Ceiling sprinkler installations

9&10 June 2026

What we will review

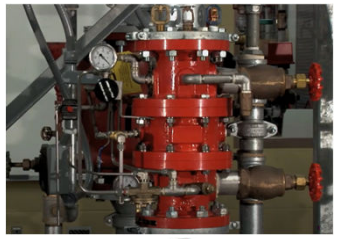
- System types
  - Wet-pipe, dry-pipe, preaction, refrigerated, vacuum, deluge, antifreeze.
- Sprinkler piping and hangers
- Ceiling slope
- Ceiling construction
- Heat and smoke vents
- Ceiling pockets and skylights
- Ceiling airflow velocities
- Obstructions to sprinkler discharge

What are the main types of water-based sprinkler systems?

Wet-pipe type

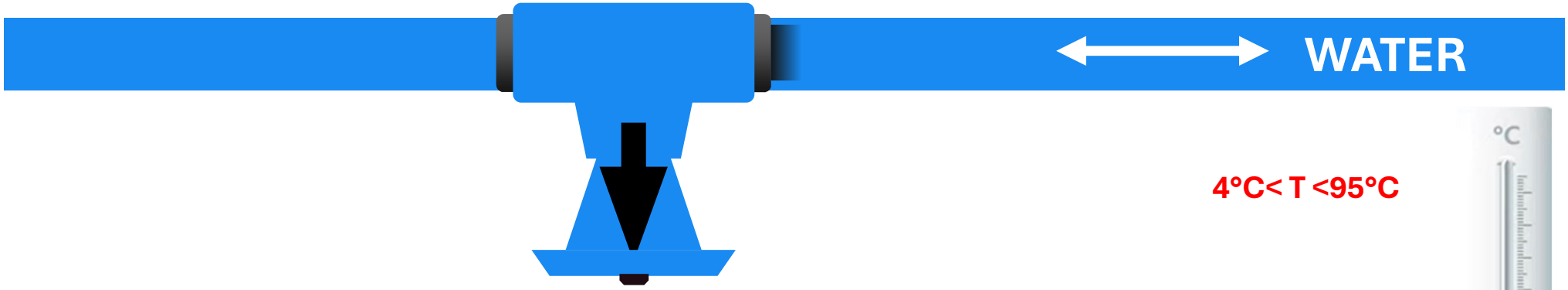
Dry-pipe type

Deluge



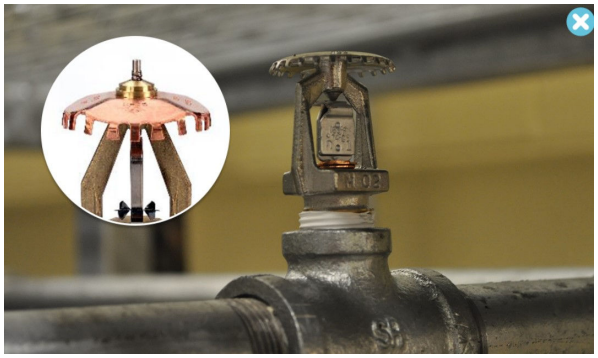
Preaction

Wet-pipe system

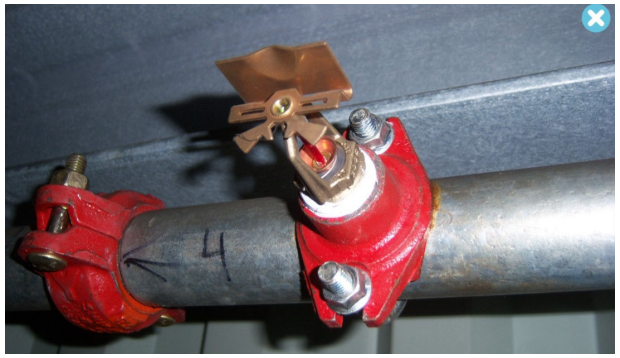


4°C< T <95°C

Pendent



Upright

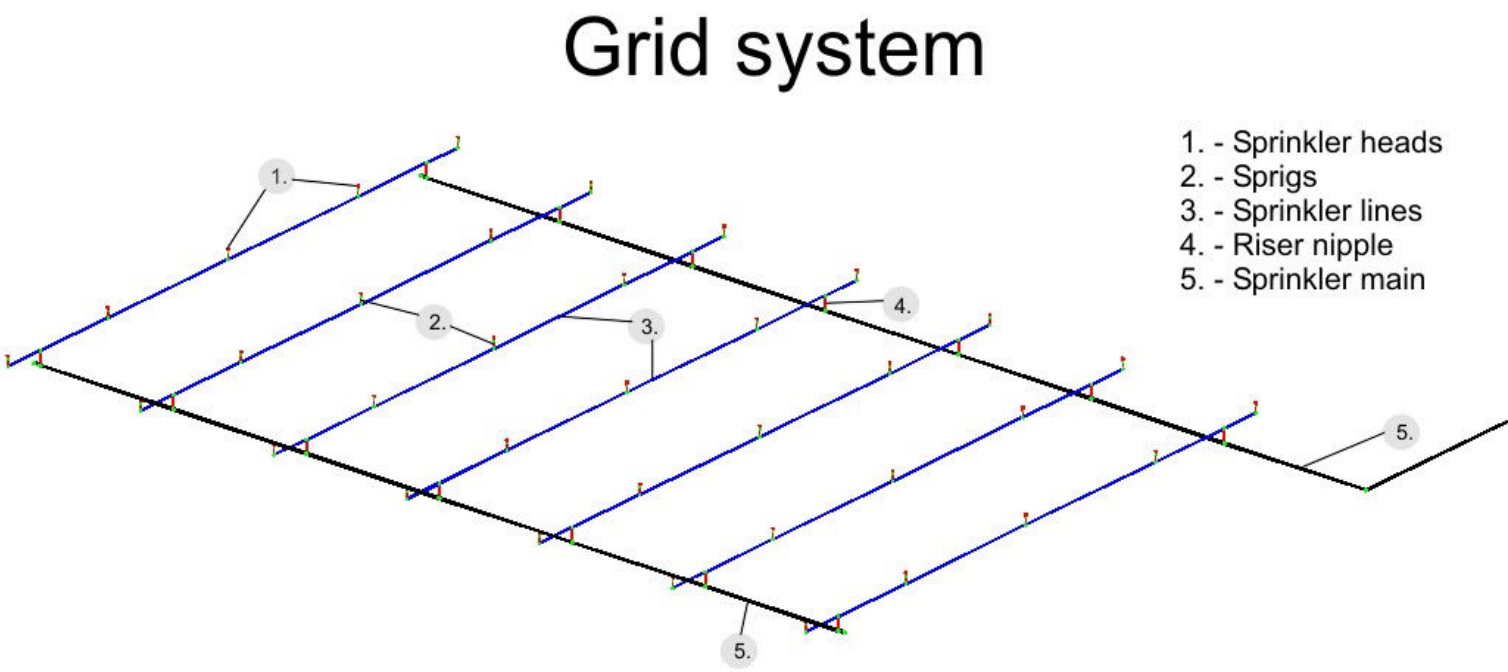


Sidewall

Wet-pipe system

Piping arrangement:

- Grid system
- Loop system
- Tree system



CEILING SPRINKLER PROTECTION

Wet-pipe system

- Maximum coverage area (size of the system)

  There is no fixed limitation, it will depend on:

  - Hydraulic design (example: 12 sprinklers at 5.2 bar)
  - Water delivery time

- Flow alarm time: 60 seconds upon sprinkler actuation

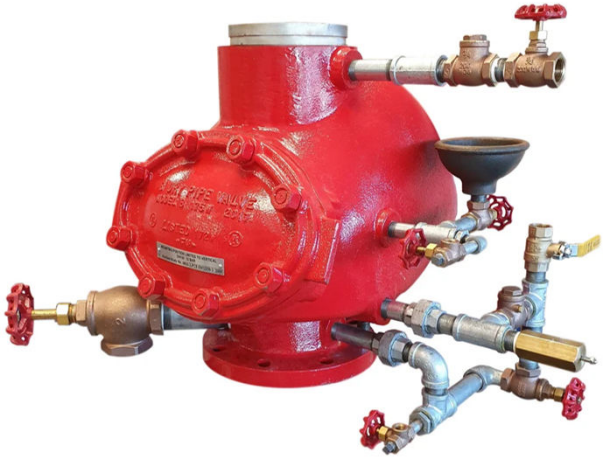
- Piping material: black steel pipe or steel that is resistant to internal oxidation (never use galvanized pipes for wet systems, possibly explosive gas development), plastic (nonstorage only)

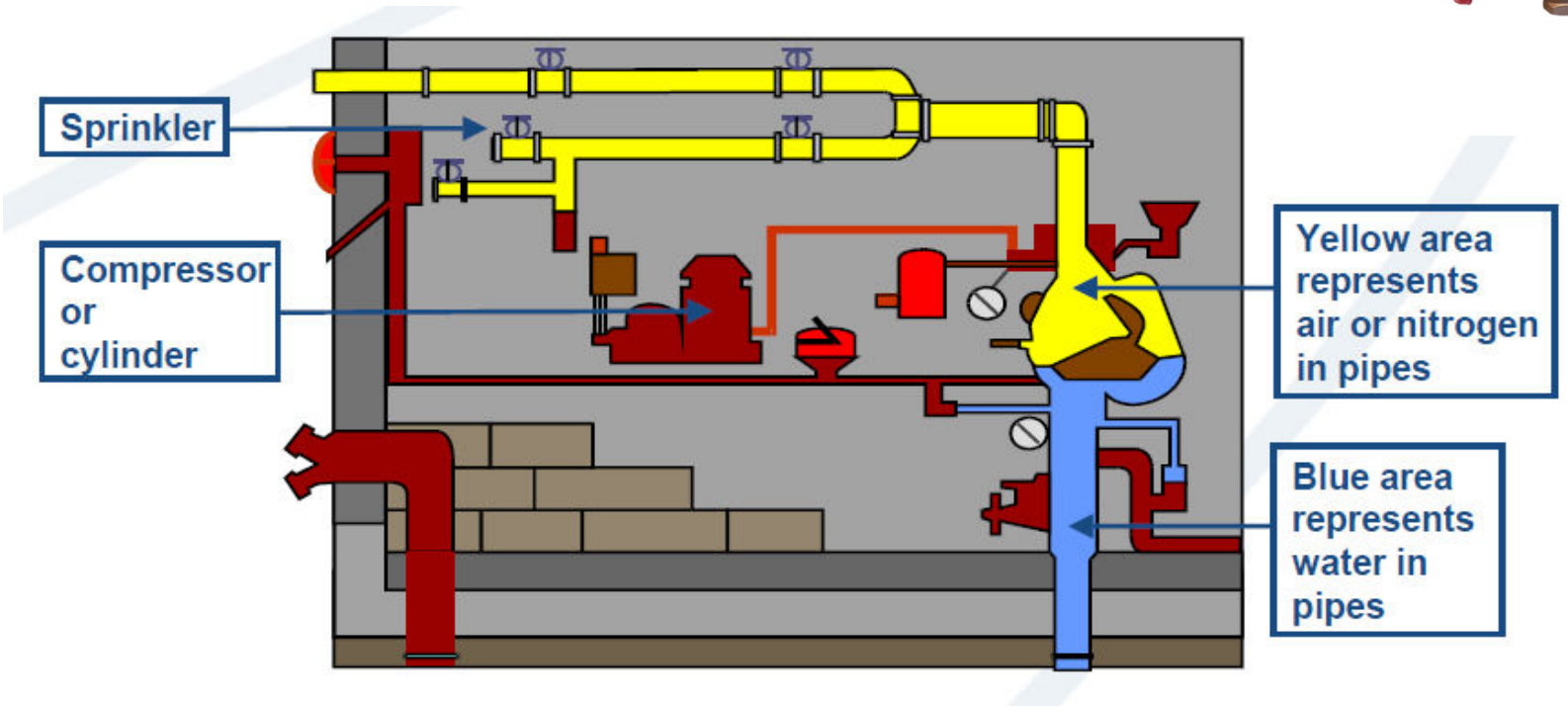
CEILING SPRINKLER PROTECTION

Wet-pipe system: in-rack sprinklers

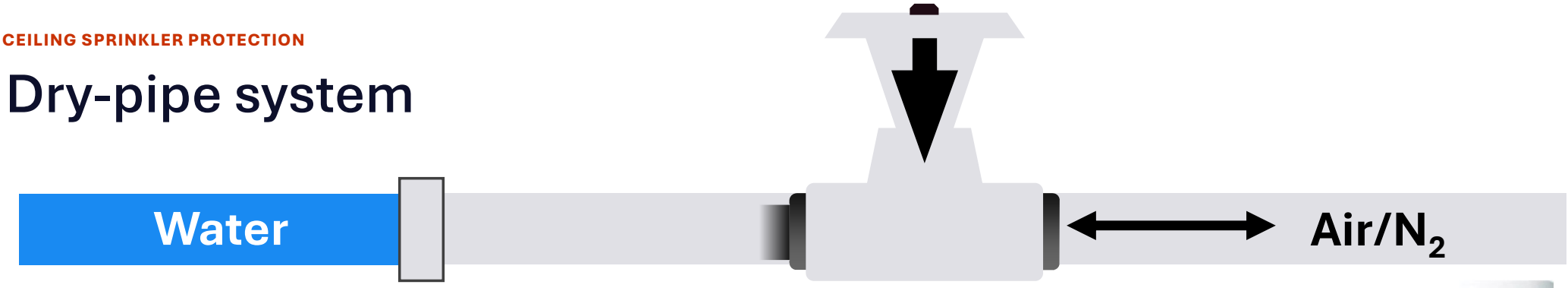
- ❑ Ambient temperature: 4°C < T < 95°C
- ❑ Sprinkler orientation: pendent or upright (no sidewall)
- ❑ Response time: quick response (except for ignitable liquids: standard response).
- ❑ Piping arrangement: single-path, loop, grid
- ❑ Maximum coverage area: 3715 m^2 of floor area (footprint: racks + aisles)
- ❑ Flow alarm time: 60 seconds upon sprinkler actuation
- ❑ In-rack system should be equipped with its own check valve, control valve and waterflow alarm

Dry-pipe system





Dry-pipe system

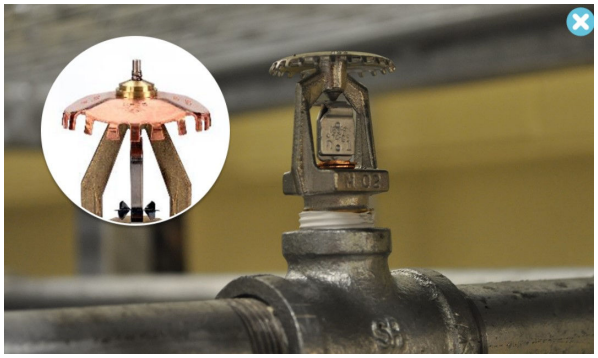


Dry pipe valve

T< 4°C or T>95°C

T: Not constantly below -7°C

Pendent



Upright

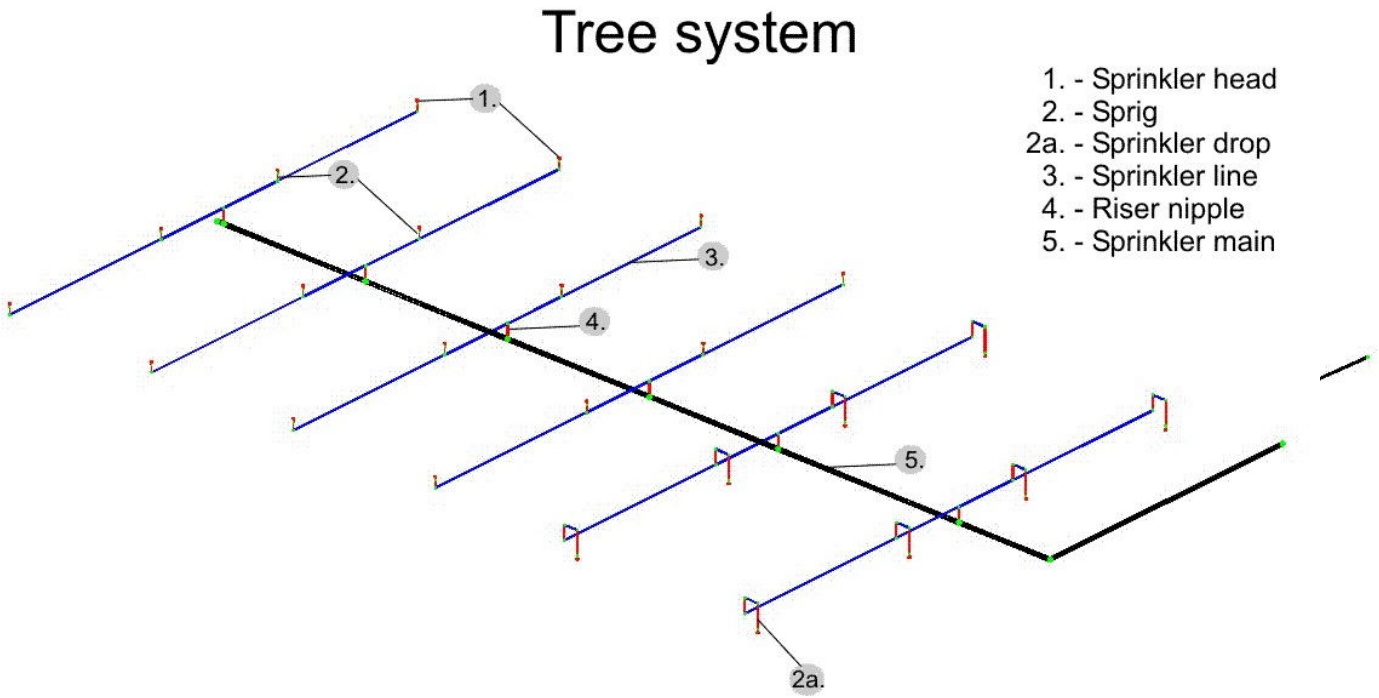
Sidewall

AND ONLY Standard Response, 141°C sprinklers!

