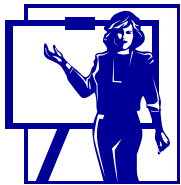




Housekeeping

- Polling
- Post-webinar assessment
- Ask questions
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1. Attendee must register/sign in with all required info.
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Portfolio of Flagship Brands

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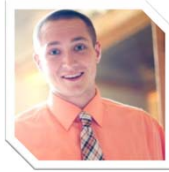
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Introduction



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

7

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Poll Question 1

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

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

8

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Objectives



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

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What was the Problem?

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Firefighters spray water onto the warehouse fire. Photo: Houston Chronicle, James Nielsen / HC.



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Commodity Classes – Class I

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▪ Noncombustible product that meets one of the following criteria:

- Placed directly on wooden pallets
- Placed in single-layer corrugated cartons, with or without single-thickness cardboard dividers, with or without pallets
- Shrink-wrapped or paper-wrapped as a unit load with or without pallets

NFPA 13- 20.4.1, Table A.20.4.1



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

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Commodity Classes – Class II

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



Metal-lined double tri-wall corrugated carton on a wood pallet



NFPA 13- 20.4.2, Table A.20.4.2

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

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Commodity Classes – Class III

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- A product fashioned from wood, paper, natural fibers, or Group C plastics with or without cartons, boxes, or crates and with or without pallets.
- Group C plastics - (NFPA 13, 5.6.4.3)
 1. Fluoroplastics (PTFE — polychlorotrifluoroethylene; PTFE — polytetrafluoroethylene)
 2. Melamine (melamine formaldehyde)
 3. Phenolic
 4. PVC (polyvinyl chloride — flexible — PVCs with plasticizer content up to 20 percent)
 5. PVDC (polyvinylidene chloride)
 6. PVDF (polyvinylidene fluoride)
 7. PVF (polyvinyl fluoride)
 8. Urea (urea formaldehyde)
- A limited amount (5% by weight or volume or less) of Group A or Group B plastics.



NFPA 13- 20.4.3, Table A.20.4.3



Paper cups in compartmented cardboard cartons on wood pallets

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

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Commodity Classes – Class IV

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



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



NFPA 13- 20.4.4, Table A.20.4.4



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FM Commodity Classes – Class IV

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FM Global 8-1:2.3.5.1 Treat stored materials that meet the following criteria as unexpanded plastic:

- A. Total weight or volume of unexpanded plastic is more than 5% for a single pallet load.
- B. Total volume of expanded plastic (foam plastic) is from 5% to 40% for a single pallet load.
- C. Total volume of expanded plastic is greater than 5% and up to 10% when exposed or located on the outer portion of the material (i.e., protects or envelops the material).

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

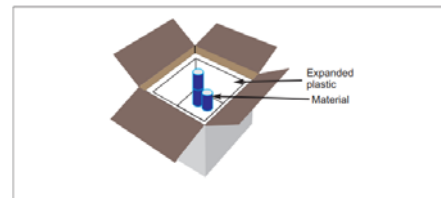


Fig. 2. Volume of EP that envelops the material

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Commodity Classes – Group A

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



NFPA 13- 20.4.5.2



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



Expanded Polystyrene
Trays Exposed
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Expanded or Unexpanded?

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Poll Question 2

Which option is another example of an expanded plastic commodity?

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

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Mixed Commodities



- Protection requirements shall not be based on the overall commodity mix in a fire area.
- In general, mixed commodity storage shall be protected by the requirements for the highest classified commodity and storage arrangement.
- The protection requirements for the lower commodity class shall be permitted to be utilized where all of the following are met:
 - Up to 10 pallet loads of a higher hazard commodity shall be permitted to be present in an area not exceeding 40,000 ft² (3716 m²).
 - The higher hazard commodity shall be randomly dispersed with no adjacent loads in any direction (including diagonally).
 - Where the ceiling protection is based on Class I or Class II commodities, the allowable number of pallet loads for Class IV or Group A plastics shall be reduced to five.
- The protection requirements for the lower commodity class shall be permitted to be utilized in the area of lower commodity class, where the higher hazard material is confined to a designated area and the area is protected to the higher hazard in accordance with the requirements of this standard.



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NFPA 13- 20.4.14



Encapsulation

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



NFPA 13- 3.3.64, A.3.3.64

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Plastic Pallet Types

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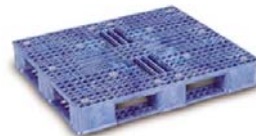
▪ Un-reinforced plastic pallets

- Melt fairly easily in a fire and are less of a fire challenge
- Material
 - Polypropylene
 - High-density polyethylene



▪ Reinforced plastic pallets

- Hold their structure and integrity longer allowing air gaps to remain longer within the pallet, which fuels the flames and creates a more intense fire
- Material
 - Polypropylene
 - High-density polyethylene



▪ Classification by Listing



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Storing Materials on Plastic Pallets

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



NFPA 13- 20.3.2.2.1.1, 20.3.2.2.2.1

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Other Types of Commodities

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Rubber Tire (Chapter 18)



Rolled Paper (Chapter 19)



Idle Pallet (20.14)



Baled Cotton (21.10)

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FM Guidelines

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Rubber Tire (8-3)



Rolled Paper (8-21)



Idle Pallet (8-24)



Baled Fiber (8-7)

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Storage Arrangements

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- Idle Pallet Storage
- Miscellaneous Storage
- Solid Pile Storage
- Palletized Pile Storage
- Bin Box Storage
- Shelf Storage
- Rack Storage

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Idle Pallet storage (Chapter 20)

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Wood Pallets



Plastic Pallets

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Miscellaneous Storage

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



NFPA 13- 3.3.123

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Solid-Pile, Palletized, Bin Box, Self Storage, or Back-to-Back Shelf *tyco.*



Solid Pile



Palletized



Bin Box



Shelf Storage



Back to Back Shelf

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Pile Stability



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



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



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

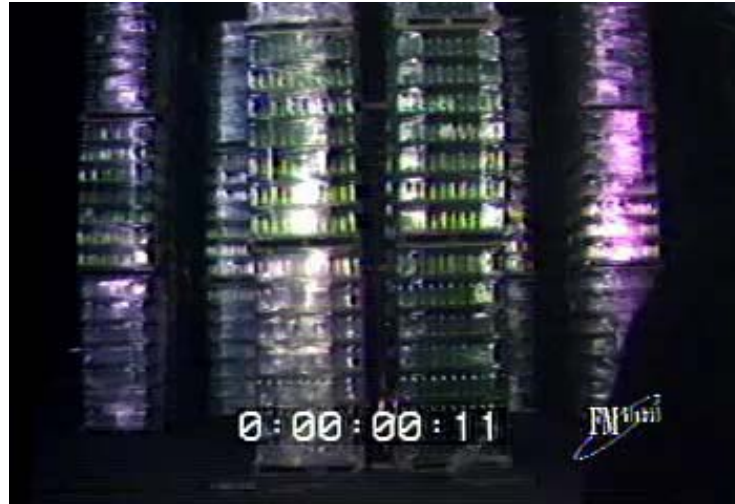
NFPA 13- 3.3.152, 3.3.153

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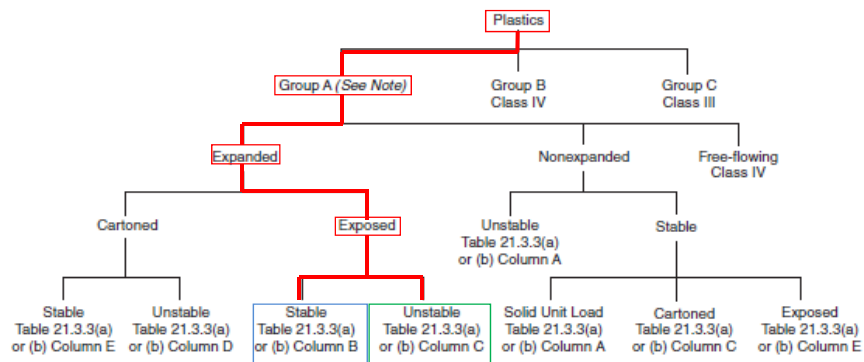
Unstable Pile



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Pile Stability

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

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

FIGURE 21.3.1 Decision Tree.

