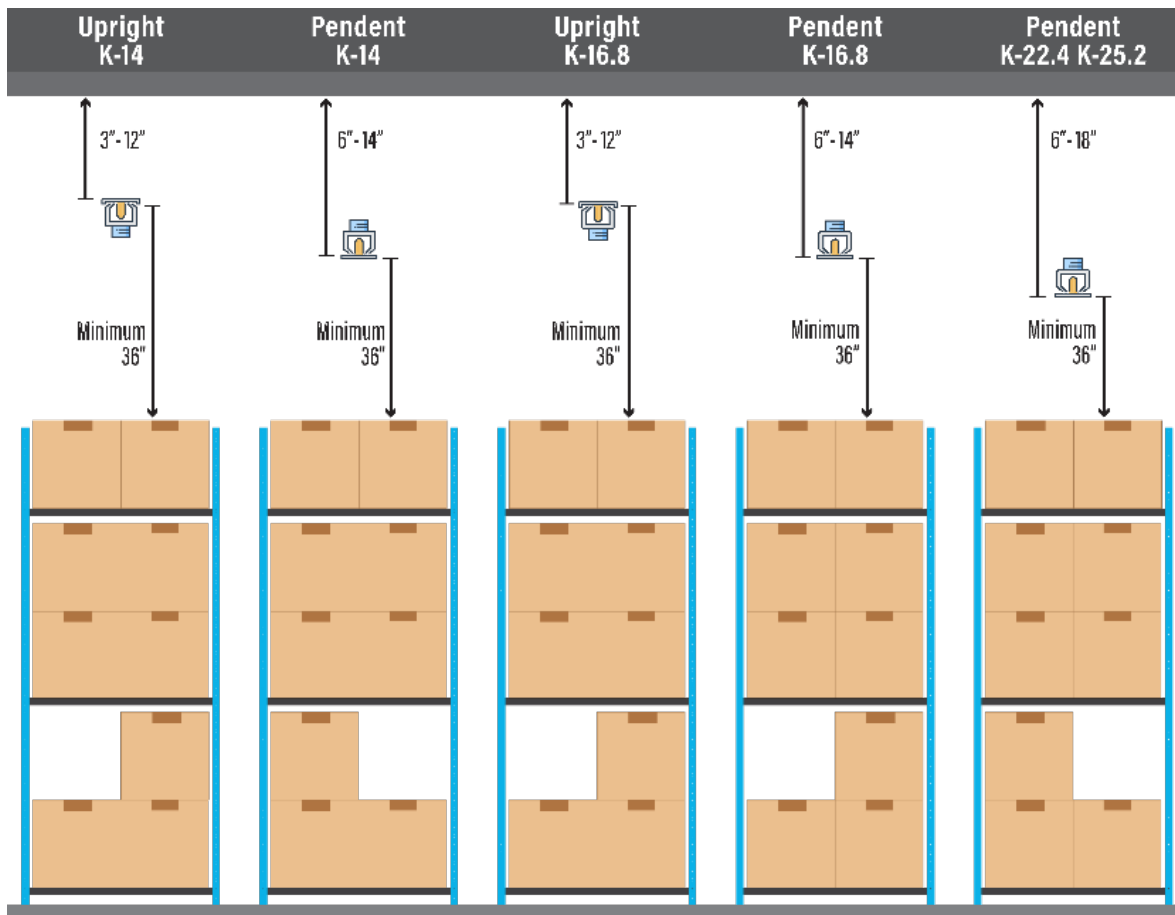
10.2 Early Suppression Fast Response (ESFR) Sprinkler Installation Requirements