Dry-pipe system

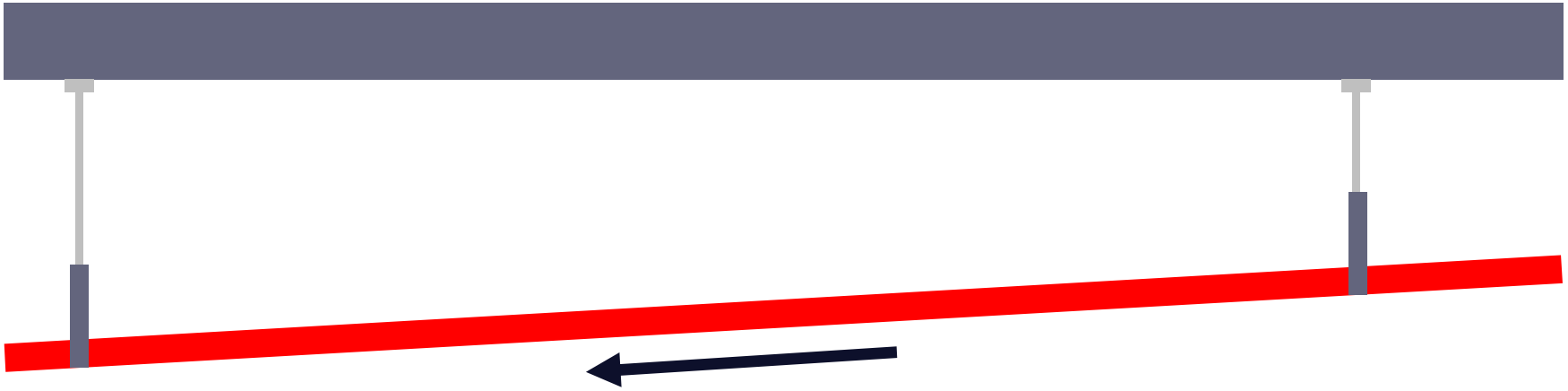
Piping arrangement:

- Tree system
- Loop system of the feed and/or cross mains and **ONLY for non-storage occupancy**
- **Never a grid system**



Dry-pipe system

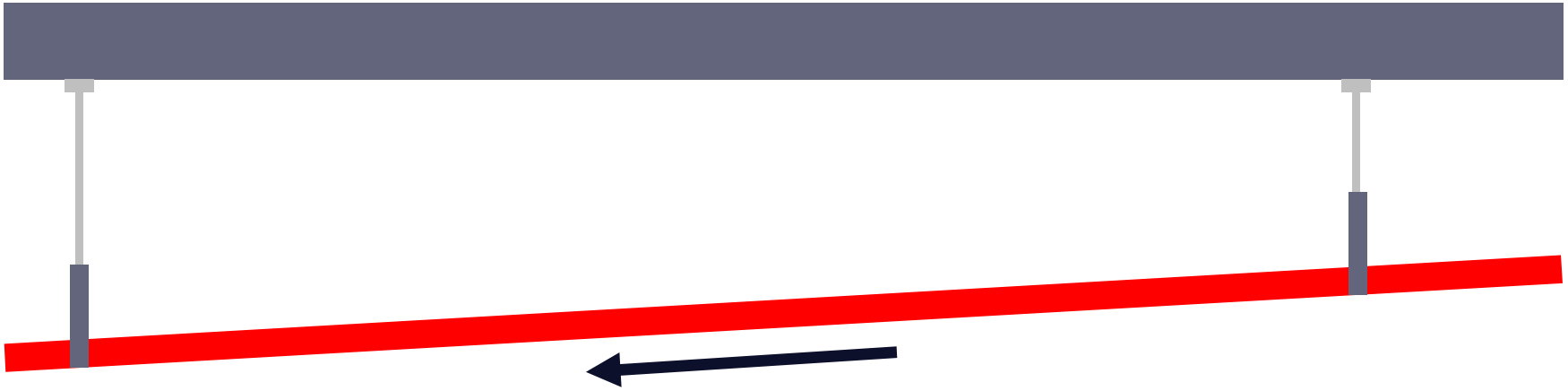
Slope for branch lines



Slope 4 mm/m to the source

Dry-pipe system

Slope for cross and/or feed mains

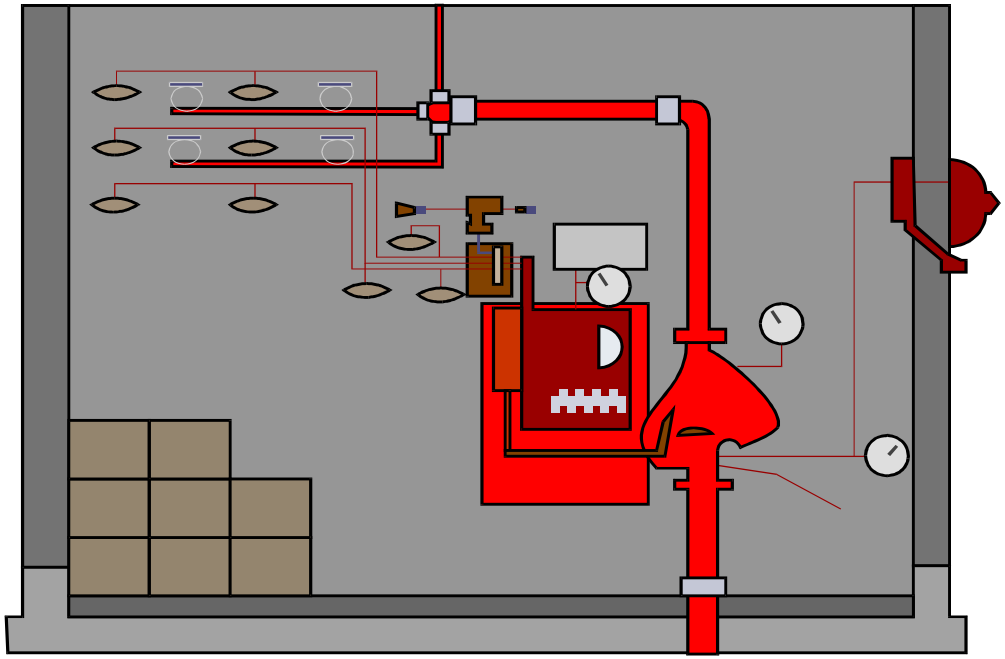


Slope 2 mm/m to the source

Dry-pipe system

- Maximum coverage area (size of the system): will depend on
  - Hydraulic design
  - Water delivery time (see relevant occupancy specific data sheet - otherwise: 60 seconds maximum)
- Gaseous medium supply:
  - Inert gaseous medium (example: nitrogen)
  - Air, if a regenerative air dryer is provided on the air supply OR if the size of the system is limited to 20 sprinklers
- Piping material:
  - Galvanized or other steel pipe resistant to internal oxidation (polymer enhanced)
  - Black steel only when the gaseous medium is inert and meets 2.2.1.10

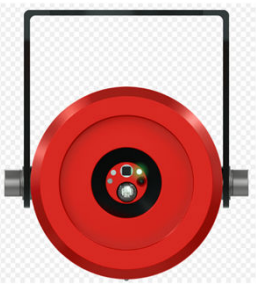
Deluge system:



CEILING SPRINKLER PROTECTION

Deluge system:

- All sprinkler heads are open
- Pipes are dry – there is no water in them until the system is activated
- An independent detection system detects a fire (heat detection, line type heat detection, UV/IR detection, a pilot line of sprinklers filled with air or nitrogen)
- When triggered, the deluge valve opens and water flow through all the sprinklers at once, flooding the area quickly
- Often requires an adequate drainage system



Deluge system

- ❑ Sprinkler orientation: pendent, upright, sidewall
- ❑ Ambient temperature: no limitation
- ❑ Piping arrangement: single flow path, looped, gridded.
- ❑ Maximum coverage area (size of the system): will depend on
  - ➢ Hydraulic design
  - ➢ Water delivery time (see relevant occupancy specific data sheet - otherwise: 30 seconds maximum)
  - ➢ Experience has demonstrated a limit of about 1,115 m^2
- ❑ Piping material:
  - ➢ Galvanized or other steel resistant to internal oxidation
  - ➢ Black steel

Preaction system:

Preaction Systems:

- Non-interlock: Closed-type sprinkler heads. Deluge valve opens on either a detection system operation OR a loss of pneumatic air pressure (sprinkler head opens).
- Single interlock: Closed-type sprinkler heads. Deluge valve opens on detection system operation. Deluge value does not open if a sprinkler head opens (loss of air pressure).
- Double interlock: Closed-type sprinkler heads. Deluge valve opens on detection system operation AND a loss of pneumatic air pressure.

Preaction system:

The valve will open	Non-interlock	Single interlock	Double interlock
Upon activation of a sprinkler	YES	NO	NO
Damage to sprinkler piping	YES	NO	NO
Upon activation of the detection only	YES	YES	NO
Upon activation of the detection and sprinkler	YES	YES	YES

Preaction system:

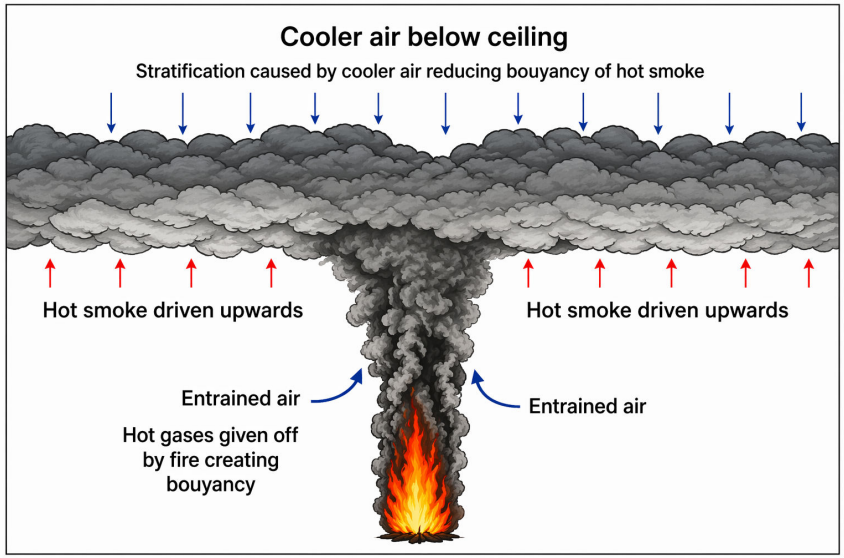
- ❑ Ambient temperature: below 4°C or above 95°C.
- ❑ When ambient temperature is between 4°C and 95°C: single-interlock
- ❑ Sprinkler orientation: only upright or dry-type sprinklers
- ❑ Pendent sprinklers can be installed if the protected area is not subject to freezing and with galvanized pipes or provided with an inert gaseous medium
- ❑ Temperature rating: unless indicated otherwise: standard response 140°C.
- ❑ Piping arrangement: same as dry-pipe system
- ❑ Maximum coverage area (size of the system): same as dry-pipe system
- ❑ Piping material: same as dry-pipe system

Treating preaction as wet-pipe or dry-pipe systems

- Treat preaction (and refrigerated-area) systems as dry-pipe systems for hydraulic design, unless
- Ceiling sprinklers (not in-rack sprinklers), can be designed as a wet-pipe system if:
  - Single interlock preaction
  - Heat detector spacing is 50% of the maximum allowed per the Approval Guide listing or on the same spacing as the sprinkler heads

Activation of preaction, refrigerated-area, and deluge systems by heat or smoke detection

- Do not use smoke detection to activate systems (unless allowed by an occupancy specific Data Sheet)
- “Smoke stratification”



Roofed-Mounted Smoke Detection

None of these systems activated during the test. They are all 2-3m above the smoke plume

Smoke Plateau

At around 9 meters, the smoke has stopped rising as it reaches a layer of warmer air near the roof.

Smoke Oven

Hot smoke is released from the ground level, after a pre-burn period.

Source: Blazeguel – The Fire Protection Specialists

Refrigerated-area system:

- ❑ Ambient temperature: below-7°C
- ❑ The occupancy of protected area is storage
- ❑ Dedicated data sheet has been moved to Data Sheet 2-0
- ❑ A double-interlocked preaction system

Antifreeze sprinkler systems

- No FM Approved antifreeze yet…
- Glycol and glycerin are ignitable liquids
- Research shows that it can raise the heat release rate in a fire
- Separation of glycol and water in multi-story facilities
- Limit operating area to 185 m^2
- If operating area is greater than 185 m^2, only acceptable if:

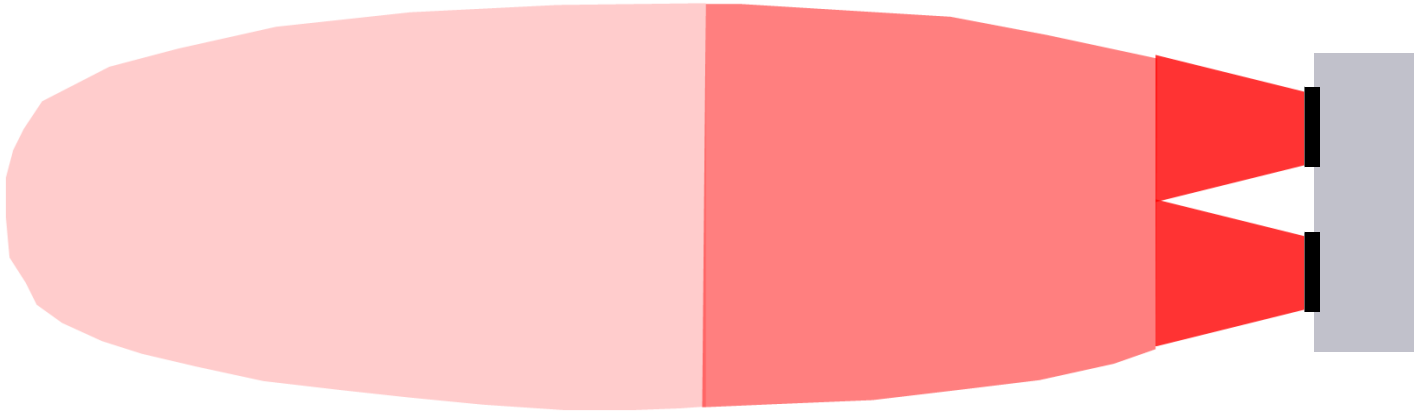
-7°C to 4°C: Dry-pipe system
< -7°C: Refrigerated area system
Dry pendent sprinklers

A. The ambient temperature of the protected area will always be maintained at or above 32°F (0°C). For this condition use either a propylene glycol solution ranging between 20% and 25%, or a glycerin solution ranging between 30% and 35%, or

B. The ambient temperature of the protected area will always be maintained at or above 25°F (-4°C). For this condition use either a propylene glycol solution ranging between 25% and 30%, or a glycerin solution ranging between 35% and 40%.

Attention, cold storage

- To get an ambient temperature of, say, 4°C (e.g., chilled storage) the air temperature from the chillers will be below 0°C
- Nearest sprinklers / branch lines can be impacted
- Need temperature and airflow speed profiles from the chillers/blowers



Sprinkler piping and hangers

- Minimum 25 mm for pipes transporting water to sprinklers
- FM Approved sprinkler piping, or
- Pipe that meets the minimum wall thickness table
- For water-sensitive occupancies (cleanrooms, data centers, etc) use thicker pipe e.g., Schedule 40, EN10217-1 ‘heavy’

Table 2.4.2.2.1(2). Recommended Minimum Steel Pipe Wall Thickness for Threaded, Roll-Grooved, Cut-Grooved, and Welded Sprinkler Piping in Millimeters

Nominal DN Pipe Diameter, mm	*Welded or Roll-Grooved Pipe, mm*	*Threaded or Cut-Groove Pipe, mm*
25	2.6*	3.2
32	2.6*	3.2
40	2.6*	3.2
50	2.6*	3.6
65	2.6	3.6
80	2.9	4.0
100	3.2	4.5
125	3.6	5.0
150	4.0	5.0
200	4.5	6.3
250	5.0	6.3
300	5.6	7.1

* The minimum wall thickness for roll-grooved steel pipe can be 1.7 mm when used with couplings or fittings indicated in the Approval Guide specifically for this minimum wall thickness

Table 2.4.1.1.2.1(b). Minimum Wall Thickness for Steel Pipe Installed Over Water-Sensitive Occupancies; Nominal Pipe Sizes Measured in Millimeters

Nominal Pipe Size, mm	*Minimum Wall Thickness, mm*
25	3.2
32	3.2
40	3.2
50	3.6
65	3.6
80	4.0
100	4.5
125	5.0
150	5.0
200	6.3
250	6.3
300	7.1

Sprinkler piping and hangers

- Building structure should be able to support weight of water-filled piping
- Pipe hangers should be FM Approved
- Do not attach pipe hangers to roof decking
  - OK for branch lines up to 75 mm using Approved hangers for steel deck and if roof deck is designed for the load
- Hanger spacing per table, depending on pipe wall thickness. Approx. one hanger per sprinkler head.
- Can increase hanger distance for >65 mm pipes if two pipe hangers are used either side of couplings

Table 2.4.3.3.1.1. Recommended Maximum Horizontal Distance Between Pipe Hangers Supporting Steel Sprinkler Pipe

	Maximum Horizontal Distance Between Sprinkler Pipe Hangers, ft (m)						
	Nominal Pipe Diameter, in. (mm)						
Sprinkler Pipe Material	1 (25)	1-1/4 (32)	1-1/2 (40)	2 (50)	2-1/2 (65)	3 (80)	Greater than 3 (80)
Steel Pipe with wall thicknesses less than those indicated in Table 2.4.3.3.1.1(1)	12 (3.7)	12 (3.7)	12 (3.7)	12 (3.7)	12 (3.7)	12 (3.7)	Not Applicable; Use pipe with minimum wall thickness per Table 2.4.3.3.1.1(1)
Steel Pipe with wall thicknesses equal to or greater than those indicated in Table 2.4.3.3.1.1(1)	12 (3.7)	12 (3.7)	15 (4.6)	15 (4.6)	15 (4.6)	15 (4.6)	15 (4.6)

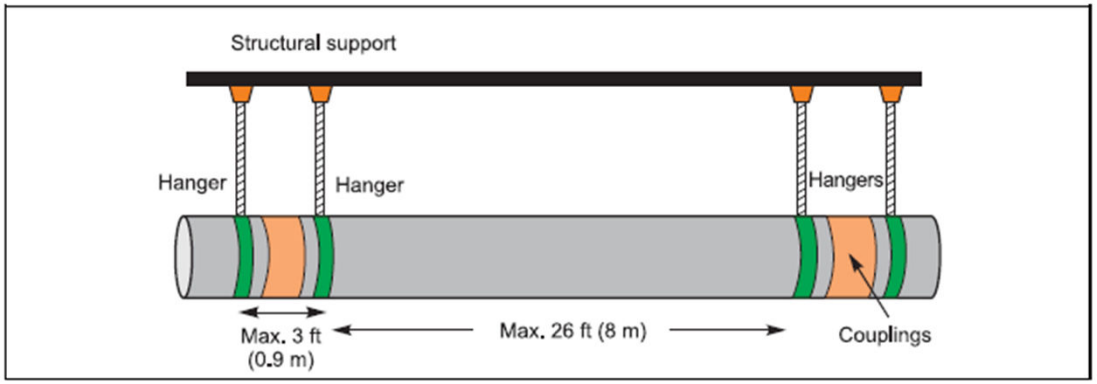
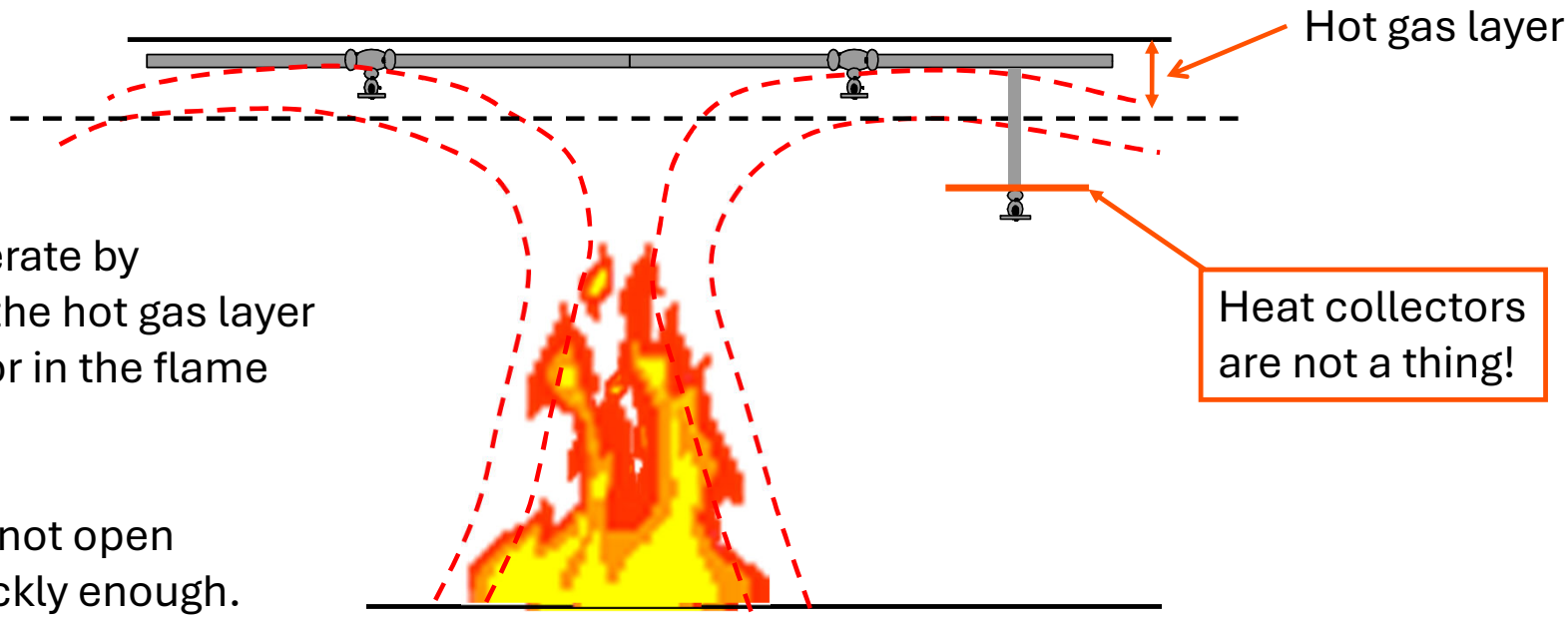


Fig. 2.4.3.3.1.9. Piping arrangement for maximum horizontal distance of 26 ft (8 m) between pipe hangers