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Pile Stability

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Table 21.3.3(a) Design Densities for Palletized, Solid-Piled, Bin Box, or Shelf Storage of Group A Plastic Commodities (U.S. Customary Units)

Maximum Storage Height (ft)	Roof/Ceiling Height (ft)	Density (gpm/ft ²)				
		A	B	C	D	E
>5 to ≤12	Up to 15	0.2	EH2	0.3	EH1	EH2
	>15 to 20	0.3	0.6	0.5	EH2	EH2
	>20 to 32	0.4	0.8	0.6	0.45	0.7
15	Up to 20	0.3	0.6	0.5	0.4	0.45
	>20 to 25	0.4	0.8	0.6	0.45	0.7
	>25 to 35	0.45	0.9	0.7	0.55	0.85
20	Up to 25	0.4	0.8	0.6	0.45	0.7
	>25 to 30	0.45	0.9	0.7	0.55	0.85
	>30 to 35	0.6	1.2	0.85	0.7	1.1
25	Up to 30	0.45	0.9	0.7	0.55	0.85
	>30 to 35	0.6	1.2	0.85	0.7	1.1

Notes:

(1) Minimum clearance between sprinkler deflector and top of storage shall be maintained as required.

(2) Column designations correspond to the configuration of plastics storage as follows:

A: (1) Nonexpanded, unstable

(2) Nonexpanded, stable, solid unit load

B: Expanded, exposed, stable

C: (1) Expanded, exposed, unstable

(2) Nonexpanded, stable, cartoned

D: Expanded, cartoned, unstable

E: (1) Expanded, cartoned, stable

(2) Nonexpanded, stable, exposed

(3) EH1 = Density required by Extra Hazard Group 1 design curve and 19.3.3.1.1

EH2 = Density required by Extra Hazard Group 2 design curve and 19.3.3.1.1

(4) Roof/ceiling height >35 ft is not permitted.

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High Piled Storage

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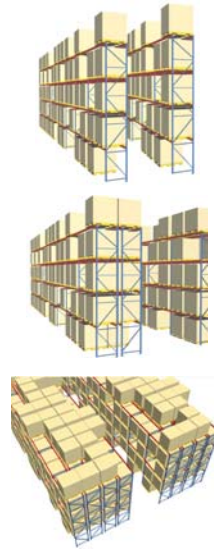
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Rack Storage Arrangements (Chapters 21-25)

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



35

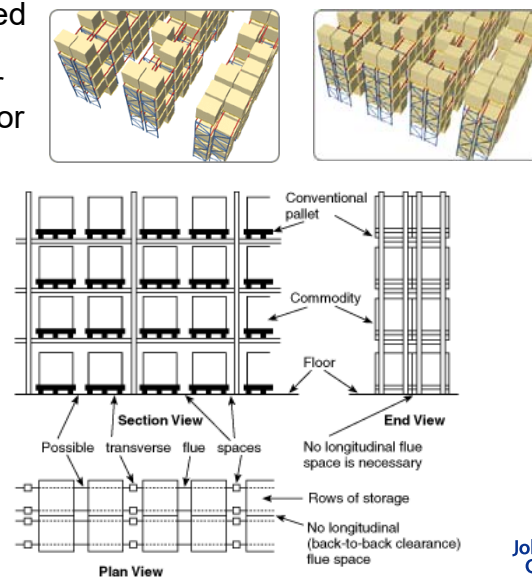
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Aisles and Flue Considerations

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



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Storage Height & Clearance

- Increased clearance delays sprinkler operation time, resulting in a larger fire size at the time of operation
- Increased clearance results in a larger fire plume above the top of storage, which reduces the ability of water from sprinklers to reach the seat of a fire.
- The minimum clearance between the sprinkler deflector and top of storage allows the proper spray pattern to develop.
- Clearance from Deflector to Storage: 20.6.6 (New to 2019)
- Excessive Clearance Protection: 25.9.5



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NFPA 13

OLD

Chapter 8	Installation Requirements	13- 45
8.1	Basic Requirements	13- 45
8.2	System Protection Area Limitations	13- 45
8.3	Use of Sprinklers	13- 46
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8.10	Residential Sprinklers	13- 70
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8.12	Early Suppression Fast-Response Sprinklers	13- 79
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NEW

Chapter	Installation Requirements for:
9	Sprinkler Location
10	Standard Pendent, Upright, and Sidewall Sprinklers
11	Extended Coverage Upright, Pendent, Sidewall Sprinkler
12	Residential Sprinklers
13	CMSA Sprinklers
14	Early Suppression Fast-Response Sprinklers
15	Special Sprinklers
16	Piping, Valves, and Appurtenances

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NFPA 13



OLD

Chapter	Title
12	General Requirements for Storage
13	Misc. and Low-Piled Storage
14	Class I-IV Palletized, Piled, Bin Boxes, or Shelf
15	Plastic and Rubber, Palletized, Piled, Bin Boxes, or Shelf
16	Class I-IV on Racks
17	Plastics and Rubbers on Racks
18	Rubber Tire Storage
19	Roll Paper
20	Special Designs Storage
21	Alternative Sprinkler System Designs

NEW

Chapter	Title
20	General Requirements for Storage
21	Protection of High Piled Storage Using Control Mode Density Area (CMDA) Sprinklers
22	CMSA Requirements for Storage Applications
23	ESFR Requirements for Storage Applications
24	Alternative Sprinkler System Designs for Chapters 20 Through 25
25	Protection of Rack Storage Using In-Rack Sprinklers

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Poll Question 3

What NFPA 13 Edition does your jurisdiction follow?

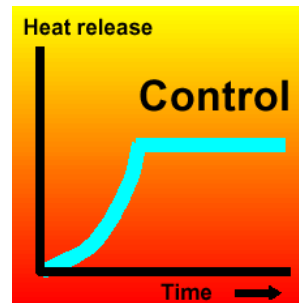
- A. 2019 Edition
- B. 2016 Edition
- C. 2013 Edition
- D. Earlier than 2013 Edition
- E. I have no idea!

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Control Mode Sprinklers

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Control Mode Density Area (CMDA)

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Density / Area Method

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

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

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

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Control Mode Density Area (CMDA)

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Density / Area Method

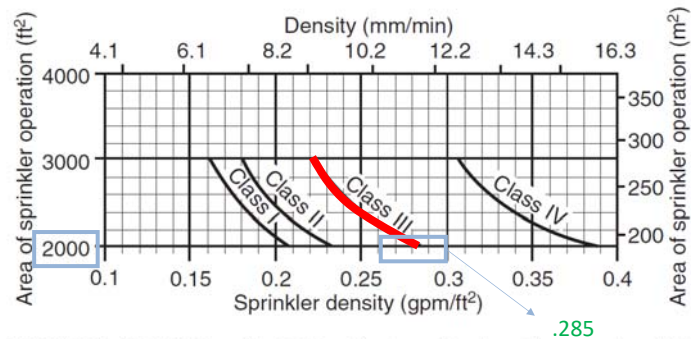


FIGURE 21.2.2.1 Sprinkler System Design Curves for 20 ft (6.1 m) High Storage — Ordinary Temperature-Rated Sprinklers.

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Control Mode Density Area (CMDA)

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Density / Area Method

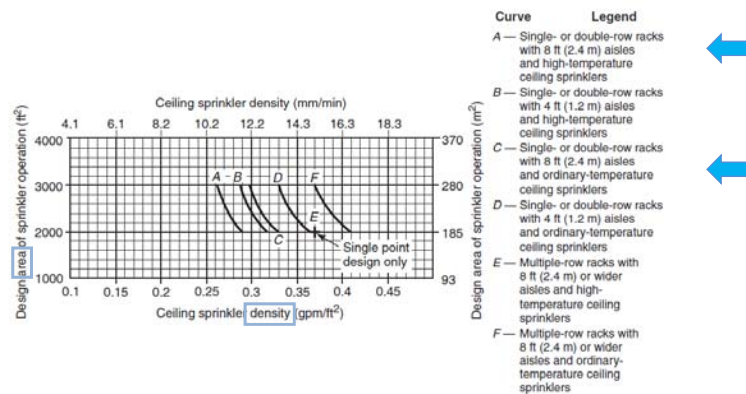


FIGURE 21.4.1.2(a) Sprinkler System Design Curves — 20 ft (6.1 m) High Rack Storage — Class I Nonencapsulated Commodities — Conventional Pallets.