ESFR Spacing



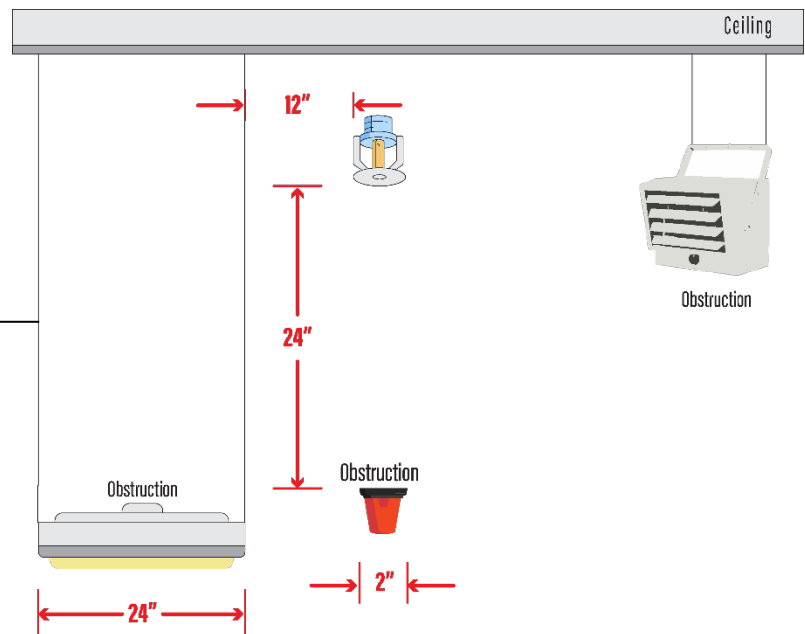
1. Protection Areas Per sprinkler (14.2.8)
 - a. Maximum 100 sq ft per sprinkler
 - b. Minimum 64 sq ft per sprinkler
2. Sprinkler Spacing (14.2.9)
 - a. Maximum 12 ft between sprinklers
 - b. Minimum 8 ft between sprinklers
 - c. When storage heights exceed 25 ft or the roof/ceiling height exceeds 30 ft, the maximum distance between sprinklers is 10 ft