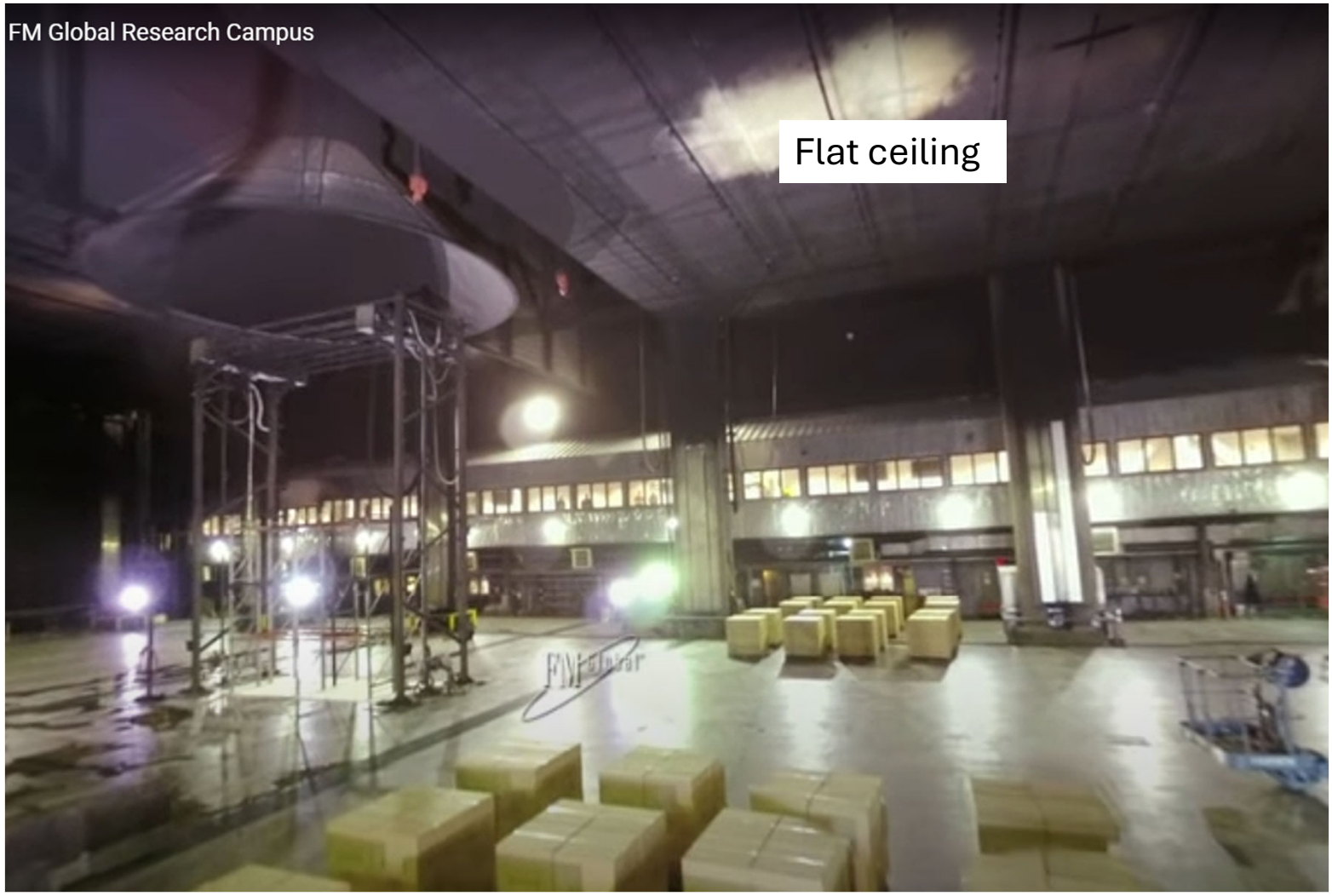
Ceiling sprinklers



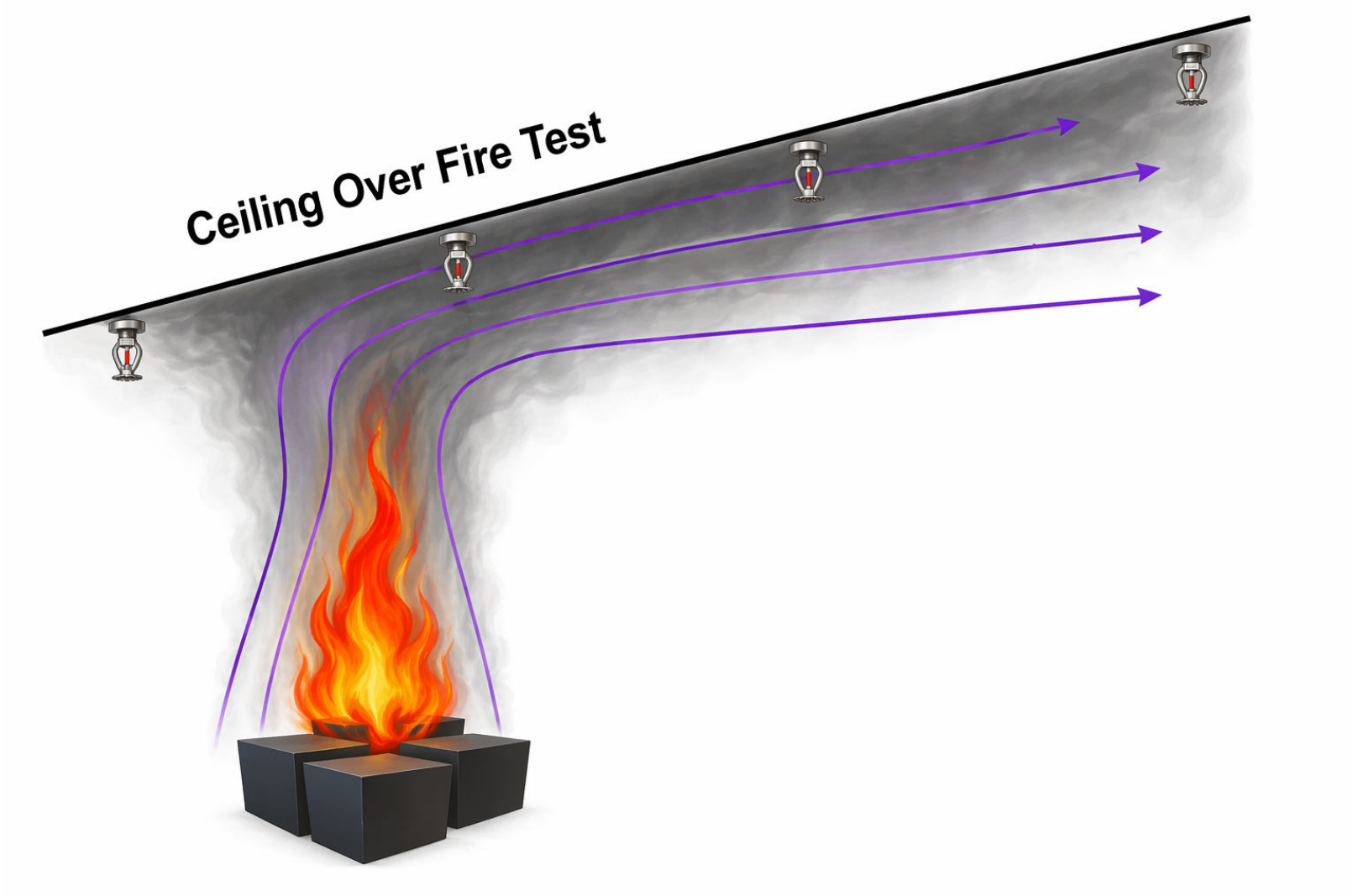
Sprinklers operate by immersion in the hot gas layer at the ceiling or in the flame plume.

Radiation will not open sprinklers quickly enough.

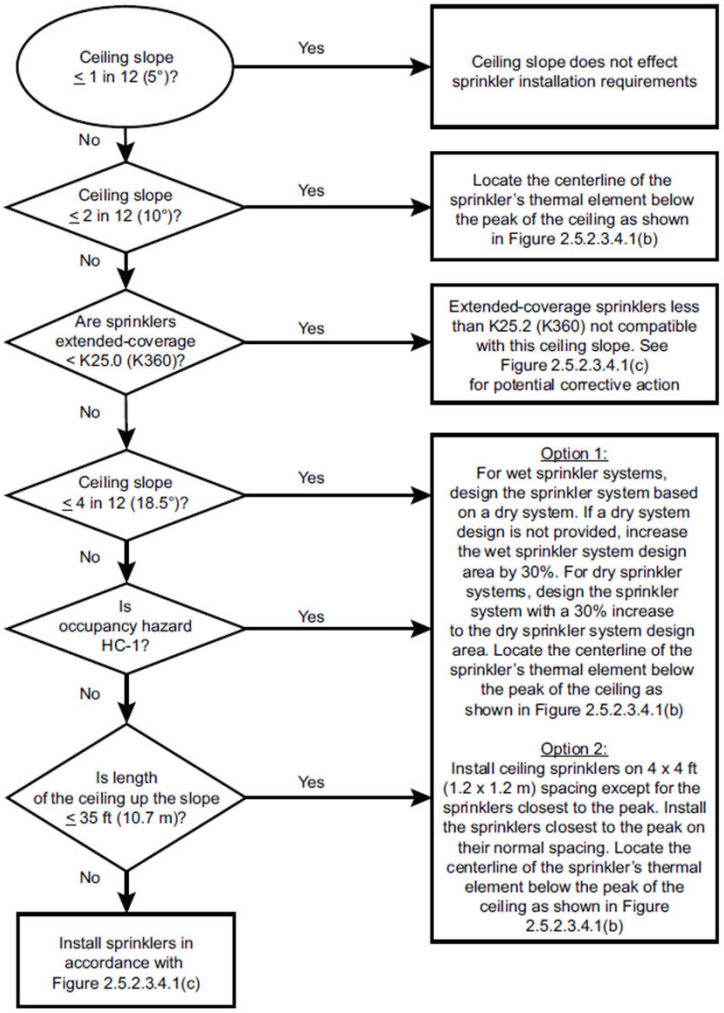
Ceiling slope and sprinkler positioning



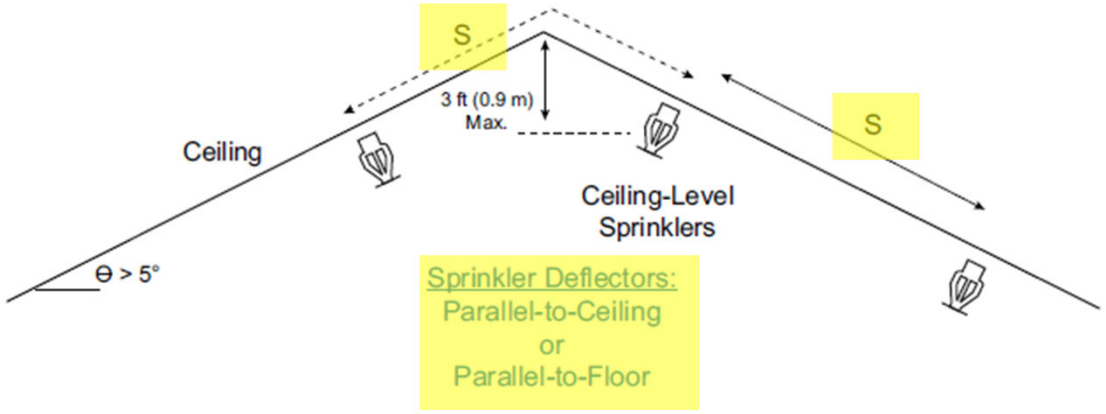
Ceiling Slope



Ceiling slope and sprinkler positioning

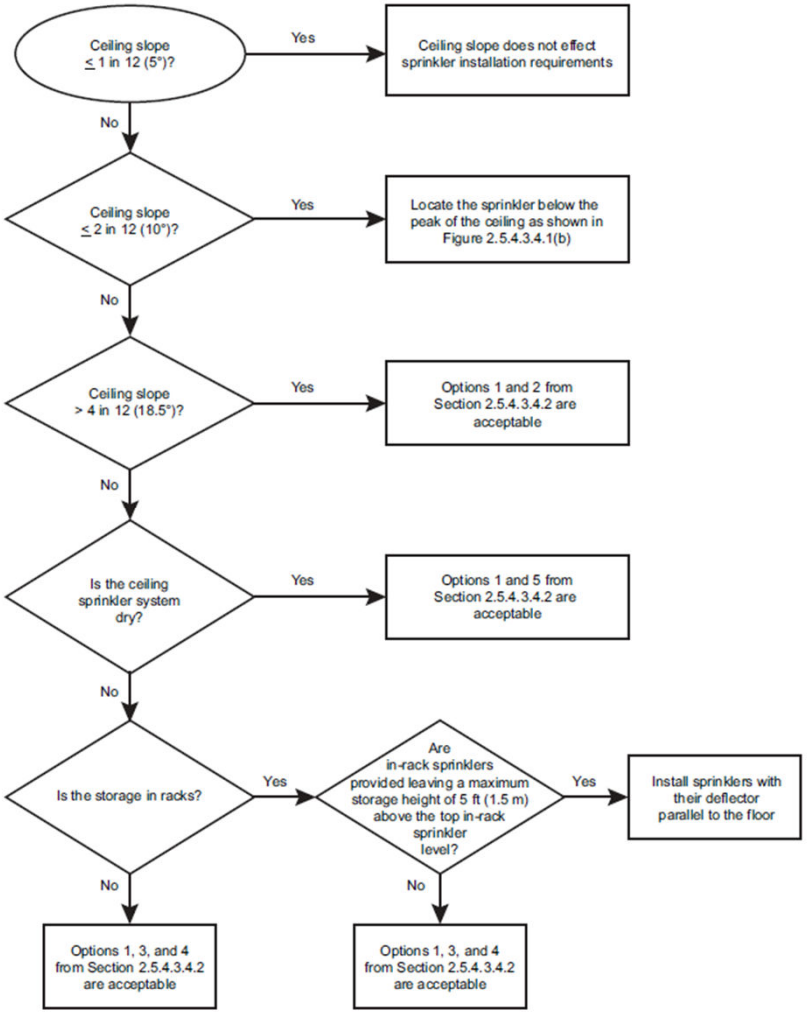


Nonstorage

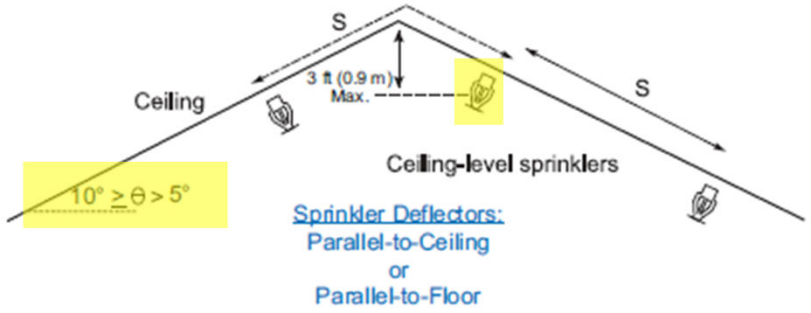


Nonstorage Occupancy - Elevation View

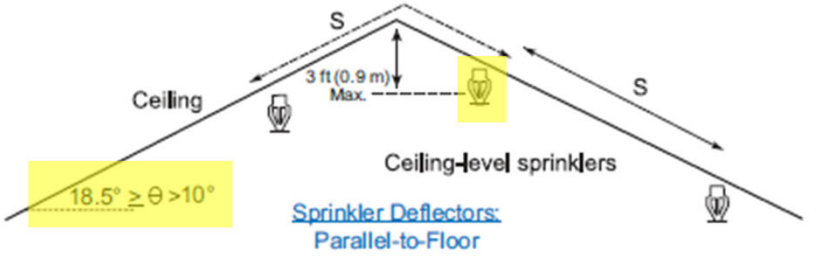
Ceiling slope and sprinkler positioning



Storage



Storage Occupancy - Elevation View



Storage Occupancy - Elevation View

Ceiling slope and sprinkler positioning

- Options per the flow diagram include:
  - No action (slope < 5°)
  - In-rack sprinklers and no storage above top level of in-racks
  - Increasing the sprinkler design operating area
  - Installing sprinklers on 1.2 m x 1.2 m spacing
  - False ceiling
  - Combination of above

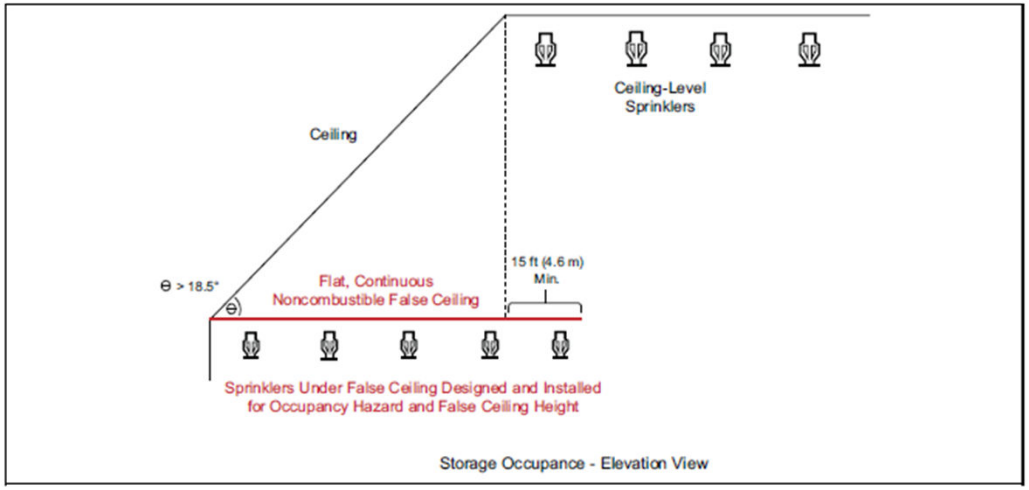


Fig. 2.5.4.3.4.2. Option 1 per Figure 2.5.4.3.4.1(a) involving the installation of a flat, continuous, false ceiling with additional ceiling sprinklers

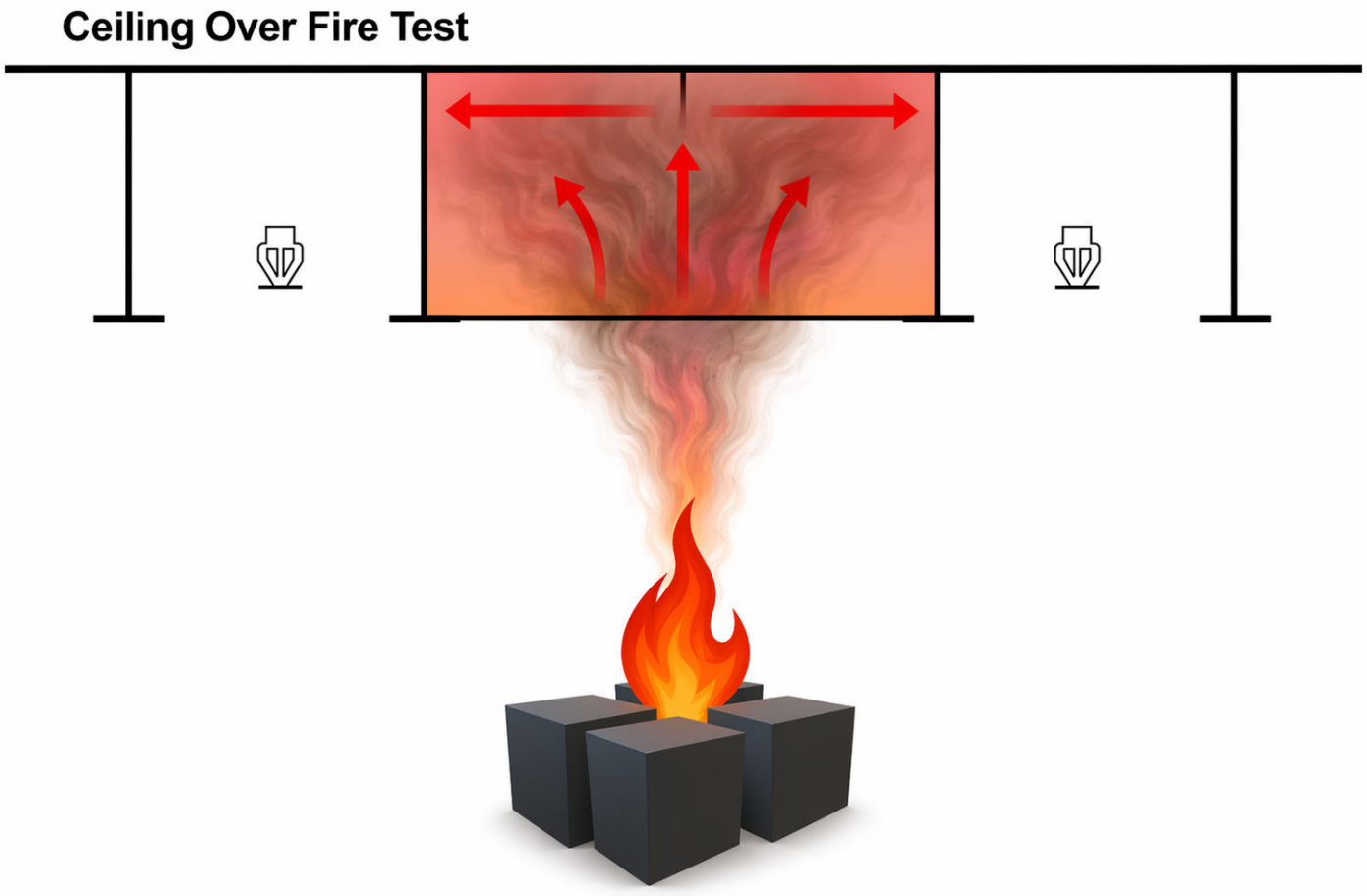
CEILING SPRINKLER INSTALLATIONS

Ceiling construction

- Smooth unobstructed
- Non-smooth unobstructed
- Obstructed

- Occupancy – nonstorage or storage
- Examples below for Nonstorage (similar process for storage)

Obstructed Construction



Ceiling Construction

Obstructed ceiling construction: A ceiling structural assembly that prevents the flow of hot gases from spreading out under the ceiling in a uniform fashion from the point of fire origin, when centered within a ceiling channel, to the nearest four sprinklers. Examples of ceilings that meet this definition include solid or semi-solid (less than 70% open) structural members, such as purlins, girders, concrete tees, I-beams, etc., that have a vertical depth greater than 4 in. (100 mm) and the horizontal distance between structural members is less than or equal to the minimum allowable linear spacing for the sprinkler being installed.