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FM 8-9: Guidelines for Class I-V Commodities

Max. Ceiling Height, ft (m)	Wet System, Pendent Sprinklers, 160°F (70°C)										Wet System, Upright Sprinklers, 160°F (70°C)										Dry System, Upright Sprinklers, 280°F (140°C)				
	Quick Response					Standard Response					Quick Response					Standard Response					Standard Response				
	K11.2 (K160)	K14.0 (K200)	K16.8 (K240)	K22.4 (K320)	K25.2 (K360EC)	K11.2 (K160)	K14.0 (K200)	K16.8 (K240)	K25.2 (K360)	K11.2 (K160)	K14.0 (K200)	K16.8 (K240)	K25.2EC (K360EC)	K11.2 (K160)	K16.8 (K240)	K25.2 (K360)	K11.2 (K160)	K16.8 (K240)	K19.6 (K280)	K25.2 (K360)					
15 (4.5)	20 @ 7 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	8 @ 20 (0.5)	20 @ 7 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	20 @ 7 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	8 @ 20 (0.5)	20 @ 7 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	20 @ 7 (0.5)					
20 (6.0)	15 @ 15 (1.0)	12 @ 12 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	8 @ 20 (0.5)	15 @ 15 (1.0)	12 @ 12 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	15 @ 15 (1.0)	12 @ 12 (0.5)	12 @ 12 (0.5)	8 @ 20 (0.5)	15 @ 15 (1.0)	12 @ 12 (0.5)	12 @ 12 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	20 @ 7 (0.5)					
25 (7.5)	15 @ 15 (1.0)	12 @ 12 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	8 @ 20 (0.5)	15 @ 15 (1.0)	12 @ 12 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	15 @ 15 (1.0)	12 @ 12 (0.5)	12 @ 12 (0.5)	8 @ 20 (0.5)	15 @ 15 (1.0)	12 @ 12 (0.5)	12 @ 12 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	20 @ 7 (0.5)					
30 (9.0)	20 @ 20 (1.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	8 @ 20 (0.5)	20 @ 20 (1.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	20 @ 20 (1.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	8 @ 20 (0.5)	20 @ 20 (1.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	20 @ 7 (0.5)					
35 (10.5)	20 @ 20 (1.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	8 @ 20 (0.5)	20 @ 20 (1.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	20 @ 20 (1.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	8 @ 20 (0.5)	20 @ 20 (1.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	20 @ 7 (0.5)					
40 (12.0)	20 @ 20 (1.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	8 @ 20 (0.5)	20 @ 20 (1.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	20 @ 20 (1.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	8 @ 20 (0.5)	20 @ 20 (1.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	20 @ 7 (0.5)					
45 (13.5)	20 @ 20 (1.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	8 @ 20 (0.5)	20 @ 20 (1.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	20 @ 20 (1.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	8 @ 20 (0.5)	20 @ 20 (1.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	20 @ 7 (0.5)					

* An acceptable alternative design is 8 @ 40 (2.8) when a 12 ft (3.6 m) maximum linear spacing is used.

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Standard Spray Sprinkler Data Sheets



tyco

Series TY-B — 2.5, 5.6, and 8.0 K-factor Upright, Pendent, and Recessed Pendent Sprinklers Quick Response, Standard Coverage

General Description

The TY-B Series 2.5, 5.6, and 8.0 K-factor Upright, Pendent, and Recessed Pendent Sprinklers are designed for use in wet pipe systems. They are available in standard and quick response versions. The quick response version is designed for use in systems with a minimum residual pressure of 7 psi (0.5 bar).

Technical Data

Operating Temperature: 160°F (70°C)

Response Class: Quick Response

Standard Coverage: 15 ft (4.5 m) diameter

Sprinkler Identification Numbers (SIN)

TY-B 2.5, 5.6, and 8.0 K-factor Upright, Pendent, and Recessed Pendent Sprinklers Quick Response, Standard Coverage

tyco

Series TY-FRL — 2.5, 5.6, and 8.0 K-factor Upright, Pendent, and Recessed Pendent Sprinklers Quick Response, Standard Coverage

General Description

The TY-FRL Series 2.5, 5.6, and 8.0 K-factor Upright, Pendent, and Recessed Pendent Sprinklers are designed for use in wet pipe systems. They are available in standard and quick response versions. The quick response version is designed for use in systems with a minimum residual pressure of 7 psi (0.5 bar).

Technical Data

Operating Temperature: 160°F (70°C)

Response Class: Quick Response

Standard Coverage: 15 ft (4.5 m) diameter

Sprinkler Identification Numbers (SIN)

TY-FRL 2.5, 5.6, and 8.0 K-factor Upright, Pendent, and Recessed Pendent Sprinklers Quick Response, Standard Coverage

tyco

Series ELO-231B — 11.2 K-factor Upright and Pendent Sprinklers Standard Response, Standard Coverage

General Description

The ELO-231B Series 11.2 K-factor Upright and Pendent Sprinklers are designed for use in wet pipe systems. They are available in standard and quick response versions. The quick response version is designed for use in systems with a minimum residual pressure of 7 psi (0.5 bar).

Technical Data

Operating Temperature: 160°F (70°C)

Response Class: Standard Response

Standard Coverage: 15 ft (4.5 m) diameter

Sprinkler Identification Numbers (SIN)

ELO-231B 11.2 K-factor Upright and Pendent Sprinklers Standard Response, Standard Coverage

Design Criteria

UL and C-UL Listing Requirements

TYCO Series ELO-231B 11.2K Standard Response, Standard Coverage Upright and Pendent Sprinklers are to be installed in accordance with NFPA 13 standard sprinkler position and area/density flow calculation requirements for light, ordinary, or extra hazard occupancies, as well as high-piled storage occupancies (solid-piled, palletized, rack storage, bin box, and shelf storage including but not limited to Class I, II, and Group A plastics) with a minimum residual (flowing) pressure of 7 psi (0.5 bar) for wet or dry pipe systems. Refer to Table B for additional information.

FM Approval Requirements

The 11.2 K-factor, Model ELO-231B Sprinklers are to be installed in accordance with the applicable control mode density/area guidelines provided by FM Global.

Note: FM Approval guidelines may differ from UL and C-UL Listing criteria.

NFPA 13:

21.1.4 For general storage applications, rack storage, rubber tire storage, roll paper storage, and baled cotton storage being protected with upright and pendent spray sprinklers with required densities greater than 0.34 gpm/ft² (139 mm/min), standard-response spray sprinklers with a K-factor of K-11.2 (161) or larger that are listed for storage applications shall be used.

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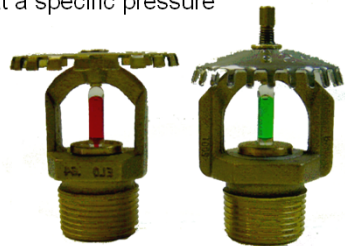
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Johnson Controls

Large Drop and Specific Application Control Mode Sprinklers

tyco

- **Large Drop Sprinkler.** A type of specific application control mode sprinkler that is capable of producing characteristic large water droplets and that is listed for its capability to provide fire control of specific high-challenge fire hazards.
- **Specific Application Control Mode Sprinkler For Storage Use.** A type of spray sprinkler listed at a minimum operating pressure or density with a specific number of operating sprinklers for a given protection scheme.
- **Design:**
 - Calculate a specific # of sprinklers at a specific pressure



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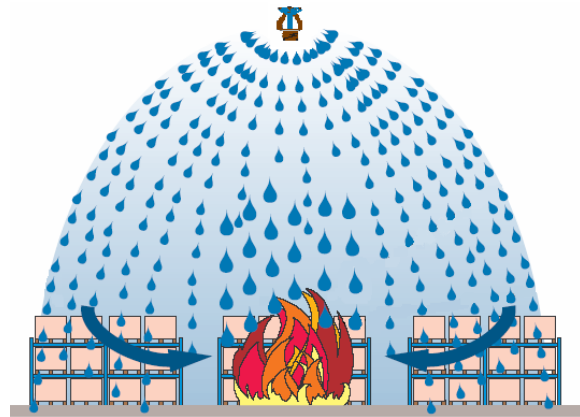
Johnson Controls



Control Mode Specific Application (CMSA) Sprinklers (2010)

- **Control Mode Specific Application (CMSA) Sprinkler.** A type of spray sprinkler that is capable of producing characteristic large water droplets and that is listed for its capability to provide fire control of specific high-challenge fire hazards.