ESFR Deflector position

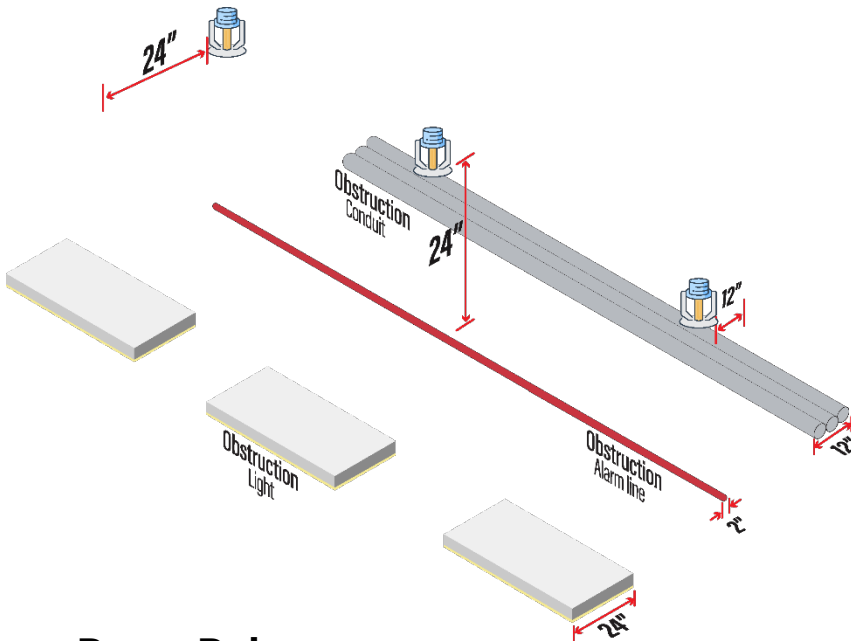


ESFR Isolated Obstruction

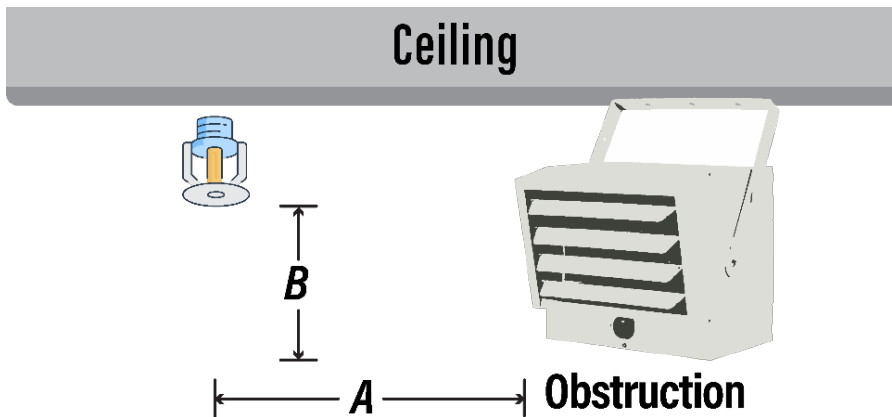
1. Obstruction is 24" or less in width and sprinkler is at least 12" away horizontally
2. Sprinklers meeting "beam rule"
3. Obstructions 2" or less in width located at least 24" below the deflector
4. Sprinklers with special obstruction allowance installed in accordance with their listing



Continuous Obstruction Rules



Beam Rule

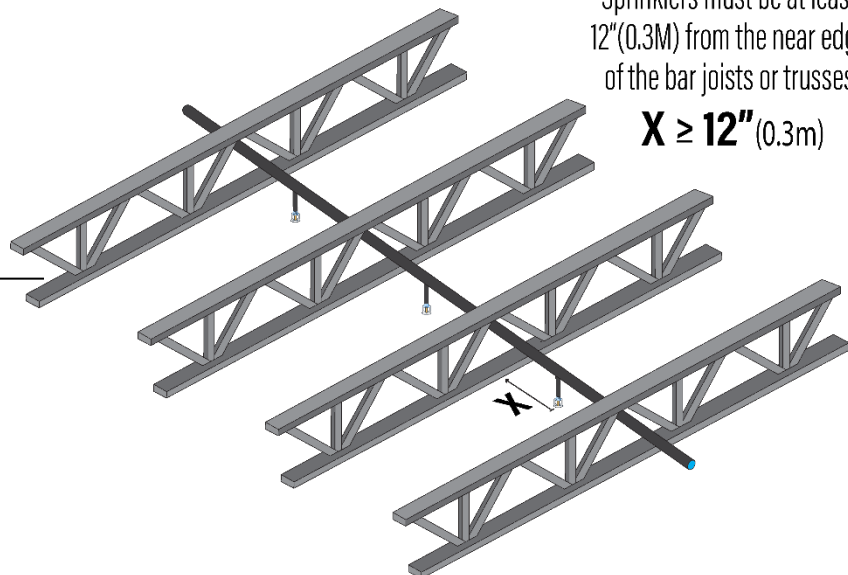


1. Meet "beam rule"
2. Install a row of sprinklers under the obstruction
3. Or meet one of the following exceptions
 - a. Obstructions 24" or less in width and sprinkler is at least 24" away horizontally
 - b. Obstructions 12" or less in width and sprinkler is at least 12" away horizontally
 - c. Obstructions 2" or less in width located at least 24" below the deflector
 - Sprinklers with special obstruction allowance installed in accordance with their listing