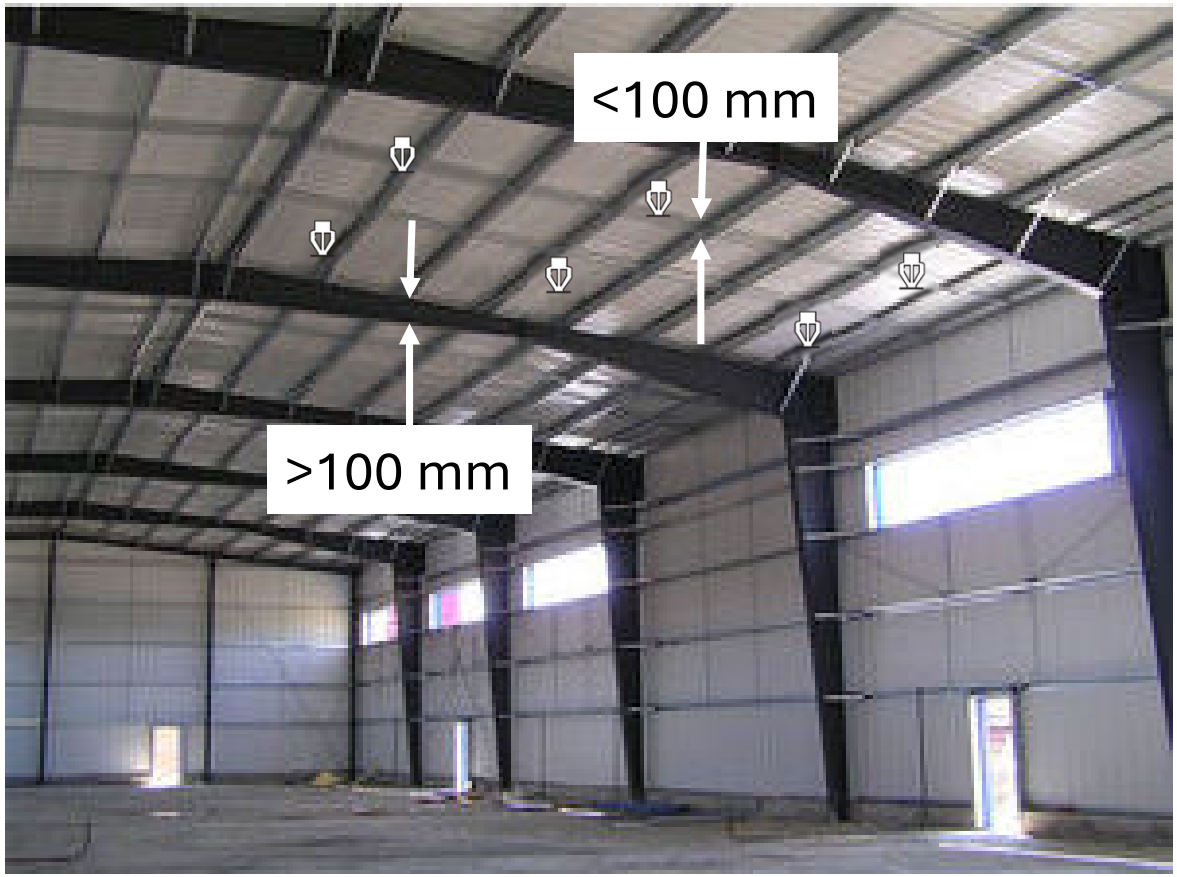
Ceiling channel: A portion of the ceiling that is bounded by solid or semi-solid (less than 70% open) structural members, such as purlins, girders, concrete tees, I-beams, etc., having a vertical depth greater than 4 in. (100 mm). The boundaries of the ceiling channel are defined by the structural members that are attached to the underside of the ceiling leaving a maximum vertical gap of 4 in. (100 mm) between the underside of the ceiling and the topside of the structural member.

Ceiling Construction

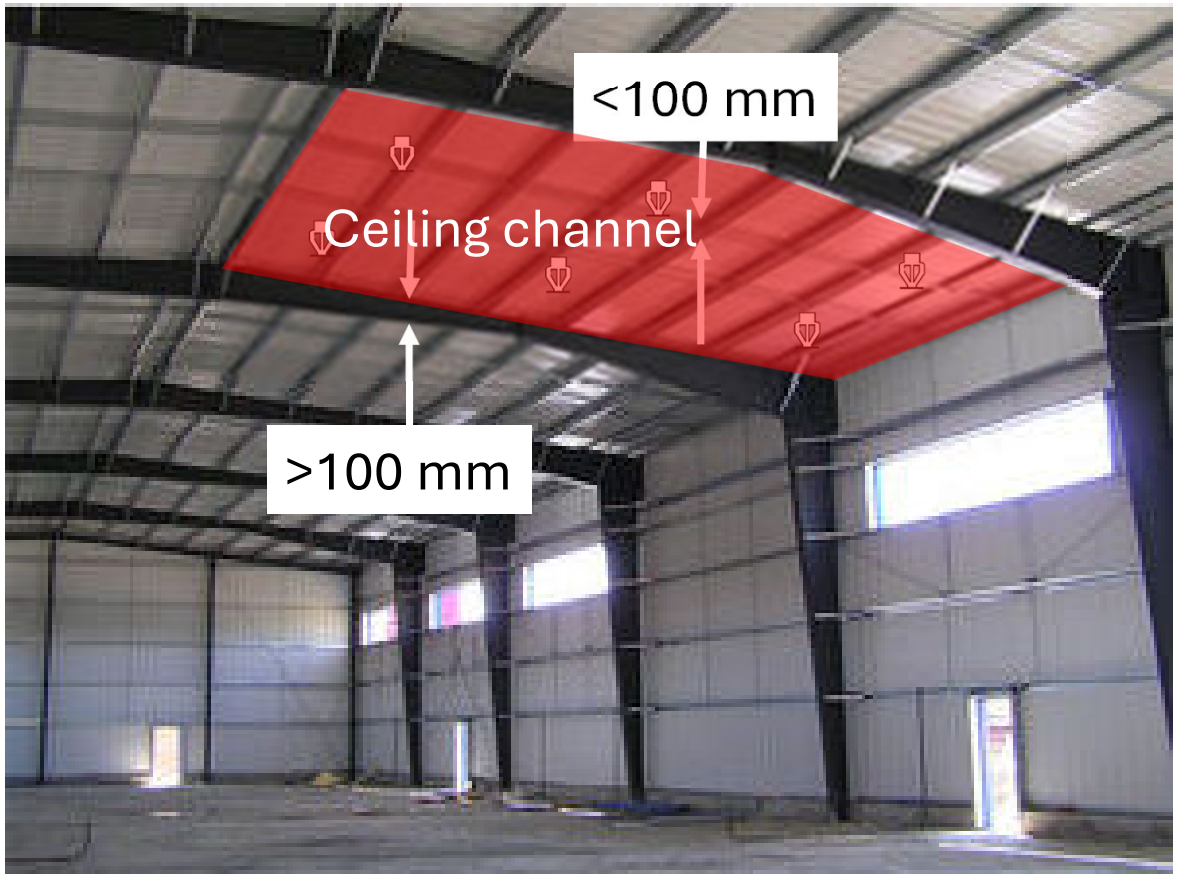
>70% open unobstructed construction

(But do need to look at the top and bottom web of the beam in terms of obstructions to sprinkler discharge)

Ceiling Construction



Ceiling Construction



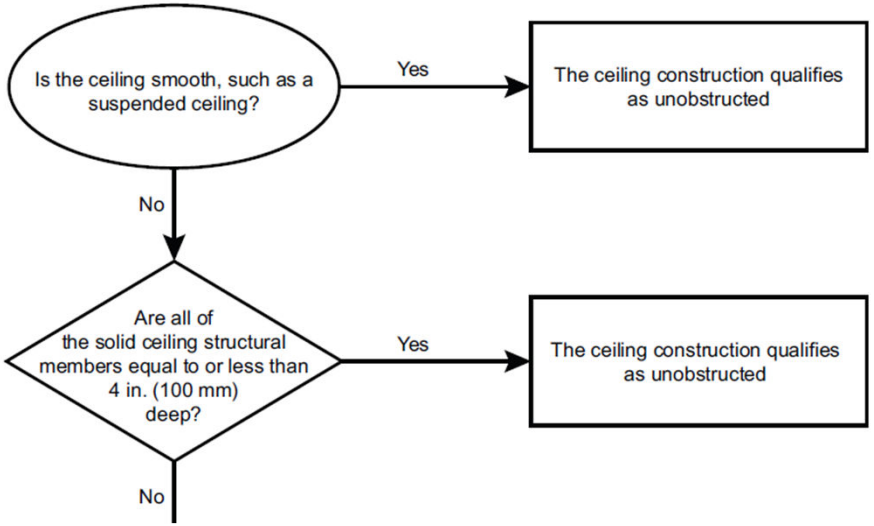
Unobstructed Construction

Ceiling Construction

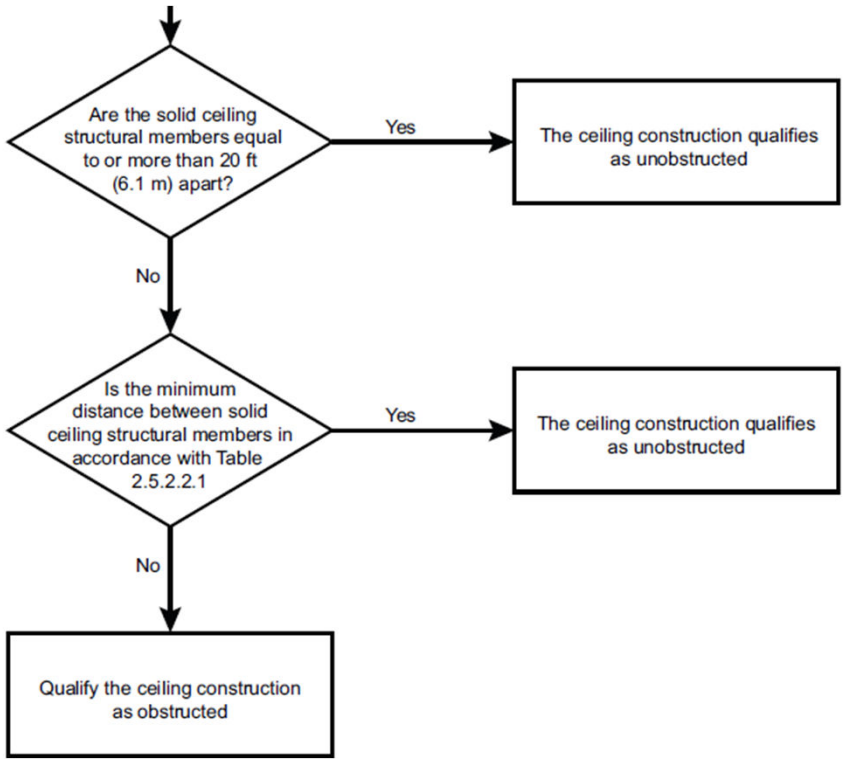
Ceiling Construction

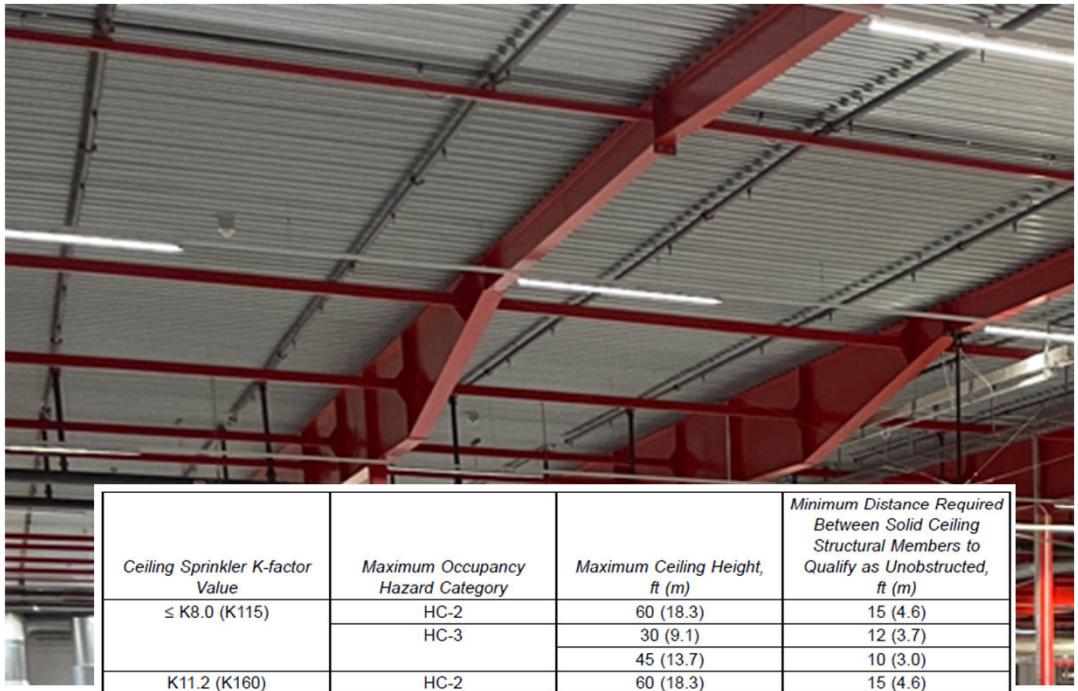
Obstructed Construction

Ceiling Construction



Ceiling Construction

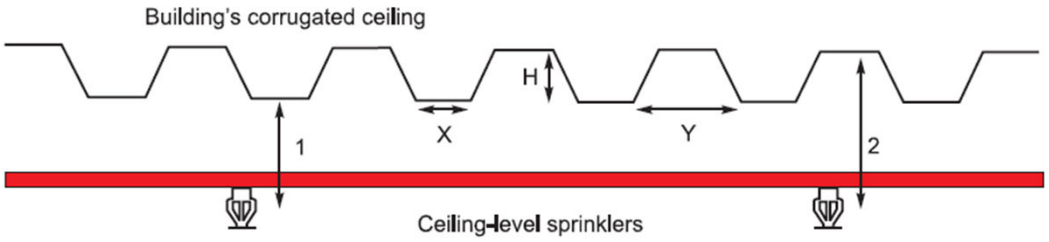




Ceiling Sprinkler K-factor Value	*Maximum Occupancy Hazard Category*	*Maximum Ceiling Height, ft (m)*	*Minimum Distance Required Between Solid Ceiling Structural Members to Qualify as Unobstructed, ft (m)*
≤ K8.0 (K115)	HC-2	60 (18.3)	15 (4.6)
	HC-3	30 (9.1)	12 (3.7)
		45 (13.7)	10 (3.0)
K11.2 (K160)	HC-2	60 (18.3)	15 (4.6)
	HC-3	30 (9.1)	12 (3.7)
		60 (18.3)	10 (3.0)
≥ K14 (K200)	HC-2	60 (18.3)	15 (4.6)
	HC-2	> 60 (18.3)	12 (3.7)
	HC-3	30 (9.1)	12 (3.7)
	HC-3	> 30 (9.1)	10 (3.0)
K11.2EC (K160EC) Upright	HC-1	30 (9.1)	20 (6.1)
	HC-2	60 (18.3)	16 (4.9)
	HC-3	45 (13.7)	16 (4.9)
K14.0EC (K200EC) Upright	HC-2	60 (18.3)	20 (6.1)
	HC-3	30 (9.1)	20 (6.1)
		45 (13.7)	16 (4.9)
K25.2EC (K360EC)	HC-3	Any	14 (4.3)

Ceiling Construction

- Unobstructed construction, install on vertical spacing per the diagrams in the Data Sheet

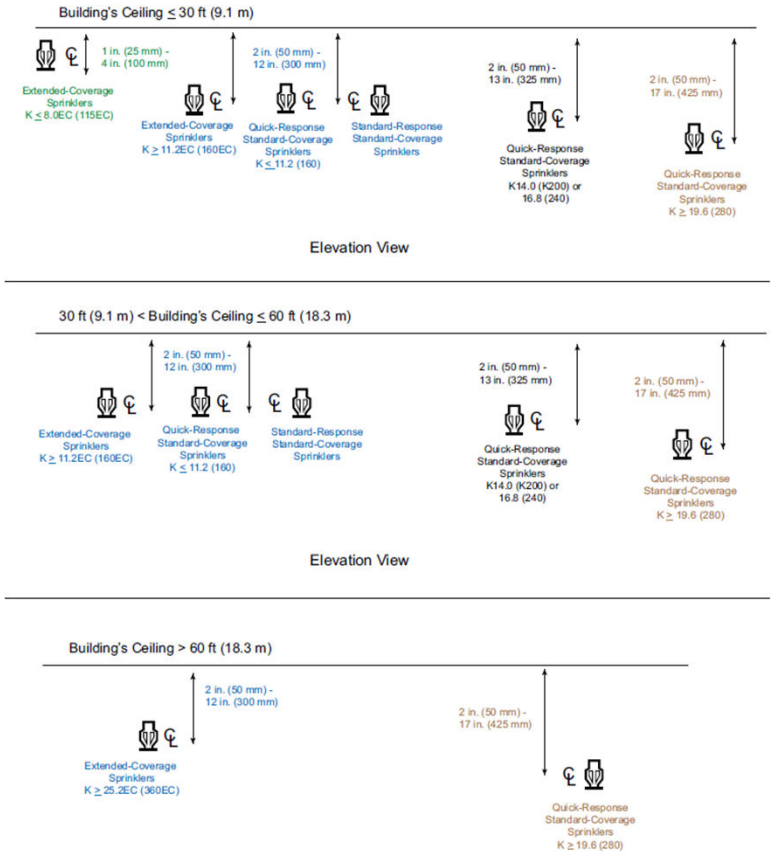


Vertical distance measured per "1" when:

- X ≥ 3 in. (75 mm), and
- Y ≤ 3 in. (75 mm), and
- H ≤ (0.5)(X)