- A high challenge fire can have an upward draft equivalent to 30 – 35 mph (50 – 56 km/h)
- The Larger K-factors produce larger water droplets at lower pressures
- Large flow rates might be required for some high challenge applications



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NFPA 13, – CMSA Protection Table Example



Table 22.4 CMSA Sprinkler Design Criteria for Rack Storage of Class I Through Class IV Commodities (Encapsulated and Nonencapsulated)

Storage Arrangement Single-, double-, and multiple- row racks (no open-end compartments)	Commodity Class	Maximum Storage Height		Maximum Ceiling-Roof Height		K-Factor / Orifice Size	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	
		ft	m	ft	m				psi	bar
Class I or II	20	6.1	30	9.1	11.2 (100) Uprights	Wet	15	25	1.7	
					16.9 (240) Uprights	Dry	25	25	1.7	
					19.0 (280) Pendents	Wet	15	18	1.1	
					25.2 (360) Pendents	Dry	25	15	1.0	
					11.2 (100) Uprights	Wet	15	18	1.1	
					25.2 (360) Pendents	Wet	15	18	0.7	
	25	7.6	40	12	11.2 (100) Uprights	Wet	15	25	1.6	
					16.9 (240) Uprights	Wet	20	25	1.7	
					19.0 (280) Pendents	Dry	30	25	1.7	
					25.2 (360) Pendents	Wet	15	18	0.7	
					11.2 (100) Uprights	Dry	30	15	1.0	
					19.0 (280) Pendents	Wet	15	18	1.1	
Class III	20	6.1	30	9.1	11.2 (100) Uprights	Wet	15	25	1.7	
					16.9 (240) Uprights	Dry	25	25	1.7	
					19.0 (280) Pendents	Wet	15	18	1.1	
					25.2 (360) Pendents	Dry	25	15	1.0	
					11.2 (100) Uprights	Wet	15	18	1.1	
					25.2 (360) Pendents	Wet	15	18	0.7	
	25	7.6	40	12	11.2 (100) Uprights	Wet	15	25	1.6	
					16.9 (240) Uprights	Wet	15	25	1.7	
					19.0 (280) Pendents	Dry	25	25	1.7	
					25.2 (360) Pendents	Wet	15	18	0.7	
					11.2 (100) Uprights	Dry	25	15	1.0	
					19.0 (280) Pendents	Wet	15	18	1.1	
Class IV	20	6.1	30	9.1	11.2 (100) Uprights	Wet	15	25	1.7	
					16.9 (240) Uprights	Dry	25	25	1.7	
					19.0 (280) Pendents	Wet	15	18	1.1	
					25.2 (360) Pendents	Dry	25	15	1.0	
					11.2 (100) Uprights	Wet	15	18	1.1	
					25.2 (360) Pendents	Wet	15	18	0.7	
	25	7.6	40	12	11.2 (100) Uprights	Wet	15	25	1.6	
					16.9 (240) Uprights	Wet	15	25	1.7	
					19.0 (280) Pendents	Dry	25	25	1.7	
					25.2 (360) Pendents	Wet	15	18	0.7	
					11.2 (100) Uprights	Dry	25	15	1.0	
					19.0 (280) Pendents	Wet	15	18	1.1	
Class V	20	6.1	30	9.1	11.2 (100) Uprights	Wet	15	25	1.7	
					16.9 (240) Uprights	Dry	25	25	1.7	
					19.0 (280) Pendents	Wet	15	18	1.1	
					25.2 (360) Pendents	Dry	25	15	1.0	
					11.2 (100) Uprights	Wet	15	18	1.1	
					25.2 (360) Pendents	Wet	15	18	0.7	
	25	7.6	40	12	11.2 (100) Uprights	Wet	15	25	1.6	
					16.9 (240) Uprights	Wet	15	25	1.7	
					19.0 (280) Pendents	Dry	25	25	1.7	
					25.2 (360) Pendents	Wet	15	18	0.7	
					11.2 (100) Uprights	Dry	25	15	1.0	
					19.0 (280) Pendents	Wet	15	18	1.1	

NA: Not applicable
 *In-rack sprinklers required. See Chapter 25.

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NFPA 13– CMSA Protection Table Example

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Table 25.2.4.2.1 CMSA Ceiling-Level Sprinkler Design Criteria for Rack Storage of Class I Through Class IV Commodities (Encapsulated and Nonencapsulated) Supplemented with In-Rack Sprinklers

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

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Johnson Controls

CMSA Data Sheets

tyco

tyco Worldwide Headquarters www.tyco-fire.com

Model LD — 11.2 K-factor Large Drop Upright Sprinkler, Standard Response Control Mode Specific Application

General Description
The TYCO Model LD 11.2 K-factor Large Drop Upright Sprinkler is a glass bulb type sprinkler designed for use in standard response control mode specific applications. It is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications. The sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications. The sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications.

Sprinkler Identification Number
The TYCO Model LD 11.2 K-factor Large Drop Upright Sprinkler is identified by the following information: LD 11.2 K-factor Large Drop Upright Sprinkler.

Technical Data
The TYCO Model LD 11.2 K-factor Large Drop Upright Sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications. The sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications.

Operation
The TYCO Model LD 11.2 K-factor Large Drop Upright Sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications. The sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications.

Design Criteria
The TYCO Model LD 11.2 K-factor Large Drop Upright Sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications. The sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications.

Additional Technical Data
The TYCO Model LD 11.2 K-factor Large Drop Upright Sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications. The sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications.

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tyco Worldwide Headquarters www.tyco-fire.com

Ultra K17 — 16.8 K-factor Upright Control Mode Specific Application Sprinkler Standard Response, 155°F (68°C) & 200°F (93°C)

General Description
The TYCO Ultra K17 16.8 K-factor Upright Control Mode Specific Application Sprinkler is a glass bulb type sprinkler designed for use in standard response control mode specific applications. It is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications. The sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications.

Sprinkler Identification Number (SIN)
The TYCO Ultra K17 16.8 K-factor Upright Control Mode Specific Application Sprinkler is identified by the following information: Ultra K17 16.8 K-factor Upright Control Mode Specific Application Sprinkler.

Technical Data
The TYCO Ultra K17 16.8 K-factor Upright Control Mode Specific Application Sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications. The sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications.

Operation
The TYCO Ultra K17 16.8 K-factor Upright Control Mode Specific Application Sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications. The sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications.

Design Criteria
The TYCO Ultra K17 16.8 K-factor Upright Control Mode Specific Application Sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications. The sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications.

Additional Technical Data
The TYCO Ultra K17 16.8 K-factor Upright Control Mode Specific Application Sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications. The sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications.

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tyco Worldwide Headquarters www.tyco-fire.com

Model EC-25 (CMSA and CMSA Applications) 25.2 (360) K-factor (360) Upright Sprinkler Extended Coverage

General Description
The TYCO Model EC-25 (360) K-factor (360) Upright Sprinkler is a glass bulb type sprinkler designed for use in standard response control mode specific applications. It is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications. The sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications.

Sprinkler Identification Number (SIN)
The TYCO Model EC-25 (360) K-factor (360) Upright Sprinkler is identified by the following information: Model EC-25 (360) K-factor (360) Upright Sprinkler.

Technical Data
The TYCO Model EC-25 (360) K-factor (360) Upright Sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications. The sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications.

Operation
The TYCO Model EC-25 (360) K-factor (360) Upright Sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications. The sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications.

Design Criteria
The TYCO Model EC-25 (360) K-factor (360) Upright Sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications. The sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications.

Additional Technical Data
The TYCO Model EC-25 (360) K-factor (360) Upright Sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications. The sprinkler is designed to provide protection for Class I, II, III, and IV commodities in rack storage applications.

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Johnson Controls

Intermediate Level Sprinkler/ In-Rack Storage Sprinklers

tyco

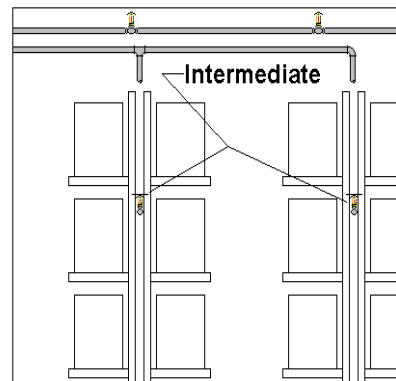
A sprinkler equipped with integral shields to protect its operating elements from the discharge of sprinklers installed at higher elevations (3.3.205.4.8).



25.3.1 In-Rack Sprinkler Water Shield for Storage of class 1 Through Class IV Commodities. Water shields shall be provided directly above in-rack sprinklers, or listed intermediate level/ rack storage sprinklers shall be used where there is more than one level, if not shielded by horizontal barriers.