| Distance from Sprinkler to Side of Obstruction. (A) | Maximum allowable distance of deflector above bottom of obstruction. (B) [in. (mm)] |
|---|--|
| Less than 1' (300mm) | 0" (0) |
| 1' (300mm) to less than 1'-6" (450mm) | 1.5" (40) |
| 1'-6" (450mm) to less than 2' (600mm) | 3" (75) |
| 2' (600mm) to less than 2'-6" (750mm) | 5.5" (140) |
| 2'-6" (750mm) to less than 3' (900mm) | 8" (200) |
| 3' (900mm) to less than 3'-6" (1.1m) | 10" (250) |
| 3'-6" (1.1m) to less than 4' (1.2m) | 12" (300) |
| 4' (1.2m) to less than 4'-6" (1.4m) | 15" (375) |
| 4'-6" (1.4m) to less than 5' (1.5m) | 18" (450) |
| 5' (1.5m) to less than 5'-6" (1.7m) | 22" (550) |
| 5'-6" (1.7m) to less than 6' (1.8m) | 26" (650) |
| 6' (1.8m) | 31" (775) |

Bar Joist

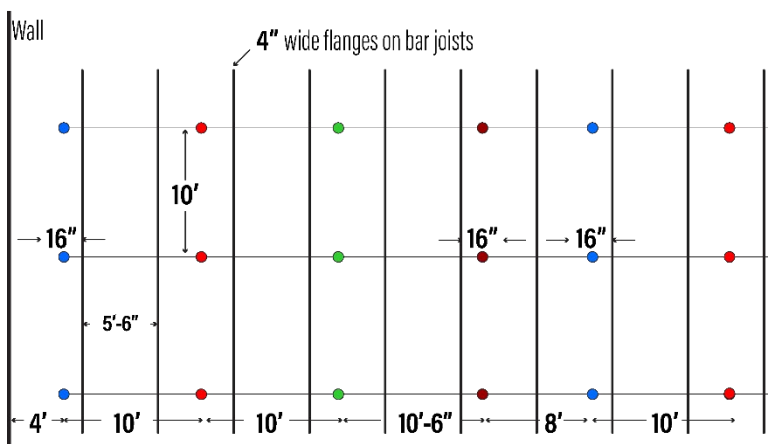
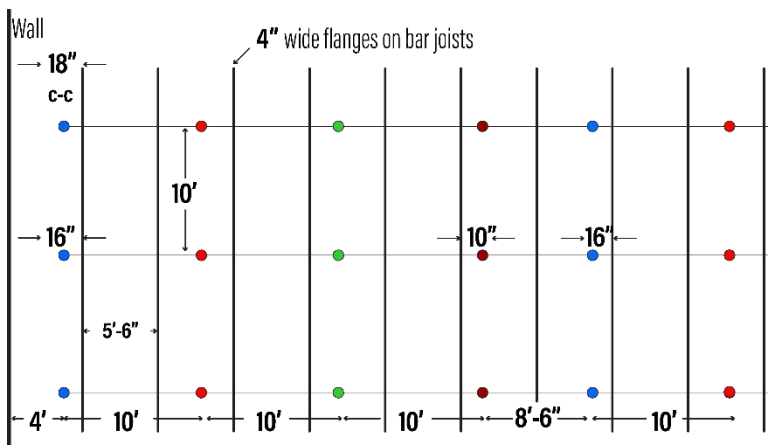
1. Pendent ESFR Sprinklers NOT allowed in centerline of bar joist or open truss unless specifically listed for these kinds of obstructions.
(sprinklers must be at least 12 inches away horizontally)
2. Sprinklers must be at least 12 inches (0.3 m) from the near edge of bar joists or trusses



Sprinklers must be at least 12" (0.3M) from the near edge of the bar joists or trusses

$$X \geq 12" (0.3m)$$

ESFR Shift Rule



1. Spacing rules of 100 sq ft per sprinkler and maximum 10 ft between sprinklers can be violated to avoid obstructions under the following conditions:
 - a. Move one sprinkler up to 1 ft on each branch line, or move one branch line up to 1 ft
 - b. Average actual floor area between moved sprinkler (or branch line) and adjacent ones is still 100 sq ft

10.3 Storage Criteria Example Comparison

Complete the [assessment](#)



Complete the course evaluation [here](#) to receive a certificate



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