Vertical distance measured per "2" when guidelines for "1" not met

Typically measure from the top of the deck



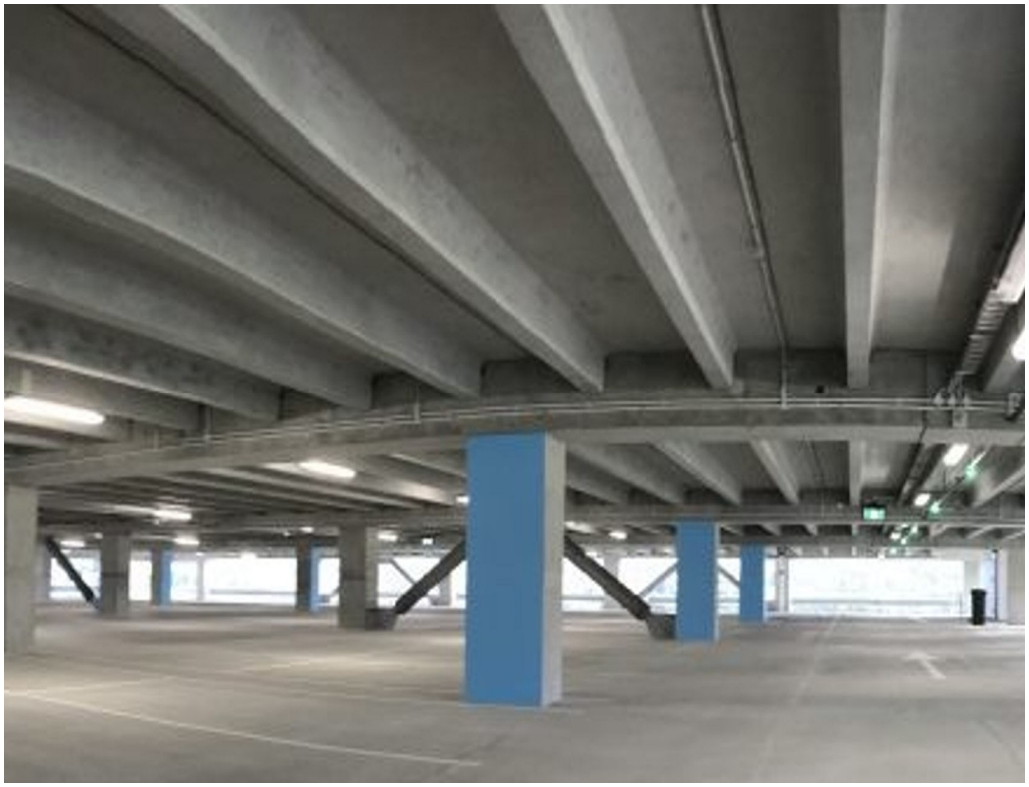
Ceiling Construction

- Unobstructed construction, install on horizontal spacing per the tables in the Data Sheet depending on hazard category

Table 2.5.2.3.1.1(b). Spacing of Ceiling-Level Nonstorage Pendent and Upright Sprinklers for Hazard Category No. 2 Under Unobstructed Ceiling Construction

Ceiling Height, ft (m)	K-Factor	Orientation	RTI Response	Ceiling Construction Type	Maximum Ceiling Slope	Linear Spacing, ft (m)		Area Spacing, ft² (m²)	
						Min.	Max.	Min.	Max.
Up to 30 (9.1)	≥ 5.6 (80)	Pendent or Upright	Quick or Standard	Unobstructed	4 in 12 (18.5°)	7 (2.1)	15 (4.6)	64 (6.0)	130 (12.1)
	11.2EC (160EC)	Pendent	Quick	Smooth, Flat	2 in 12 (10°)	10 (3.0)	16 (4.9)	100 (9.3)	256 (23.8)
	14.0EC (200EC)	Pendent	Quick	Smooth, Flat	2 in 12 (10°)	10 (3.0)	20 (6.1)	100 (9.3)	400 (37.2)
	11.2EC (160EC)	Upright	Quick	Unobstructed	2 in 12 (10°)	10 (3.0)	16 (4.9)	100 (9.3)	256 (23.8)
	14.0EC (200EC)	Upright	Quick	Unobstructed	2 in 12 (10°)	10 (3.0)	20 (6.1)	100 (9.3)	400 (37.2)
	25.2EC (360EC)	Pendent or Upright	Quick	Unobstructed	4 in 12 (18.5°)	10 (3.0)	14 (4.3)	100 (9.3)	196 (18.2)
Over 30 (9.1) and up to 60 (18.3)	≥ 5.6 (80)	Pendent or Upright	Quick or Standard	Unobstructed	4 in 12 (18.5°)	7 (2.1)	15 (4.6)	64 (6.0)	130 (12.1)
	11.2EC (160EC)	Upright	Quick	Unobstructed	2 in 12 (10°)	10 (3.0)	16 (4.9)	100 (9.3)	256 (23.8)
	14.0EC (200EC)	Upright	Quick	Unobstructed	2 in 12 (10°)	10 (3.0)	20 (6.1)	100 (9.3)	400 (37.2)
	25.2EC (360EC)	Pendent or Upright	Quick	Unobstructed	4 in 12 (18.5°)	10 (3.0)	14 (4.3)	100 (9.3)	196 (18.2)
Over 60 (18.3)	≥ 14.0 (200)	Pendent or Upright	Quick	Unobstructed	4 in 12 (18.5°)	8 (2.4)	10 (3.0)	64 (6.0)	100 (9.3)
	25.2EC (360EC)	Pendent or Upright	Quick	Unobstructed	4 in 12 (18.5°)	10 (3.0)	14 (4.3)	100 (9.3)	196 (18.2)

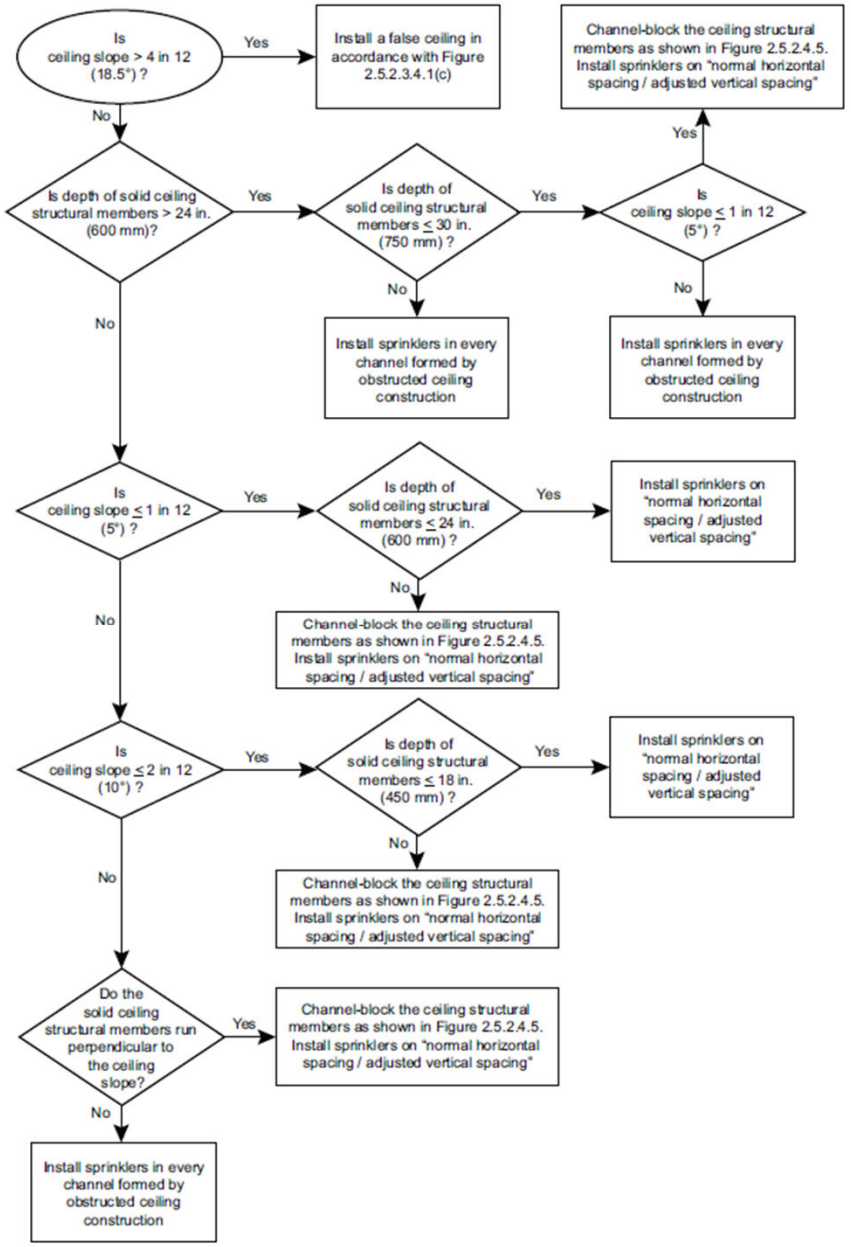
Ceiling Construction



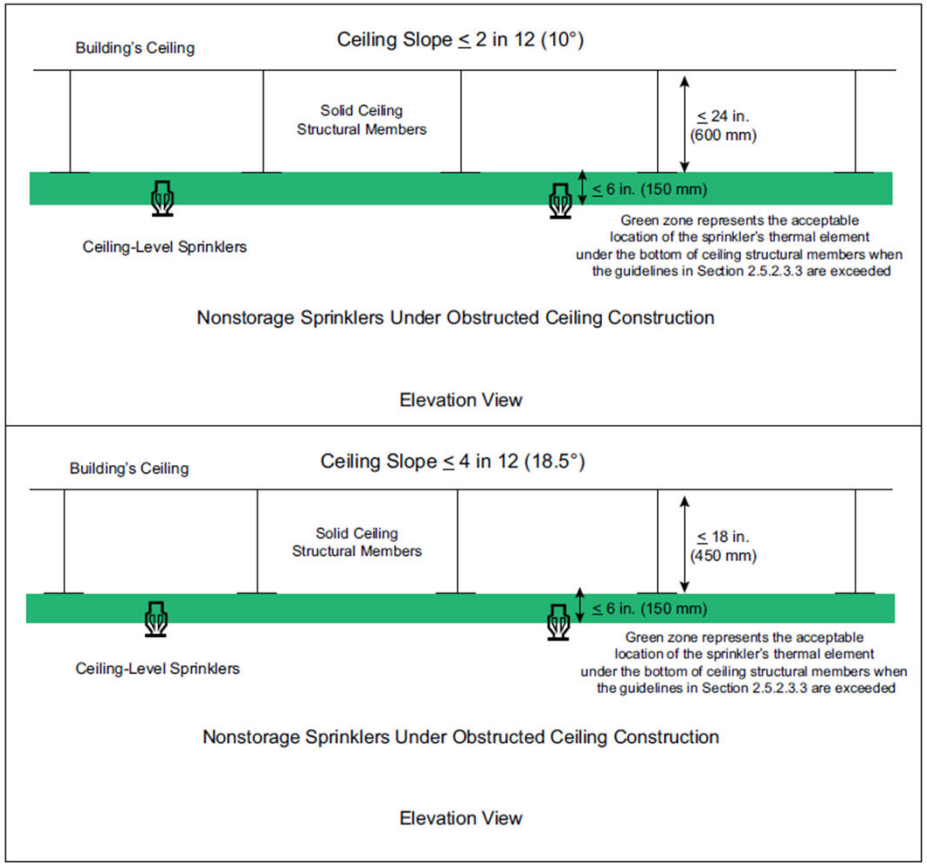
Obstructed construction

Obstructed Construction

- Options include:
  - Install sprinklers in every channel
  - Normal horizontal spacing / adjusted vertical spacing
  - Normal horizontal spacing / adjusted vertical spacing with channel blocking



Obstructed Construction



Adjusted vertical spacing

Must look at the flow chart with this diagram (channel-blocking or not)

CEILING SPRINKLER INSTALLATIONS

Heat and Smoke Vents

- Research report from 2023
- No benefit to property loss prevention in unsprinklered properties

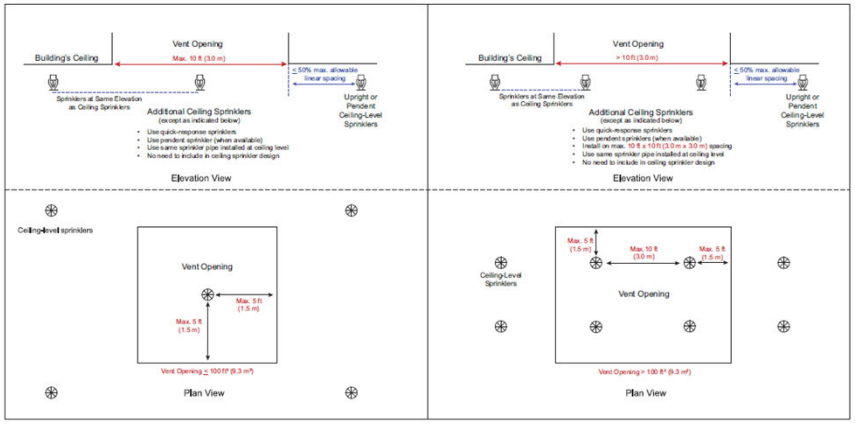
CEILING SPRINKLER INSTALLATIONS

Heat and Smoke Vents

- Research report from 2023
- No benefit to property loss prevention in unsprinklered properties
- Limited effect of smoke vents on sprinklers if *adequate* protection is provided
- Adverse effects of smoke vents if protection is marginal

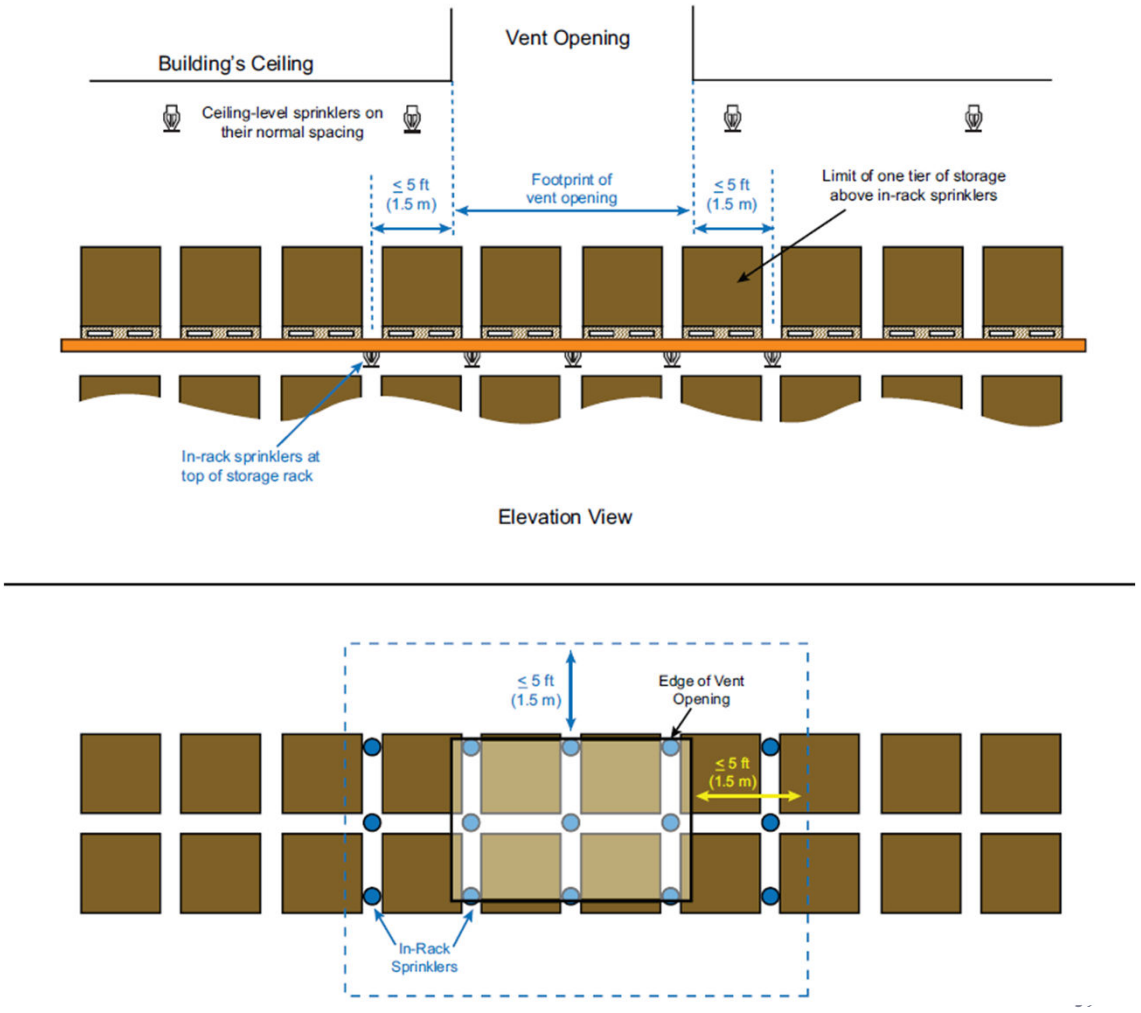
Heat and Smoke Vents

- Flow charts in the Data Sheet
- Manually operated only?
- Can it be left open in warm weather?
- Vent area?
- Distance to other smoke vents?
- Wet-pipe sprinkler system?
- Various options can include it being acceptable, installing thermal link of 180°C, installing sprinklers below, or 10-minute delay (for nonstorage occupancies)



Heat and Smoke Vents

- Similar methodology and options for storage occupancies, but options include 20-minute delay or in-rack sprinklers



Ceiling Pockets and Skylights

Ceiling pocket: An architectural ceiling feature that consists of a bounded area of ceiling located at a higher elevation than the attached lower ceiling.

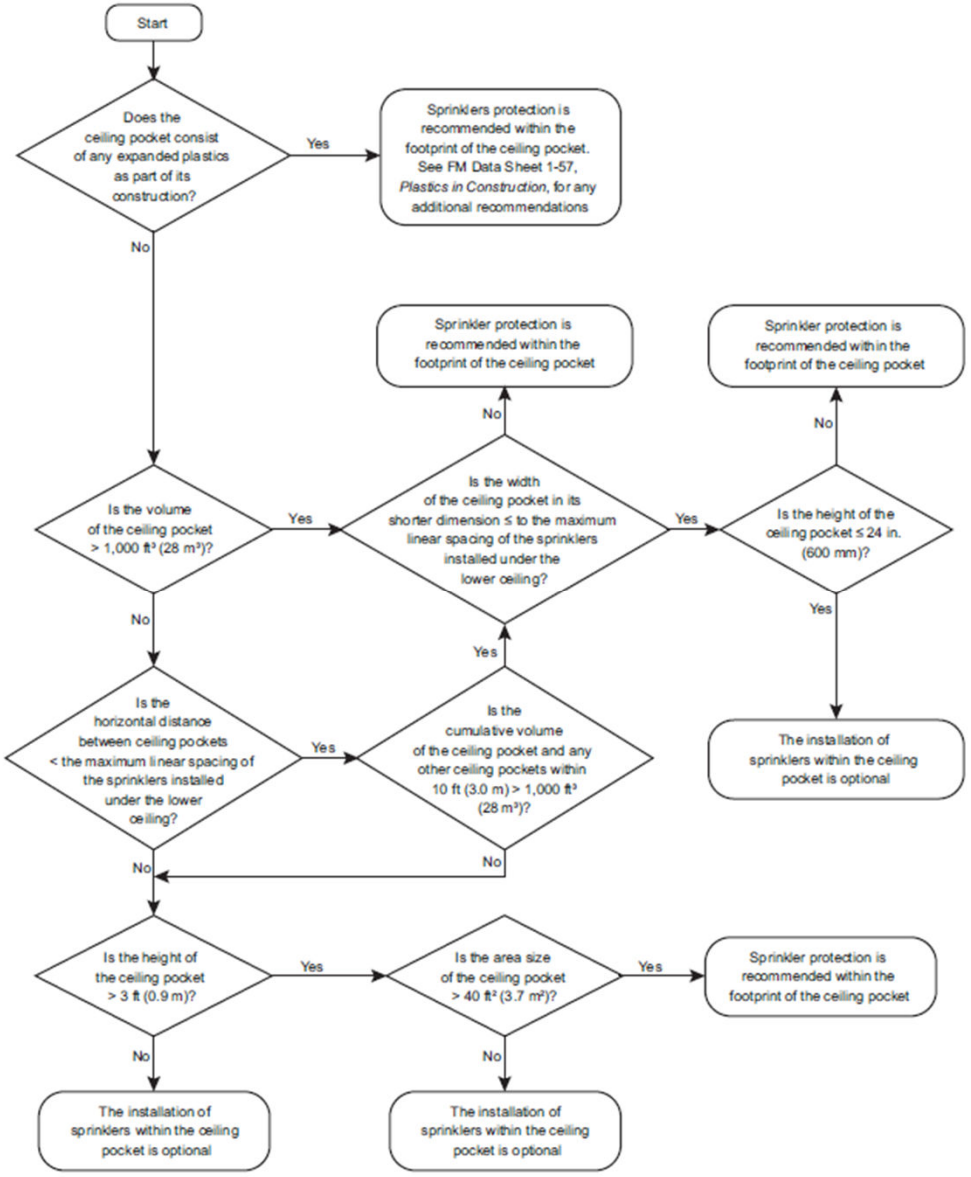
Ceiling Pockets and Skylights

- In 2021, new table for ceiling pockets (similar guidance to NFPA)