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

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



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Poll Question 4

What are the metal discs installed on intermediate sprinklers

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

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In-Rack Sprinkler Protection



Table 25.5.2.2.3 Horizontal Spacing for In-Rack Sprinklers in Combination with CMDA Ceiling Sprinklers That Are Represented by Figures

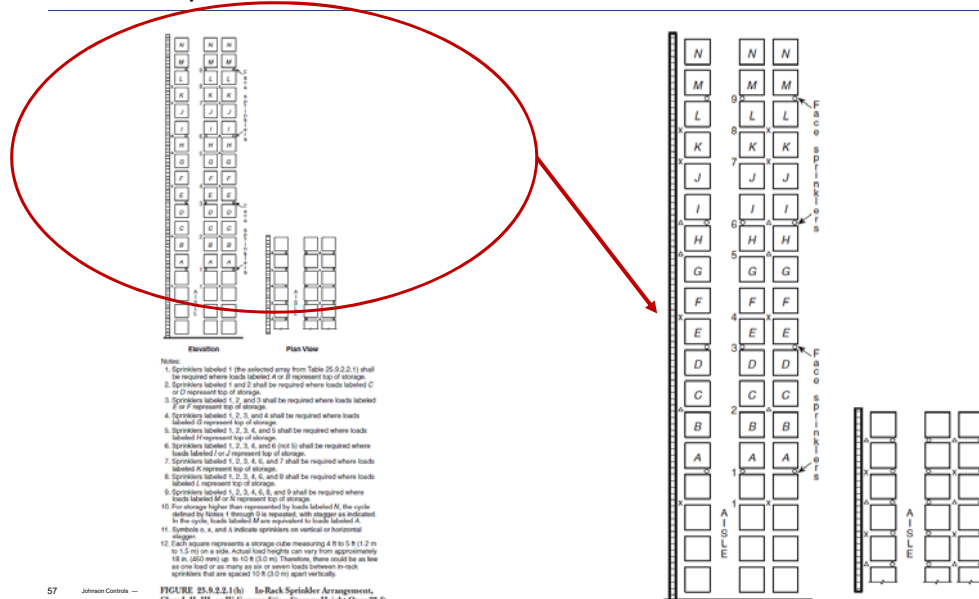
Commodity Class	Storage Rack Type	Storage Height		Applicable Table and/or Figure for Horizontal Spacing of In-Rack Sprinklers
		ft	m	
Class I through IV	Single-row	Over 25	Over 7.6	Table 25.9.2.1.1 and Figures 25.9.2.1.1 (a)–(e)
	Double-row	Over 25	Over 7.6	Table 25.9.2.2.1 and Figures 25.9.2.2.1 (a)–(j)
	Multiple-row	Over 25	Over 7.6	Table 25.9.2.3.1 and Figures 25.9.2.3.1 (a)–(c)
Group A plastics	Single-, double-, and multiple-row	Up to 25	Up to 7.6	Figures 25.9.3.1 (a)–(e)
Group A plastics, cartoned	Single-row	Over 25	Over 7.6	Figures 25.9.4.1.1 (a)–(d)
	Double-row	Over 25	Over 7.6	Figures 25.9.4.2.1 (a)–(c)
	Multiple-row	Over 25	Over 7.6	Figures 25.9.4.3.1 (a)–(f)
Group A plastics, exposed nonexpanded	Single-row, maximum 3 ft (0.9 m) deep	Over 25	Over 7.6	Figure 25.9.4.1.3
	Multiple-row	Over 25	Over 7.6	Figures 25.9.4.3.1 (a)–(f)

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In-Rack Sprinkler Protection

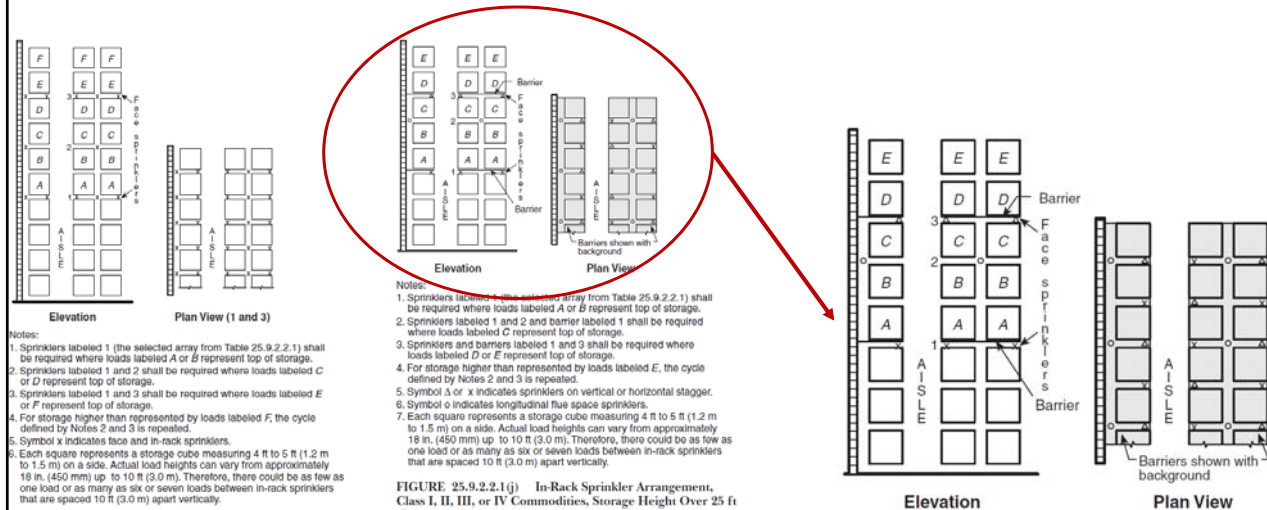
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Other In-Rack Sprinkler Protection Requirements

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Other In-Rack Sprinkler Protection Requirements

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

Type of Storage	Commodity Class	Rack Type	Ceiling Sprinkler Type	No. of Required In-Rack Sprinkler Levels	No. of In-Rack Sprinklers in the Design
Miscellaneous	Class I through IV, Group A plastics, and rubber tires	Any	Any	Any	4
Storage not meeting the definition of miscellaneous	Class I through III	Solid shelf	Any	One	6
			Any	More than one	10 (5 on each of the top two levels)
		Open	CMDA	One	6
			CMDA	More than one	10 (5 on each of the top two levels)
	Class I through IV	Open	CMSA	One	8
	Class I through IV and Group A plastics	Open	ESFR	One	8
	Class IV	Open	CMDA	More than one	10 (5 on each of the top two levels)
	Class IV and Group A plastics	Solid shelf	Any	One	8
				More than one	14 (7 on each of the top two levels)
		Open	CMDA	One	8
		Open	CMSA	One	8
				More than one	14 (7 on each of the top two levels)
	Group A plastics	Open	CMSA	One	8
	Rubber tires	Open	CMDA	One	12

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Other In-Rack Sprinkler Protection Requirements

Table 25.12.3.1 In-Rack Sprinkler System Design: Minimum Required Flow/Pressure from In-Rack Sprinklers

Type of Storage	Commodity Class	Rack Type	Ceiling Sprinkler Type	Storage Height		Minimum Design Flow/Pressure for In-Rack Sprinklers
				ft	m	
Miscellaneous	Class I through IV, Group A plastics, and rubber tires	Any	Any	Any	Any	15 psi (1.0 bar)
Storage not meeting the definition of miscellaneous	Class I through IV	Open	CMDA	Up to 25	Up to 7.6	15 psi (1.0 bar)
			CMSA	Any	Any	15 psi (1.0 bar)
	Class I through IV and Group A plastics	Open	CMDA	Over 25	Over 7.6	30 gpm (115 L/min)
			ESFR	Any	Any	60 gpm (230 L/min)
		Solid shelves	Any	Any	Any	30 gpm (115 L/min)
	Group A plastics	Open	CMDA	Up to 25	Up to 7.6	15 psi (1.0 bar)
			CMSA	Up to 25	Up to 7.6	15 psi (1.0 bar)
	Rubber tires	Open	CMDA	Any	Any	30 psi (2.1 bar)

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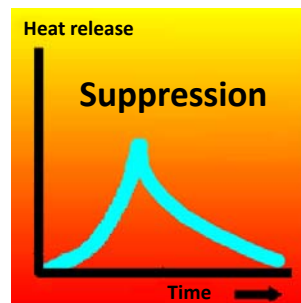
In-Rack Sprinklers Data Sheets

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Johnson Controls

Suppression Mode Sprinklers

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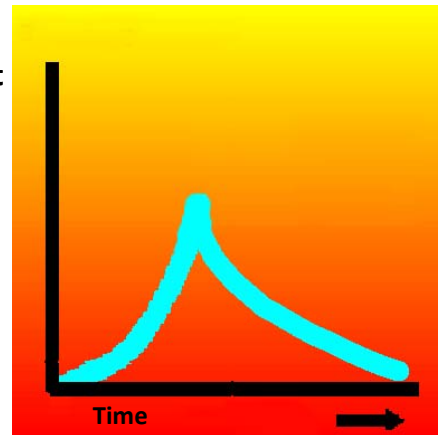
Johnson Controls

Suppression Mode (SM) Sprinklers

tyco.