Table 2.5.1.9. Determining if Sprinkler Protection is Needed in Ceiling Pockets

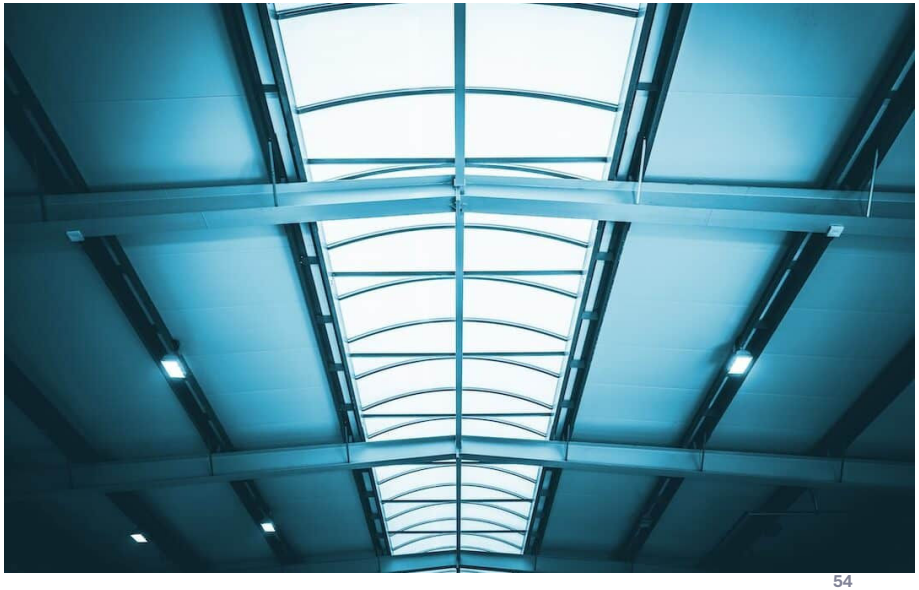
Ceiling Pocket Construction Type	*Depth of Ceiling Pocket, ft (m)*	*Area of Ceiling Pocket ft², (m²)*	*Volume of Ceiling Pocket, ft³ (m³)*	*Horizontal Distance Between Ceiling Pockets, ft (m)*	*Total Volume of Ceiling Pockets within 10 ft (3.0 m)*	*Lower Ceiling Sprinkler RTI Rating*	*Sprinklers Needed in Ceiling Pocket?*
Limited Combustibility or Noncombustible	≤ 3 (0.9)	DNA	≤ 1000 (28)	≥ 10 (3.0)	DNA	Quick-Response	No
				< 10 (3.0)	≤ 1000 (28)		
	> 3 (0.9)	≤ 32 (3.0)	≤ 1000 (28)	≥ 10 (3.0)	DNA		
				< 10 (3.0)	≤ 1000 (28)		
	> 3 (0.9)	> 32 (3.0)	Any	Any	Any	Any	Yes
	Any	Any	> 1000 (28)	Any	Any	Any	
	Any	Any	Any	Any	> 1000 (28)	Any	
	Any	Any	Any	Any	Any	Standard-Response	
Combustible	≤ 3 (0.9)	≤ 32 (3.0)	≤ 1000 (28)	≥ 10 (3.0)	DNA	Quick-Response	No
				< 10 (3.0)	≤ 1000 (28)		
	> 3 (0.9)	Any	Any	Any	Any	Any	Yes
	Any	> 32 (3.0)	Any	Any	Any	Any	Yes
	Any	Any	> 1000 (28)	Any	Any	Any	Yes
	Any	Any	Any	Any	> 1000 (28)	Any	Yes
	Any	Any	Any	Any	Any	Standard-Response	Yes

- April 2025, flow diagrams replace the table.



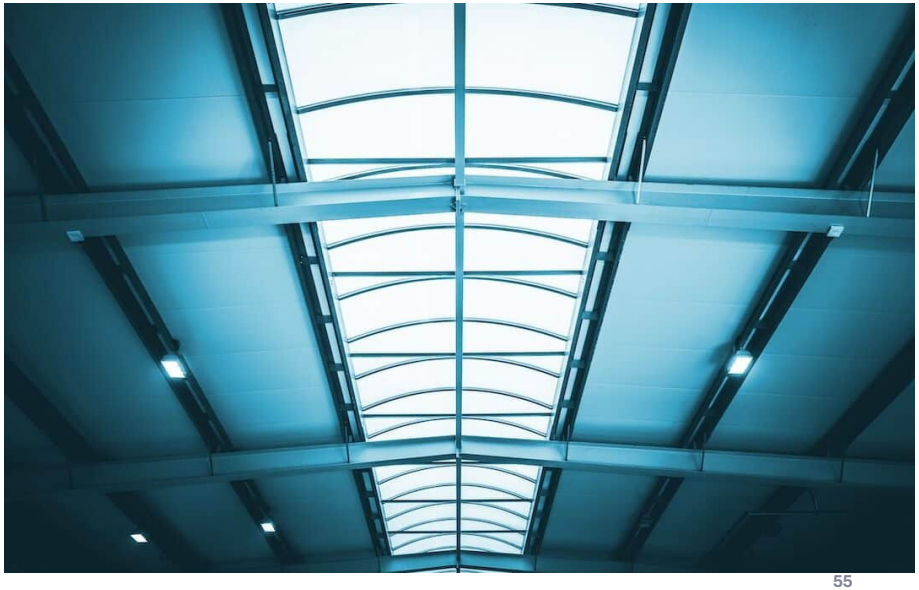
Ceiling Pockets and Skylights

- Confusion between DS 1-57, *Plastics in Construction,* and DS 2-0 on skylights
- DS 1-57 is focused on fire spread involving plastic materials, not where protection for a fire in the occupancy could be influenced by a skylight (melting a hole, collecting heat etc.)
- Skylight guidance in older versions of DS 2-0 could lead to excessive amounts of sprinklers in long-wide skylights



Ceiling Pockets and Skylights

- FM research on smoke vents and plastic skylights showed presence of plastic skylights not to be a major concern for sprinkler protection of the occupancy
- But skylights can also be a “ceiling pocket”
- January 2024, wording that “no additional recommendations are needed” due to the presence of plastic skylights could lead to missed ceiling pockets



Ceiling Pockets and Skylights

- If the skylight has a smoke vent in it, follow guidance for smoke vents
- If skylight is raised, follow guidance for ceiling pockets (flow chart diagrams)

Ceiling Pockets and Skylights

- If sprinklers are needed within the ceiling pocket:
  - Treat the top of the ceiling pocket or skylight as the ceiling
  - Install sprinklers on normal vertical spacing from the ‘ceiling’
  - Install sprinklers on normal horizontal and vertical spacing
- Alternative is to install sprinklers on the same level as the main ceiling/roof and on 1.2 m x 1.2 m spacing

Ceiling Airflow Velocities

- Large ceiling fans, not common but do exist in Europe
- Horizontal HVAC fans are common, especially in cold storage

Ceiling Airflow Velocities

- Ignore if < 1.5 m/s
- If > 1.5 m/s, options per the diagrams include:
  - Interlock to shutdown with sprinkler activation (not an option for horizontal airflow in storage occupancies)
  - Interlock fans to FM Approved flame detection
  - Design as a dry-pipe system or increase sprinkler design area by 30%
  - Additional sprinklers under a false ceiling where airflows exceed 1.5 m/s
  - Interlock fans to linear heat detection cable at the top of rack storage

Ceiling Airflow Velocities

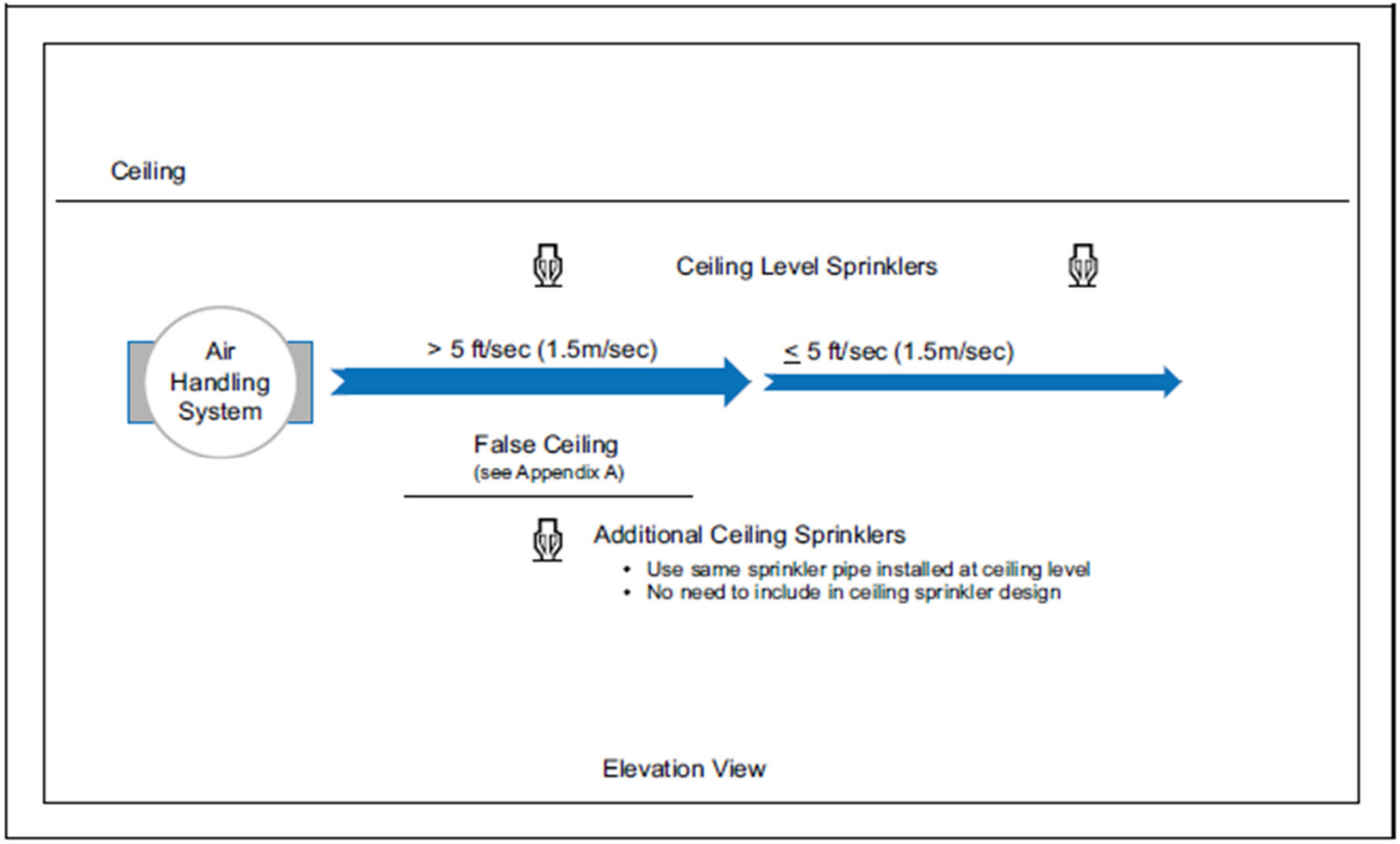
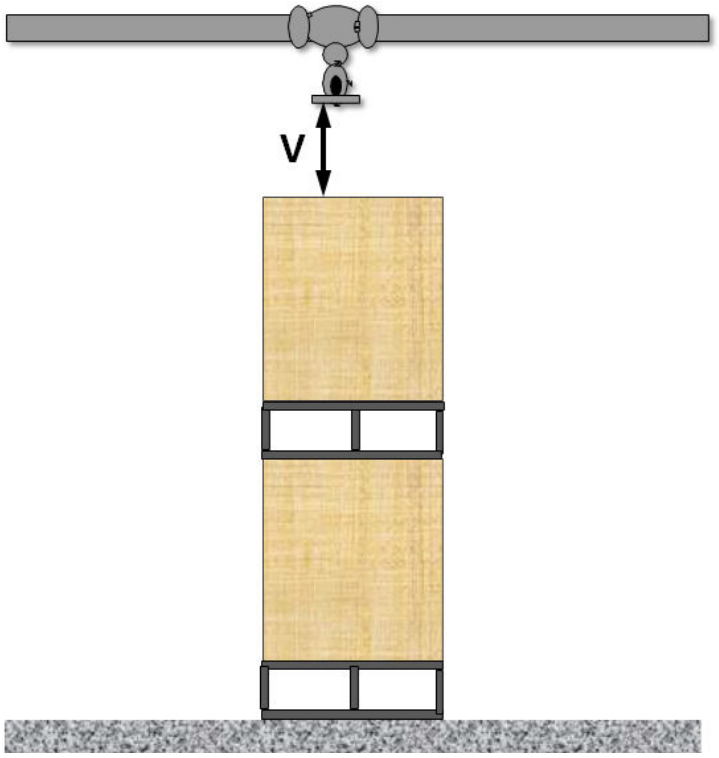


Fig. 2.5.4.1.9.1(b). Acceptable arrangement of additional ceiling-level sprinklers in areas where airflow velocities exceed 5 ft/sec (1.5 m/sec)

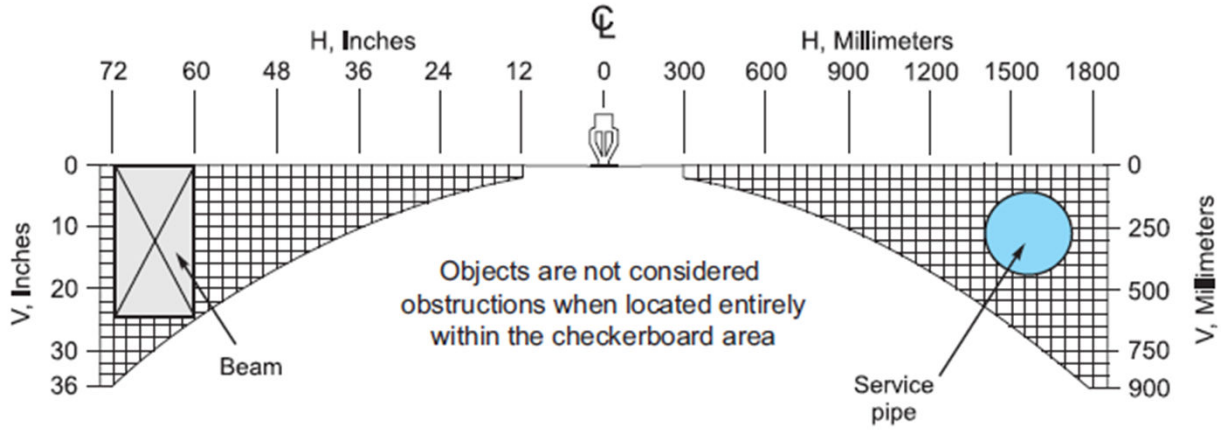
Obstructions to Sprinkler Discharge

- Vertical distance from sprinkler deflector to combustible materials (V)
  - Standard coverage sprinklers: 0.9 m
  - Extended coverage sprinklers: 1.5 m



Obstructions to Sprinkler Discharge

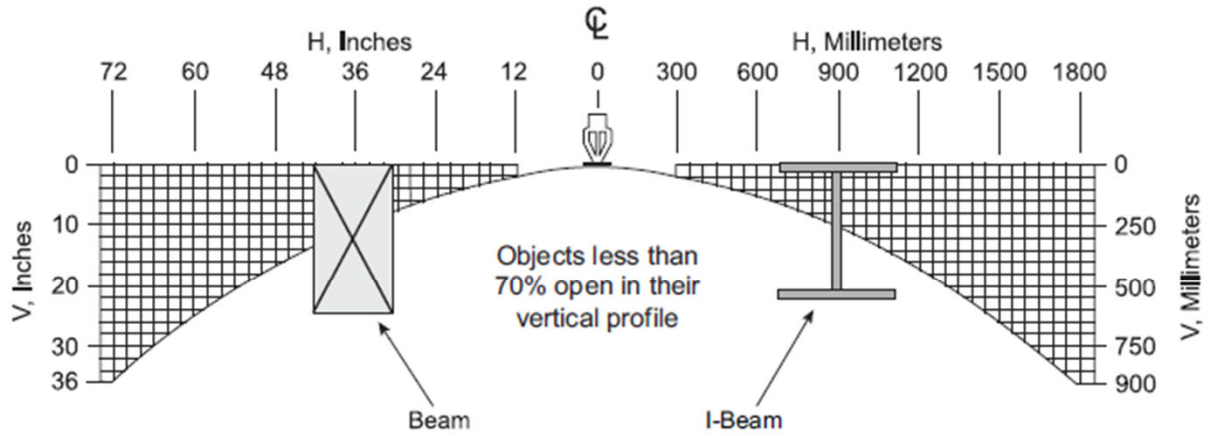
- Anything within the checkerboard area is not an obstruction



Non-Storage Occupancy

Obstructions to Sprinkler Discharge

- Solid (<70% open) structural members / objects that extend down from the ceiling are an obstruction