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

Heat



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Controls

NFPA 13 Table of Contents

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Controls



Suppression Mode Sprinklers

- Sprinkler Type:
 - 14.0 (200) K Up & Pend
 - 16.8 (240) K Up & Pend
 - 22.4 (326) K Pend
 - 25.2 (360) K Pend
- Max Area of Coverage:
 - 100 sq.ft. (9.3 m²)
- Max Distance Between Sprinklers:
 - 12' (3.7m) – 30' (9.1m) Building
 - 10' (3.01m) – >30' (9.1m) Building
- Design:
 - Calculate a specific # of sprinklers at a specific



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NFPA 13, 2017 – ESFR Protection Table Example



Table 23.4.2 ESFR Protection of Palletized and Solid Piled Storage of Group A Plastic Commodities

Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure	
		ft	m	ft	m			psi	bar
Palletized and solid piled storage (no open-top containers)	Carroll's nonexpanded plastic	20	6.1	25	7.6	14.0 (200)	Upright/pendant	50	3.4
						16.8 (240)	Upright/pendant	35	2.4
						22.4 (320)	Pendant	25	1.7
						25.2 (360)	Pendant	15	1.0
				30	9.1	14.0 (200)	Upright/pendant	50	3.4
						16.8 (240)	Upright/pendant	35	2.4
						22.4 (320)	Pendant	25	1.7
						25.2 (360)	Pendant	15	1.0
				35	11	14.0 (200)	Upright/pendant	75	5.2
						16.8 (240)	Upright/pendant	52	3.6
						22.4 (320)	Pendant	40	2.7
						25.2 (360)	Pendant	30	2.1
		30	9.1	40	12	14.0 (200)	Upright/pendant	75	5.2
						16.8 (240)	Upright/pendant	52	3.6
						22.4 (320)	Pendant	40	2.7
						25.2 (360)	Pendant	30	2.1
				45	14	14.0 (200)	Upright/pendant	75	5.2
						16.8 (240)	Upright/pendant	52	3.6
						22.4 (320)	Pendant	40	2.7
						25.2 (360)	Pendant	30	2.1
				50	15	14.0 (200)	Upright/pendant	75	5.2
						16.8 (240)	Upright/pendant	52	3.6
						22.4 (320)	Pendant	40	2.7
						25.2 (360)	Pendant	30	2.1

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Table 23.4.2 ESFR Protection of Palletized and Solid Piled Storage of Group A Plastic Commodities

Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure	
		ft	m	ft	m			psi	bar
Palletized and solid piled storage (no open-top containers)	Carroll's nonexpanded plastic	20	6.1	25	7.6	14.0 (200)	Upright/pendant	50	3.4
						16.8 (240)	Upright/pendant	35	2.4
						22.4 (320)	Pendant	25	1.7
						25.2 (360)	Pendant	15	1.0
				30	9.1	14.0 (200)	Upright/pendant	50	3.4
						16.8 (240)	Upright/pendant	35	2.4
						22.4 (320)	Pendant	25	1.7
						25.2 (360)	Pendant	15	1.0
				35	11	14.0 (200)	Upright/pendant	75	5.2
						16.8 (240)	Upright/pendant	52	3.6
						22.4 (320)	Pendant	40	2.7
						25.2 (360)	Pendant	30	2.1
		30	9.1	40	12	14.0 (200)	Upright/pendant	75	5.2
						16.8 (240)	Upright/pendant	52	3.6
						22.4 (320)	Pendant	40	2.7
						25.2 (360)	Pendant	30	2.1
				45	14	14.0 (200)	Upright/pendant	75	5.2
						16.8 (240)	Upright/pendant	52	3.6
						22.4 (320)	Pendant	40	2.7
						25.2 (360)	Pendant	30	2.1
				50	15	14.0 (200)	Upright/pendant	75	5.2
						16.8 (240)	Upright/pendant	52	3.6
						22.4 (320)	Pendant	40	2.7
						25.2 (360)	Pendant	30	2.1

FM 8-9- Protection Table Example

tyco

Table 11. Ceiling-Level Protection Guidelines for Uncartoned Expanded Plastic Commodities in Open-Frame Rack Storage Arrangements

Protection of Uncartoned Expanded Plastic Commodities in Open-Frame Storage Racks; No. of AS @ psi (bar)																		
Max. Ceiling Height, ft (m)	Wet System, Pendant Sprinklers, 160°F (70°C)*										Wet System, Upright Sprinklers, 160°F (70°C)						Dry System, Upright Sprinklers, 280°F (140°C)	
	Quick Response					Standard Response					Quick Response			Standard Response				
	K11.2 (K180)	K14.0 (K200)	K16.8 (K240)	K22.4 (K320)	K25.2 (K360)	K25.2EC (K360EC)	K11.2 (K180)	K14.0 (K200)	K16.8 (K240)	K25.2 (K360)	K11.2 (K180)	K14.0 (K200)	K16.8 (K240)	K25.2 (K360)	K11.2 (K180)	K16.8 (K240)	K19.6 (K280)	K25.2 (K360)
5 (1.5)	20 @ 7 (0.5)	12 @ 7 (0.5)	12 @ 7 (0.5)	12 @ 7 (0.5)	12 @ 7 (0.5)	10 @ 7 (0.5)	20 @ 7 (0.5)	20 @ 7 (0.5)	20 @ 7 (0.5)	20 @ 7 (0.5)	20 @ 7 (0.5)	20 @ 7 (0.5)	20 @ 7 (0.5)	20 @ 7 (0.5)	20 @ 7 (0.5)	20 @ 7 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)
8 (2.4)	20 @ 12 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	12 @ 12 (0.5)	10 @ 12 (0.5)	20 @ 12 (0.5)	20 @ 12 (0.5)	20 @ 12 (0.5)	20 @ 12 (0.5)	20 @ 12 (0.5)	20 @ 12 (0.5)	20 @ 12 (0.5)	20 @ 12 (0.5)	20 @ 12 (0.5)	20 @ 12 (0.5)	25 @ 12 (0.5)	25 @ 12 (0.5)
10 (3.0)	20 @ 16 (1.1)	12 @ 16 (1.1)	12 @ 16 (1.1)	12 @ 16 (1.1)	12 @ 16 (1.1)	10 @ 16 (1.1)	20 @ 16 (1.1)	20 @ 16 (1.1)	20 @ 16 (1.1)	20 @ 16 (1.1)	20 @ 16 (1.1)	20 @ 16 (1.1)	20 @ 16 (1.1)	20 @ 16 (1.1)	20 @ 16 (1.1)	20 @ 16 (1.1)	25 @ 16 (1.1)	25 @ 16 (1.1)
12 (3.6)	20 @ 20 (2.1)	12 @ 20 (2.1)	12 @ 20 (2.1)	12 @ 20 (2.1)	12 @ 20 (2.1)	10 @ 20 (2.1)	20 @ 20 (2.1)	20 @ 20 (2.1)	20 @ 20 (2.1)	20 @ 20 (2.1)	20 @ 20 (2.1)	20 @ 20 (2.1)	20 @ 20 (2.1)	20 @ 20 (2.1)	20 @ 20 (2.1)	20 @ 20 (2.1)	25 @ 20 (2.1)	25 @ 20 (2.1)
15 (4.5)	25 @ 25 (3.5)	12 @ 25 (3.5)	12 @ 25 (3.5)	12 @ 25 (3.5)	12 @ 25 (3.5)	10 @ 25 (3.5)	25 @ 25 (3.5)	25 @ 25 (3.5)	25 @ 25 (3.5)	25 @ 25 (3.5)	25 @ 25 (3.5)	25 @ 25 (3.5)	25 @ 25 (3.5)	25 @ 25 (3.5)	25 @ 25 (3.5)	25 @ 25 (3.5)	35 @ 25 (3.5)	35 @ 25 (3.5)
20 (6.0)	30 @ 30 (4.2)	12 @ 30 (4.2)	12 @ 30 (4.2)	12 @ 30 (4.2)	12 @ 30 (4.2)	10 @ 30 (4.2)	30 @ 30 (4.2)	30 @ 30 (4.2)	30 @ 30 (4.2)	30 @ 30 (4.2)	30 @ 30 (4.2)	30 @ 30 (4.2)	30 @ 30 (4.2)	30 @ 30 (4.2)	30 @ 30 (4.2)	30 @ 30 (4.2)	35 @ 30 (4.2)	35 @ 30 (4.2)
25 (7.5)	35 @ 35 (4.9)	12 @ 35 (4.9)	12 @ 35 (4.9)	12 @ 35 (4.9)	12 @ 35 (4.9)	10 @ 35 (4.9)	35 @ 35 (4.9)	35 @ 35 (4.9)	35 @ 35 (4.9)	35 @ 35 (4.9)	35 @ 35 (4.9)	35 @ 35 (4.9)	35 @ 35 (4.9)	35 @ 35 (4.9)	35 @ 35 (4.9)	35 @ 35 (4.9)	35 @ 35 (4.9)	35 @ 35 (4.9)
30 (9.0)	40 @ 40 (5.6)	12 @ 40 (5.6)	12 @ 40 (5.6)	12 @ 40 (5.6)	12 @ 40 (5.6)	10 @ 40 (5.6)	40 @ 40 (5.6)	40 @ 40 (5.6)	40 @ 40 (5.6)	40 @ 40 (5.6)	40 @ 40 (5.6)	40 @ 40 (5.6)	40 @ 40 (5.6)	40 @ 40 (5.6)	40 @ 40 (5.6)	40 @ 40 (5.6)	40 @ 40 (5.6)	40 @ 40 (5.6)
35 (10.5)							20 @ 75 (5.2)											
40 (12.0)							20 @ 75 (5.2)											


* The protection options indicated in the protection table for upright sprinklers can also be used as an alternative option for pendant sprinklers having the same K-factor, RTI rating, nominal temperature rating and spacing requirements as the upright sprinkler.

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Early Suppression Fast Response (ESFR) Data Sheets

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Model ESFR-14
14.0 K-factor Dry Type Pendant Sprinkler
Early Suppression, Fast Response

General Description

Sprinkler Identification Number (SIN)

Technical Data

Operation




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Model ESFR-17
17.0 K-factor Dry Type Pendant Sprinkler
Early Suppression, Fast Response

General Description

Sprinkler Identification Number (SIN)

Technical Data

Operation




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Model ESFR-22
22.4 K-factor Dry Type Pendant Sprinkler
Early Suppression, Fast Response

General Description

Sprinkler Identification Number (SIN)

Technical Data

Operation



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Model ESFR-25
25.2 K-factor Dry Type Pendant Sprinkler
Early Suppression, Fast Response

General Description

Sprinkler Identification Number (SIN)

Technical Data

Operation



tyco
Model ESFR-25
25.2 K-factor Dry Type Pendant Sprinkler
Early Suppression, Fast Response

General Description

Sprinkler Identification Number (SIN)

Technical Data

Operation

Specific Application Listing (UL)

TYCO Model ESFR-25 Pendant Sprinklers are listed by Underwriters Laboratories (UL) for Specific Applications with a ceiling height greater than 45 ft (13.7 m) up to and including 48 ft (14.6 m), and a storage arrangement up to and including 43 ft (13.1 m). Refer to Table C for guidelines for the TYCO Model ESFR-25 Pendant Sprinkler Specific Applications Listing (UL) Design Criteria. Refer to Table C for additional information.

Class I-IV, Cartoned Nonexpanded Plastic

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Positioning ESFR-34 in the Market

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

Value Proposition:

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

DESIGN FLEXIBILITY FOR INCREASED STORAGE

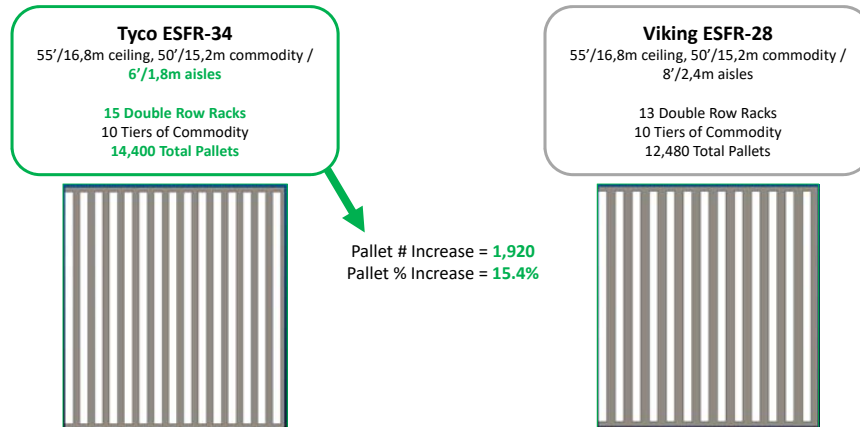
Manufacturer	Viking ESFR-28 (FM)	JCI ESFR-34 (FM)
SIN	VK514	TY9286
Approval/Listing	FM Approval	FM Approval
K-Factor	28.0 / 404	33.6 / 487
Thread	1" NPT	1-1/4" NPT
Max Ceiling Height (ft)	55' / 16,8m	55' / 16,8m
Max Commodity Height (ft)	50' / 15,2m	50' / 15,2m
Commodity	Cartoned Unexpanded	Cartoned Unexpanded
Min Aisle Width (ft)	8' / 2,4m	6' / 1,8m
Sprinklers in design	9	9
Minimum Pressure	80 psi / 5,5 bar	55 psi / 3,8 bar
Flow per sprinkler	250 gpm (948 ltr/min)	249 gpm (943 ltr/min)
Max Flow (theoretical)	2,254 gpm (8,532 ltr/min)	2,243 gpm (8,489 ltr/min)
Duration time	60 min	60 min
Racks	Single or Double	Single or Double
Center of Element to Ceiling	13" / 325mm	17" / 432mm



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Positioning ESFR-34 in the Market



Narrower aisles → more rows → more pallets → more value



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Suppression Mode Sprinklers- Head Guard

tyco



Worldwide
Contacts | www.tyco-fire.com

Model EG-25 Sprinkler Guard For Model ESFR-25 Pendent Sprinkler

General Description

The TYCO Model EG-25 Sprinkler Guard is designed to be used with the TYCO Model ESFR-25 Pendent Sprinkler and may be used in areas that make it susceptible to mechanical or physical damage.

The Model EG-25 Sprinkler Guard is seen in Figure 1, provides protection from mechanical and physical damage, for example, such storage vehicle installation.

The Model EG-25 Sprinkler Guard is intended for use in fire sprinkler systems designed in accordance with the standard installation rules being used by the applicable listing agency.

NOTE: The Model EG-25 Sprinkler Guard described herein must be installed and maintained in compliance with this document and with the applicable standards of the applicable authority having jurisdiction (AHJ), in addition to the standards of any authority having jurisdiction. Failure to do so may impact the performance of these devices.

Owners are responsible for maintaining the fire protection system and ensuring proper operating condition. The installing contractor or sponsor must ensure that the system is installed and maintained in accordance with the standards of the AHJ.

IMPORTANT: Refer to Technical Data Sheet TFP704 for warnings pertaining to regulatory and health information. Always refer to Technical Data Sheet TFP704 for the "WARRANTY INFORMATION" that provides customers with regard to handling and installation of the product. Improper handling and installation can permanently damage a sprinkler system or its components and cause the sprinkler to fail to operate in the event of a fire.

Technical Data

Approvals
UL Approved

Features
Heat sensitive and non-removable

Physical Characteristics
Material: Steel
Weight: 1.0 lb (0.45 kg)

Design Criteria

In accordance with the requirements of the AHJ, the Model EG-25 Sprinkler Guard must be installed in accordance with the standard installation rules being used by the applicable listing agency. The Model EG-25 Sprinkler Guard should only be used with the TYCO Model ESFR-25 Pendent Sprinkler.

Installation

The TYCO Model EG-25 Sprinkler Guard must be installed onto the TYCO Model ESFR-25 Pendent Sprinkler in accordance with the standard installation rules being used by the applicable listing agency. Refer to Figures 1 and 2.

NOTE: The Model EG-25 Sprinkler Guard must be installed in accordance with Technical Data Sheet TFP704, including the Model EG-25 Sprinkler Guard.

Step 1: With the clip loose, carefully insert the top screw of the guard into the top of the sprinkler head and the top of the guard head from the top.

Step 2: Push the guard in until the head of the screw is flush with the top of the guard head. The guard head will be flush with the top of the guard head.

Step 3: Insert the top clip to engage the top of the guard head and the top of the guard head. The top clip will be flush with the top of the guard head.



Step 4: Insert the second clip to engage the top of the guard head and the top of the guard head. The second clip will be flush with the top of the guard head.

NOTE: The installation of the guard head in Figure 2 may be used as an aid when installing and testing the clip. After the clip is installed, the clip must be tested to ensure proper operation of the guard head.

NOTE: In compliance with the installation, the clip must be tested to ensure proper operation of the guard head.

Care and Maintenance

The TYCO Model EG-25 Sprinkler Guard does not require any regular maintenance, inspection, testing or replacement of the guard head. The guard head should be tested during the annual inspection of the sprinkler.

NOTE: In compliance with the installation, the clip must be tested to ensure proper operation of the guard head.