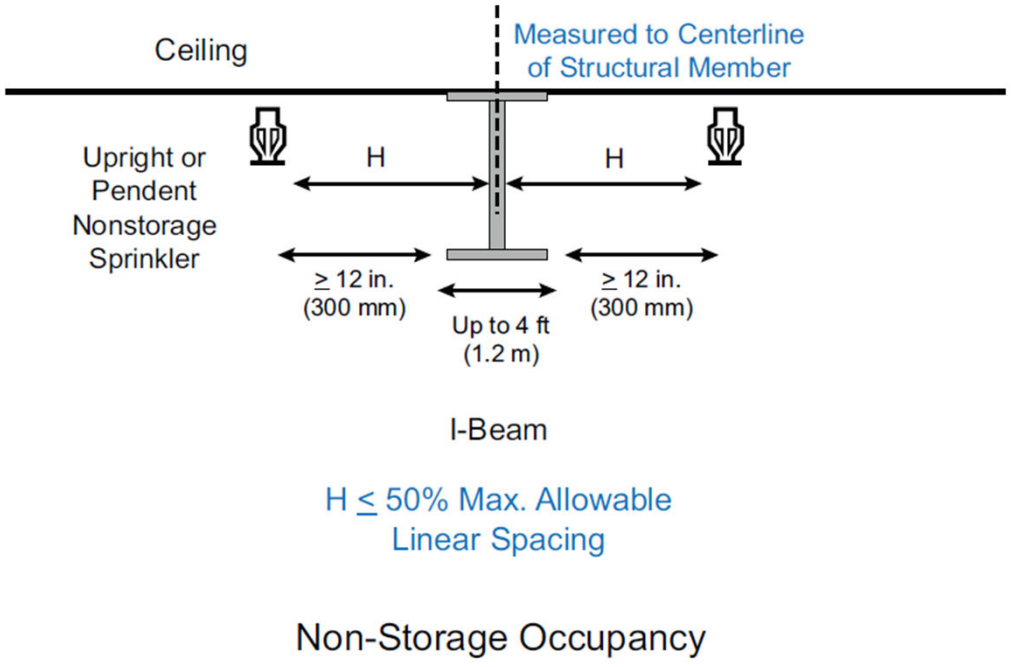


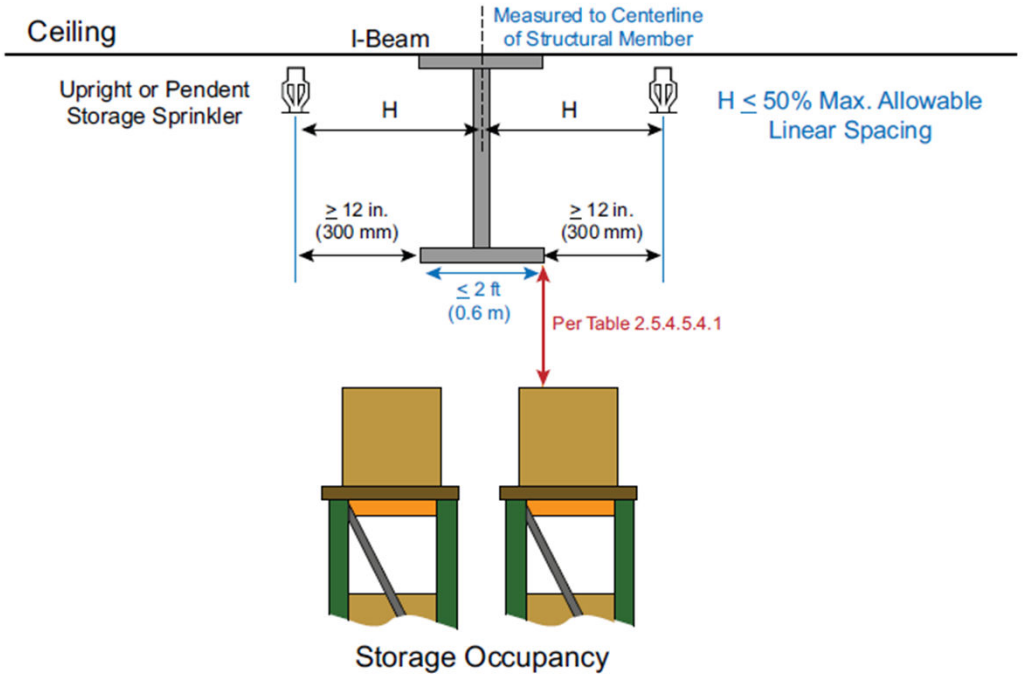
Standard-Coverage Sprinklers

Non-Storage Occupancy

Obstructions to Sprinkler Discharge

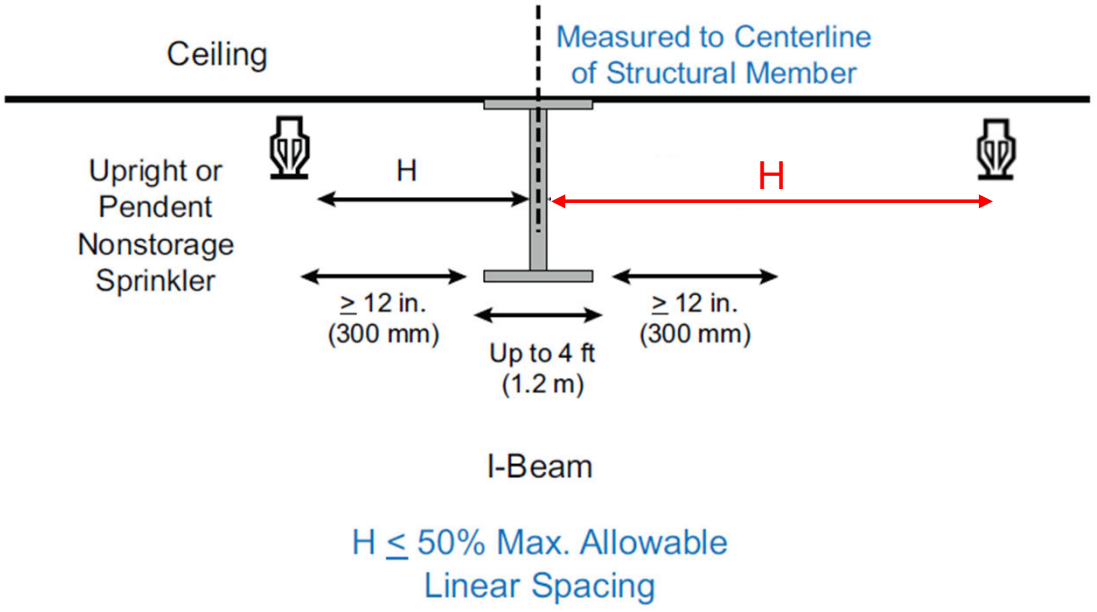
- Solid (<70% open) structural members / objects that extend down from the ceiling are an obstruction





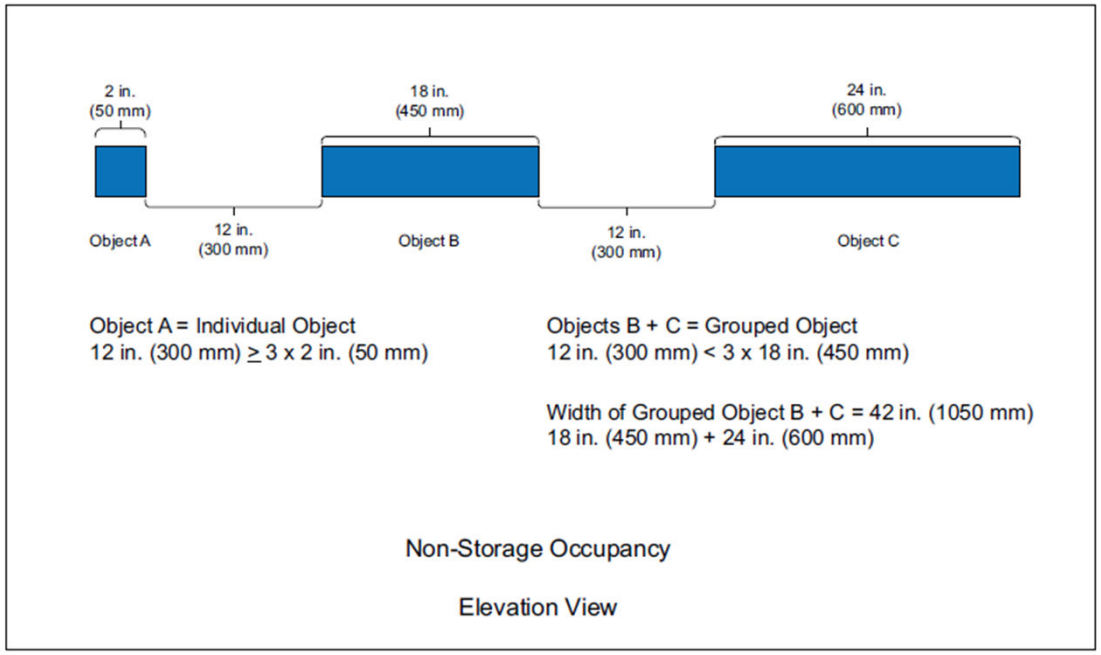
Obstructions to Sprinkler Discharge

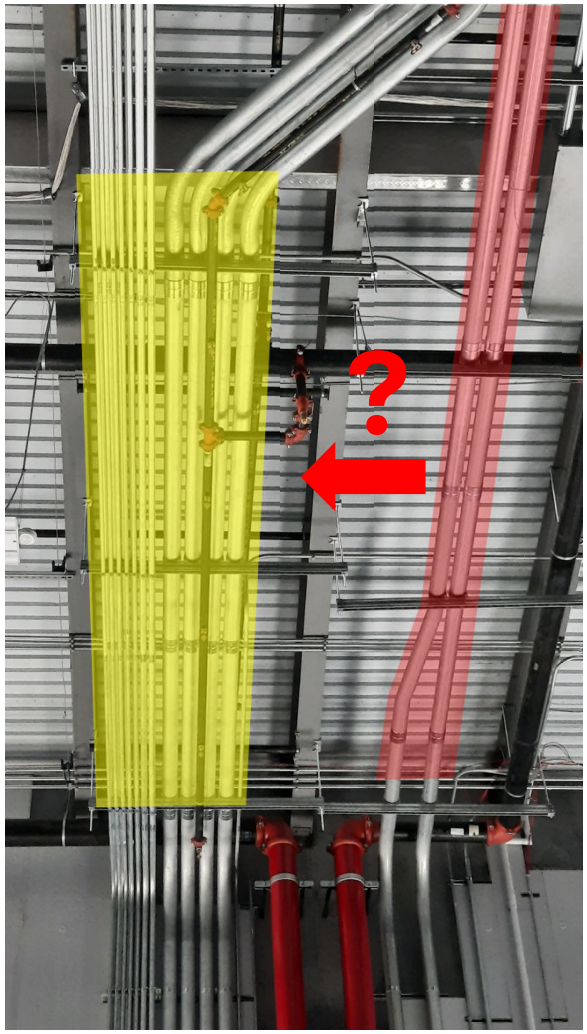
- “H” does not need to be the same on both sides



Obstructions to Sprinkler Discharge

- Obstructions below sprinklers
- Consider the object individually or a group?





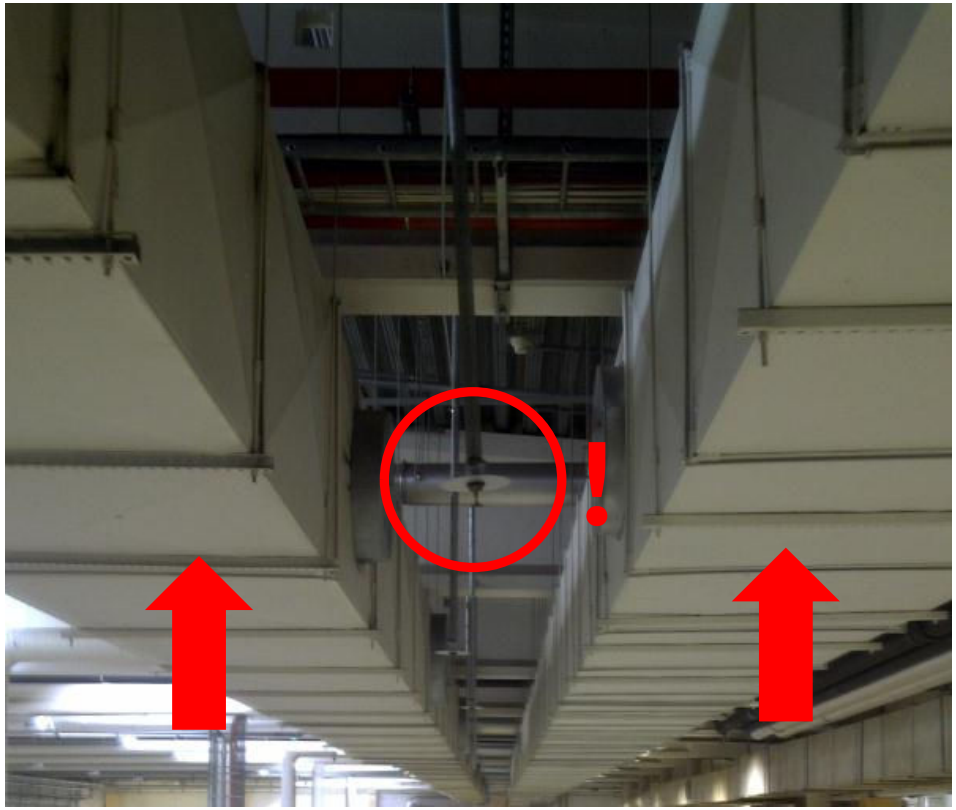
Obstructions to Sprinkler Discharge

- Nonstorage occupancies:
- Objects up to 1.2 m wide, measured in the objects *least dimension*, not considered an obstruction

Obstructions to Sprinkler Discharge

- Nonstorage occupancies:
- Objects up to 1.2 m wide, measured in the objects *least dimension*, not considered an obstruction
- Objects wider than 1.2 m:
  - Install supplemental sprinklers below the object (as close underneath as possible)
  - Within the footprint of the obstruction
  - Normal linear (horizontal) spacing
  - Use same sprinklers and pipe work as the ceiling then no need to hydraulically balance with the ceiling system, or
  - Calculate hydraulically and include four supplemental sprinklers in the ceiling hydraulic design

Obstructions to Sprinkler Discharge



Obstructions to Sprinkler Discharge

- Storage occupancies:
- Similar analysis of individual or grouped objects

Obstructions to Sprinkler Discharge

- Research fire testing
- Rack storage of CUP commodity
- 9 m storage height, 12 m ceiling height
- K240 QR pendent sprinklers, 325 mm below ceiling
- Design 3.6 bar

- Baseline test, 1 sprinkler operation

Obstructions to Sprinkler Discharge

Test No.	Width of object in least dimension, in. (mm)	Horizontal offset from sprinkler, in. (mm)	Vertical offset from sprinkler, in. (mm)	Number of operating sprinklers during test
1	5 (125)	3 (75)	16 (400)	12
2	1-1/2 (38)	0 (0)	8 (200)	23
3	1-1/2 (38)	0 (0)	12 (300)	1
4	12 (300)	6 (150)	20 (500)	10
5	6 (150)	6 (150)	20 (500)	1
6	24 (600)	12 (300)	22 (550)	1

Obstructions to Sprinkler Discharge

Test No.	Width of object in least dimension, in. (mm)	Horizontal offset from sprinkler, in. (mm)	Vertical offset from sprinkler, in. (mm)	Number of operating sprinklers during test
1	5 (125)	3 (75)	16 (400)	12
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3	1-1/2 (38)	0 (0)	12 (300)	1
4	12 (300)	6 (150)	20 (500)	10
5	6 (150)	6 (150)	20 (500)	1
6	24 (600)	12 (300)	22 (550)	1

Obstructions to Sprinkler Discharge

Test No.	Width of object in least dimension, in. (mm)	Horizontal offset from sprinkler, in. (mm)	Vertical offset from sprinkler, in. (mm)	Number of operating sprinklers during test
1	5 (125)	3 (75)	16 (400)	12
2	**1-1/2 (38)**	**0 (0)**	**8 (200)**	**23**
3	**1-1/2 (38)**	**0 (0)**	**12 (300)**	**1**
4	12 (300)	6 (150)	20 (500)	10
5	6 (150)	6 (150)	20 (500)	1
6	24 (600)	12 (300)	22 (550)	1

Obstructions to Sprinkler Discharge

Test No.	Width of object in least dimension, in. (mm)	Horizontal offset from sprinkler, in. (mm)	Vertical offset from sprinkler, in. (mm)	Number of operating sprinklers during test
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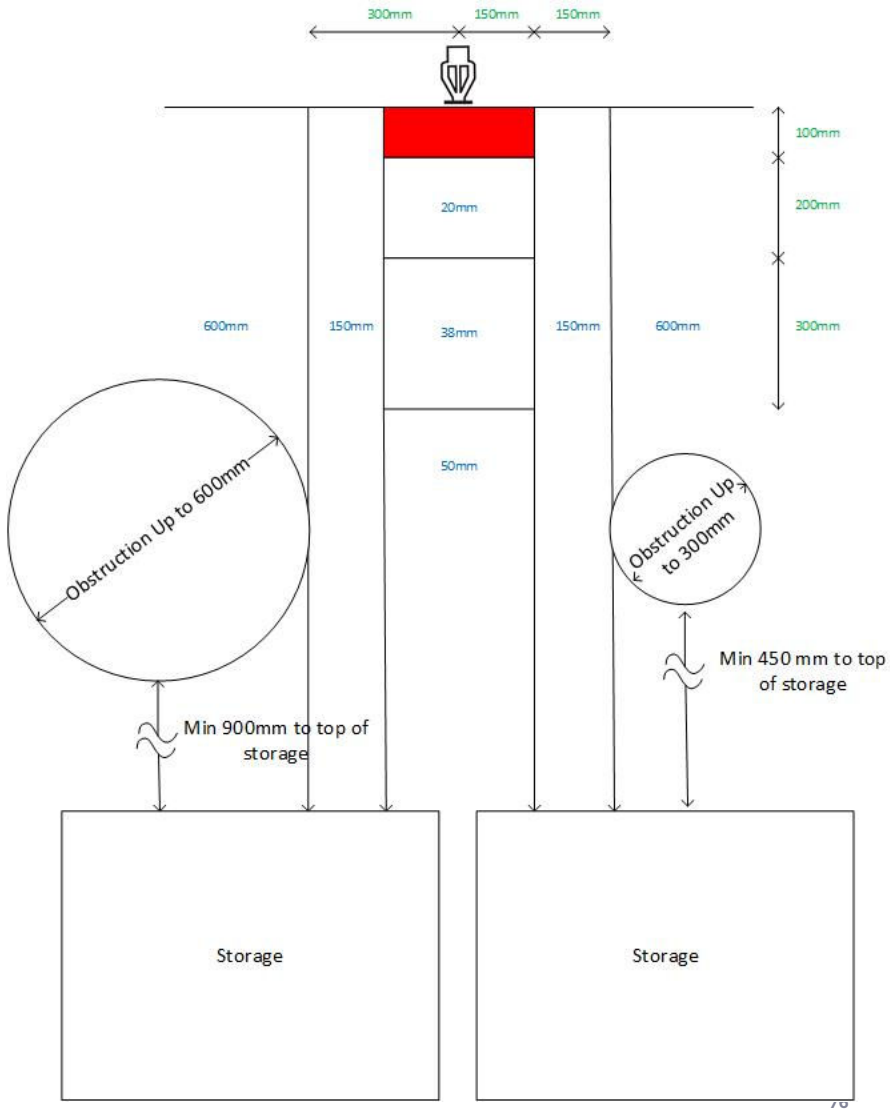
3	1-1/2 (38)	0 (0)	12 (300)	1
4	**12 (300)**	**6 (150)**	**20 (500)**	**10**
5	6 (150)	6 (150)	20 (500)	1
6	**24 (600)**	**12 (300)**	**22 (550)**	**1**

Obstructions to Sprinkler Discharge

- Maximum width (in blue) of obstruction allowed in the area below a storage sprinkler
- Object “width” is the lesser of width or length when viewed from above
- If obstructions are too large or too close to the top of storage, install sprinklers below them



Summary

- System types
  - Wet-pipe, dry-pipe, refrigerated, preaction, deluge, vacuum, antifreeze
- Sprinkler piping and hangers
- Ceiling slope
- Ceiling construction
- Heat and smoke vents
- Ceiling pockets and skylights
- Ceiling airflow velocities
- Obstructions to sprinkler discharge

Sprinklers and Earthquake

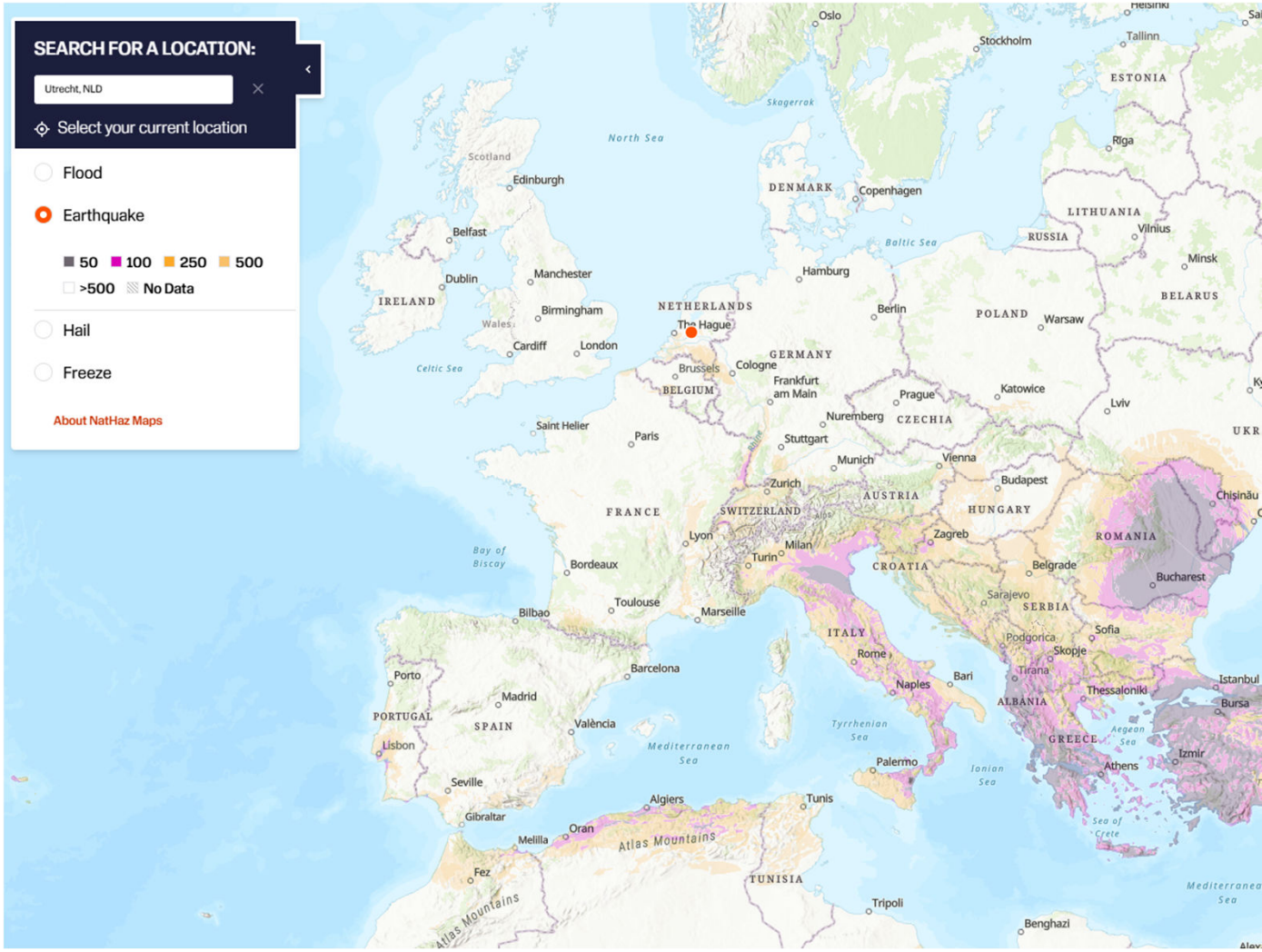
27 & 28 May 2026

EARTHQUAKE

Earthquake map

- Classification of the earthquake zones in 50 to >500 years
- Considers condition of the subsoil
- Considers vulnerability of structures to earthquake damage

FM earthquake map is the only public map that takes these factors into account.