Responsibility lies with the installing contractor for the inspection, testing and maintenance of the fire protection system and ensuring compliance with this document. In order to ensure proper operation of the guard head, the clip must be tested during the annual inspection of the sprinkler.

Page 1 of 2
AUGUST 2018
TFP704

Alternative Solutions



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

ELECTRONIC SPRINKLER SYSTEM PROTECTION FOR HAZARDS UP TO AND INCLUDING EXPOSED AND EXPANDED GROUP A PLASTICS

GENERAL GUIDELINES:
When Tyco Electronic Sprinklers, paired with Simplex 4098 TrueAlarm Heat Sensors, are installed to provide ceiling-only protection of storage occupancies including single, double, palletized, and solid piled storage, up to and including exposed, expanded, Group A plastics commodities as defined by NFPA 13 (no open top containers or solid shelves), the installation criteria is as follows:

- a maximum coverage area of 100 ft² (9.3 m²) per sprinkler
- a minimum coverage area of 64 ft² (5.9 m²) per sprinkler
- a water supply duration of 60 minutes minimum is required

The sprinkler spacing criteria is:

- maximum spacing shall be 12 ft (3.66 m) for buildings having a ceiling height less than 30 ft (9.14 m)
- maximum spacing shall be 10 ft (3.05 m) for buildings having a ceiling height greater than 30 ft (9.14 m)
- 8 ft (2.4 m) minimum spacing for all construction types

MINIMUM RECOMMENDED NO. OF SPRINKLERS

CEILING HEIGHT ft (m)	STORAGE HEIGHT ft (m)	MINIMUM AISLE SPACING ft (m)	DESIGN PRESSURE psi (bar)	MINIMUM RECOMMENDED NO. OF SPRINKLERS
35 (10.7)	30 (9.1)	8 (2.4)	52 (3.6)	9 Sprinklers in 4-4-1 arrangement: 4 on 2 most remote branch lines, 1 on next nearest branch line

**TABLE C
ELECTRONIC SPRINKLER SYSTEM
DESIGN CRITERIA**



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

EC-25

Upright



K Factor	K=25.2 (362.9)
Thread Size	1" NPT or ISO 7-R1
Approvals	UL, C-UL, FM, NYC
Temperature	165°F/74°C, 212°F/100°C
Sprinkler Finish	Natural Brass
SIN	TY9128
Wrench Type	W-TYPE 1
Tech Data Sheet	TFP213

For use in high density applications such as "big box" retailing, extra hazard, and high-piled storage occupancies ■ Solder type ■ CMAA and CMSA Applications and FM Approved for storage and non-storage applications ■ Minimum operating pressure of 7 psi (0.48 bar) ■ The maximum coverage area per sprinkler is 196 ft.² (18.2 m²), which is almost double the area offered by standard coverage sprinklers used for similar applications.

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

Table 24.3.1 Extended Coverage, CMSA [K-Factor 25.2 (360)] Sprinkler Design Criteria for Single-, Double-, and Multiple-Row Racks Without Solid Shelves of Class I Through Class IV and Cartoned Nonexpanded Plastic Commodities

Storage Arrangement	Commodity Class	Maximum Storage Height		Maximum Ceiling/Roof Height		K-Factor / Orientation	Type of System	Number of Design Sprinklers	Minimum Operating Pressure	Maximum Coverage Area
		ft	m	ft	m					
Single-, double-, and multiple-row racks without solid shelves (no open-top containers)	Class I through Class IV, encapsulated and nonencapsulated, and cartoned nonexpanded plastics	20	6.1	30	9.1	25.2 (360) Uprights/pendent	Wes	6	30 psi (2.1 bar)	12 ft × 12 ft (3.7 m × 3.7 m) 144 ft ² (13 m ²)
		20	6.1	30	9.1	25.2 (360) Uprights/pendent	Wes	6	30 psi (2.1 bar)	14 ft × 14 ft (4.3 m × 4.3 m) 196 ft ² (18 m ²)
		25	7.6	30	9.1	25.2 (360) Uprights/pendent	Wes	6	30 psi (2.1 bar)	12 ft × 12 ft (3.7 m × 3.7 m) 144 ft ² (13 m ²)
		25	7.6	30	9.1	25.2 (360) Uprights/pendent	Wes	6	30 psi (2.1 bar)	14 ft × 14 ft (4.3 m × 4.3 m) 196 ft ² (18 m ²)
		25	7.6	35	11	25.2 (360) Uprights/pendent	Wes	8	40 psi (2.6 bar)	12 ft × 12 ft (3.7 m × 3.7 m) 144 ft ² (13 m ²)
		25	7.6	35	11	25.2 (360) Uprights	Wes	8	40 psi (2.6 bar)	14 ft × 14 ft (4.3 m × 4.3 m) 196 ft ² (18 m ²)
		30	9.1	35	11	25.2 (360) Uprights/pendent	Wes	8	40 psi (2.7 bar)	12 ft × 12 ft (3.7 m × 3.7 m) 144 ft ² (13 m ²)
		30	9.1	35	11	25.2 (360) Uprights	Wes	8	40 psi (2.6 bar)	14 ft × 14 ft (4.3 m × 4.3 m) 196 ft ² (18 m ²)

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Water Supply Duration and Other Standards

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Water Supply Allowances

tyco.

Table 24.4.1 Hose Stream Allowance and Water Supply Duration

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

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Water Supply Allowances: FM Global

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Table 14. Hose Demand and Water Supply Duration Design Guidelines

Sprinkler Type by Spacing	No. of Sprinklers in Ceiling Design	Hose Demand, gpm (L/min)	Duration, min
Standard spacing	Up to 12	250 (950)	60
	13 to 19	500 (1,900)	90
	20 or more	500 (1,900)	120
Extended-coverage	Up to 6	250 (950)	60
	*7 to 9	500 (1,900)	90
	10 or more	500 (1,900)	120

* When the maximum linear spacing is 12 ft (3.7 m), the hose demand can be 250 gpm (950 L/min) and the duration can be 60 minutes.

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Other Standards to Be Familiar With

FM Technical Datasheets	NFPA Standards
FM 2-0 Installation	NFPA 30: Flammable and Combustible Liquids Code
FM 8-24: Idle Pallet Storage	NFPA 30B: Code for the Manufacture and Storage of Aerosol Products
FM 8-29: Refrigerated Storage	NFPA 20: Standard for the Installation of Stationary Fire Pumps for Fire Protection
FM 8-33: Carousel Storage and Retrieval Systems	NFPA 24: Standard for the Installation of Private Fire Service Main
FM 8-34: Protection for Automatic Storage and Retrieval Systems	NFPA 25: Standard for the Inspection Testing and Maintenance of Water-based Fire Protection
2-81: Fire Protection System Inspection, Testing and Maintenance	

NFPA 13: 28.4 The installing contractor shall provide the property owner or the property owner's authorized representative with the following:

1. **All literature and instructions** provided by the manufacturer describing proper operation and maintenance of any equipment and devices installed
2. NFPA 25

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FM 8-34

Table 6. In-Rack Sprinkler Design Guidelines

Depth of ASRS Row	Tray or Container Material Composition	Maximum Vertical Distance Between In-Rack Sprinklers	No. of IRAS in Design	Design Flow from Most Remote IRAS, gpm (L/min)	
				Vertical Distances Between Tier Levels ≥ 9 in. (225 mm)	Vertical Distances Between Tier Levels < 9 in. (225 mm)
Up to 3 ft (0.9 m)	Noncombustible Closed-Top Container	10 ft (3.0 m)	4	30 (115)	50 (190)
		15 ft (4.5 m)	6	60 (230)	80 (300)
	Corrugated or Expanded Plastic Trays or Containers	10 ft (3.0 m)	6	60 (230)	80 (300)
		15 ft (4.5 m)	6	100 (380)	120 (455)
Over 3 ft (0.9 m) and up to 6 ft (1.8 m)	Noncombustible Closed-Top Container	10 ft (3.0 m)	6	30 (115)	50 (190)
		15 ft (4.5 m)	9	60 (230)	80 (300)
	Corrugated or Expanded Plastic Trays or Containers	10 ft (3.0 m)	8	60 (230)	80 (300)
		15 ft (4.5 m)	9	100 (380)	120 (455)
Over 6 ft (1.8 m)	Noncombustible Closed-Top Container	10 ft (3.0 m)	8	30 (115)	50 (190)
		15 ft (4.5 m)	12	60 (230)	80 (300)
	Corrugated or Expanded Plastic Trays or Containers	10 ft (3.0 m)	10	60 (230)	80 (300)
		15 ft (4.5 m)	12	100 (380)	120 (455)

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Poll Question 4

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

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

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Questions?



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