EARTHQUAKE

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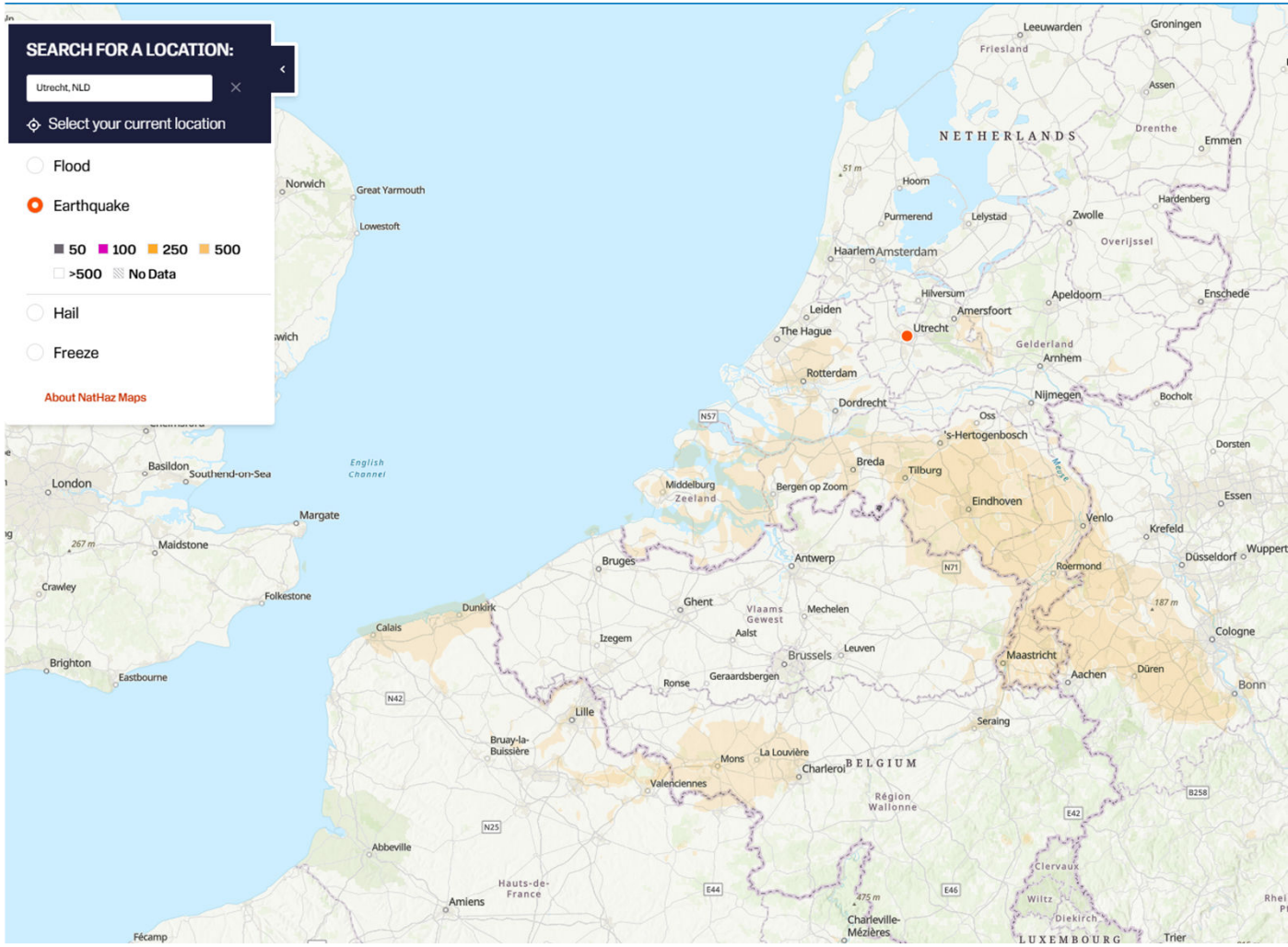
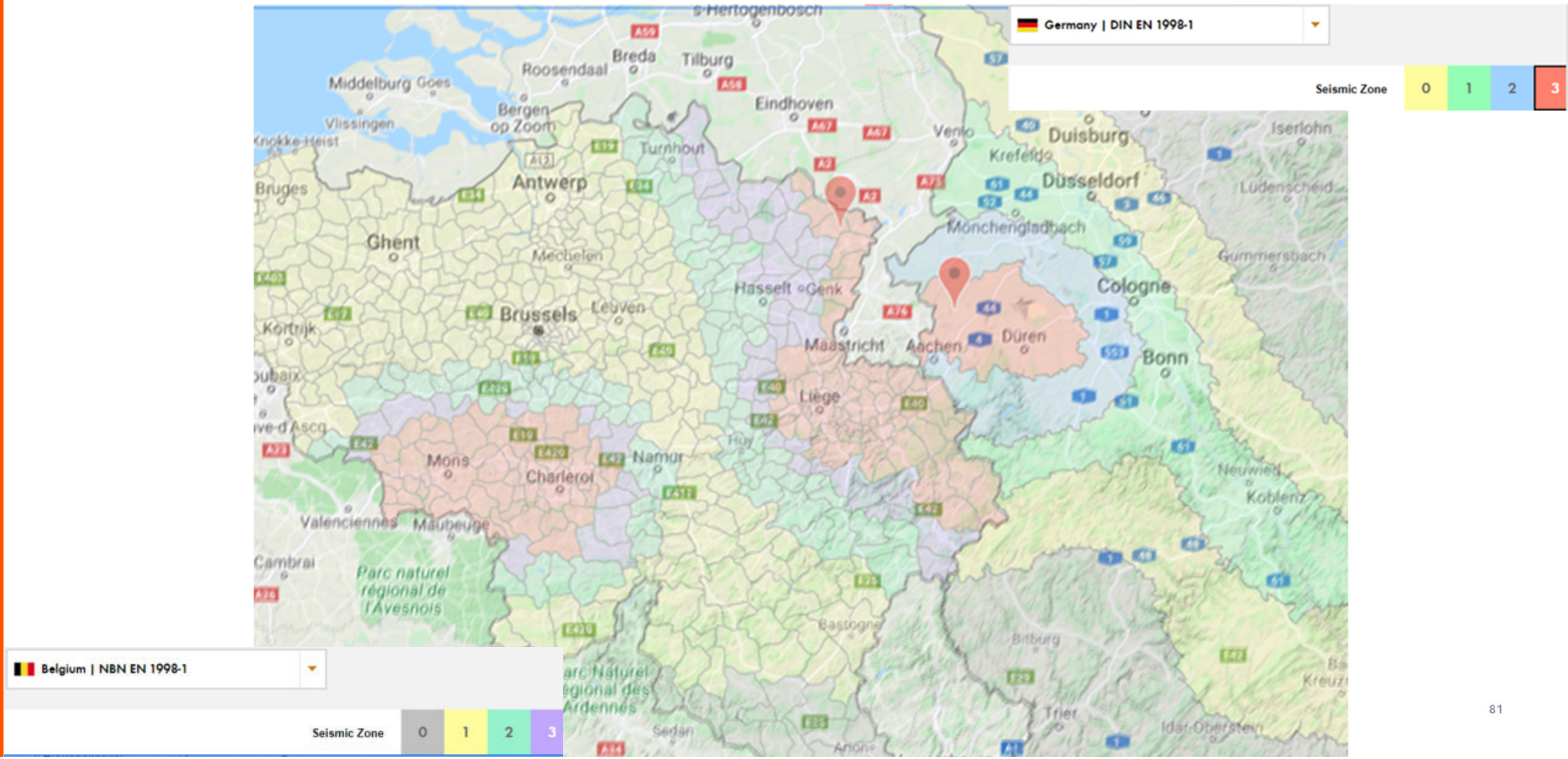


EARTHQUAKE

The Netherlands have no building code for earthquake

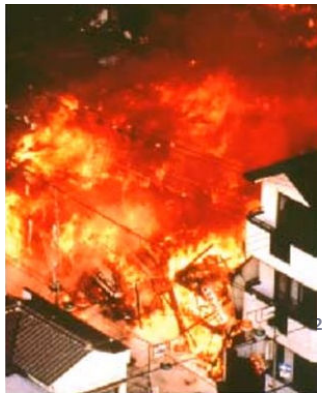


EARTHQUAKE

Engineering earthquake hazards

MAIN HAZARDS

1. **Direct Earthquake damage**:
   - Building and structures
   - Support systems
2. **Indirect Earthquake damage**
   - Toppling electrical cabinets
   - Toppling storage racking
3. **Fire following earthquake**
   - Protection systems impairments
   - Gas or Ignitable liquid piping broken



EARTHQUAKE

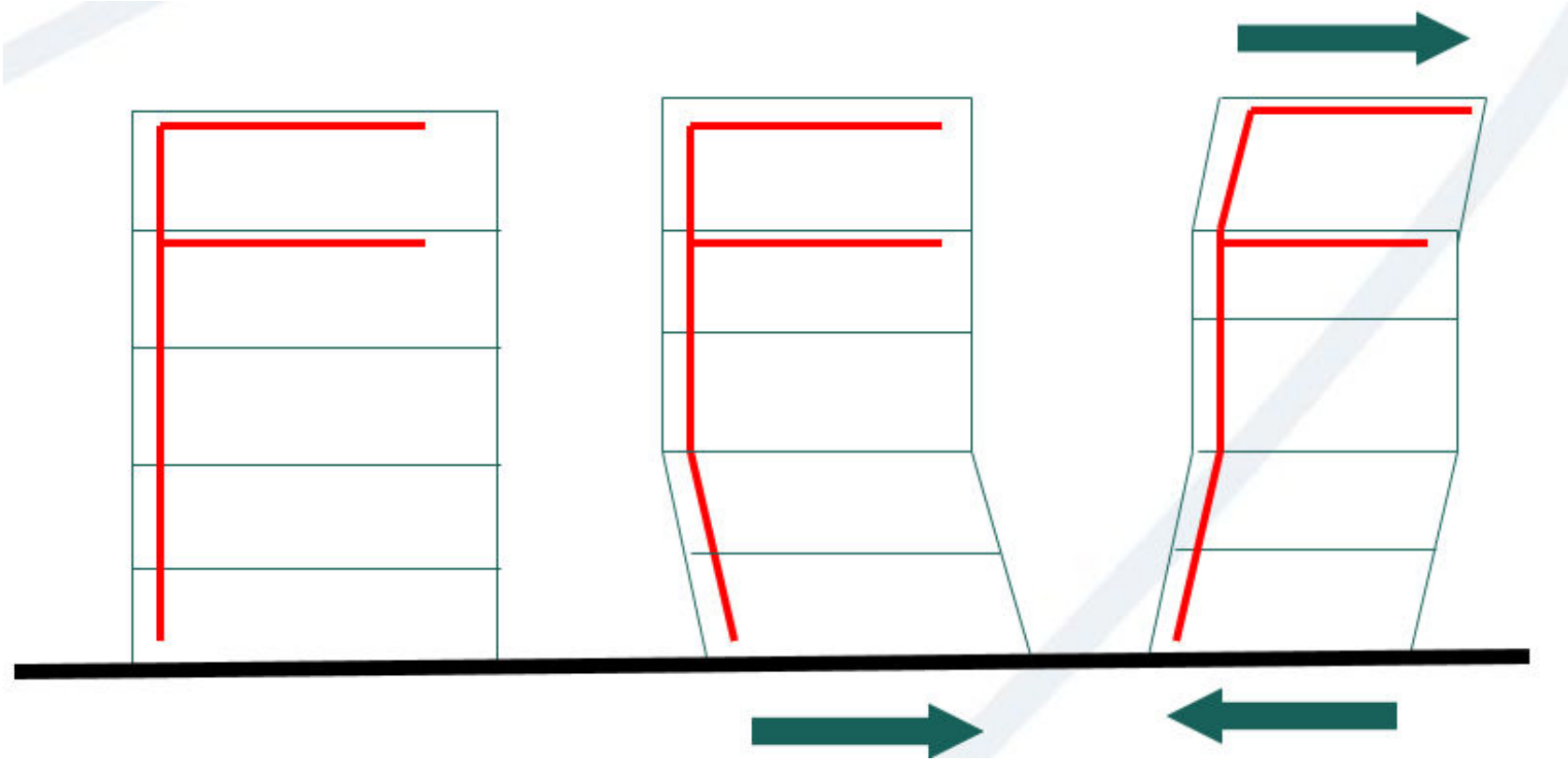
Earthquake and sprinkler systems

EARTHQUAKE PROTECTION FOR WATER-BASED FIRE PROTECTION SYSTEMS

Table of Contents

Earthquake and sprinkler systems

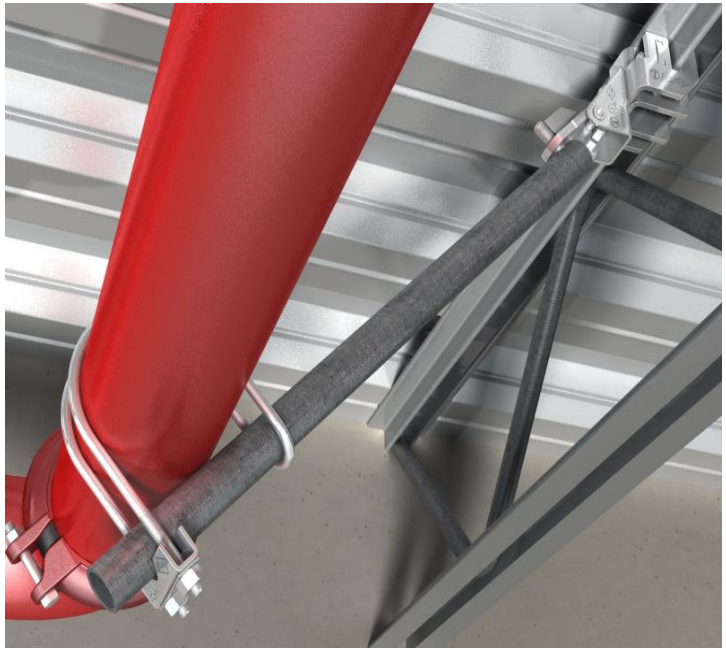
Move with the building while maintaining flexibility at key locations



Earthquake and sprinkler systems

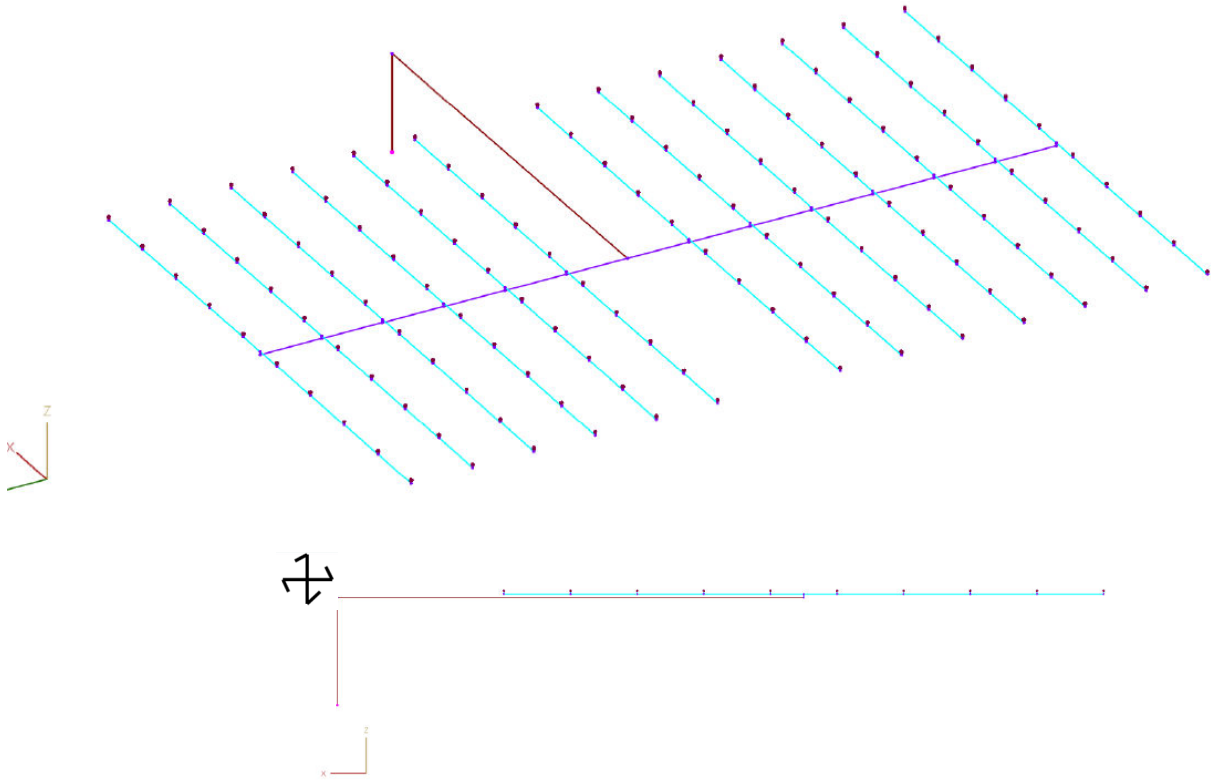
What are the best ways to ensure sprinkler protection functionality following an earthquake?

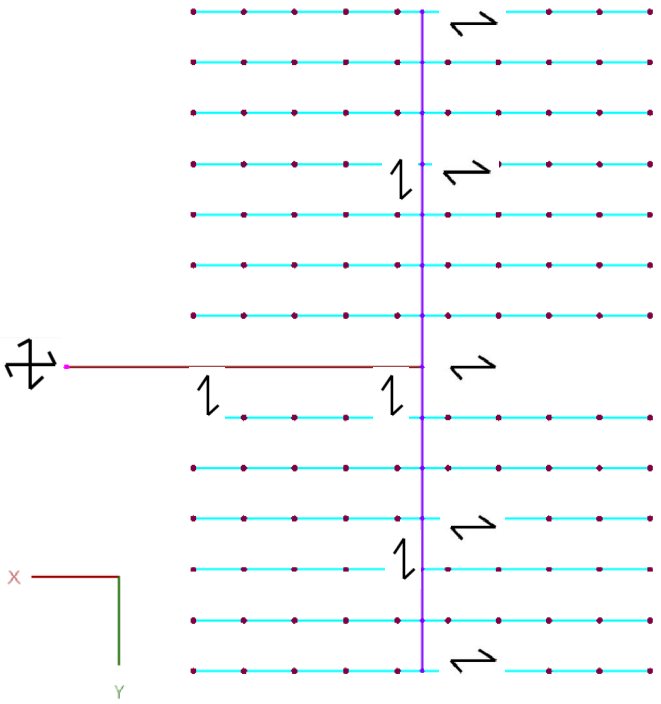
Bracing sprinkler pipes to building



Earthquake and sprinkler systems

Where should braces be placed?





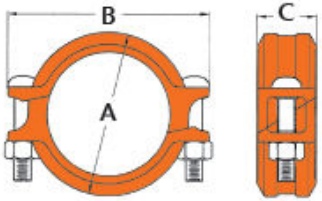
Earthquake and sprinkler systems

Flexible couplings

Can you tell which Viking coupling below is "flexible" and which one is "rigid"?

angled grooves

straight grooves



angled grooves = rigid coupling

straight grooves ? inconclusive (mostly flexible couplings, but can also be rigid)

Need to know coupling manufacturer and model