Reliable
Safety & Flow Corporation™

Use of Reliable Sprinklers in Storage Areas according to FM Guidelines and EN 12845-2

Built for Those Who Build™

FM Global: Organization, history, standards

Fire hazard classification according to FM

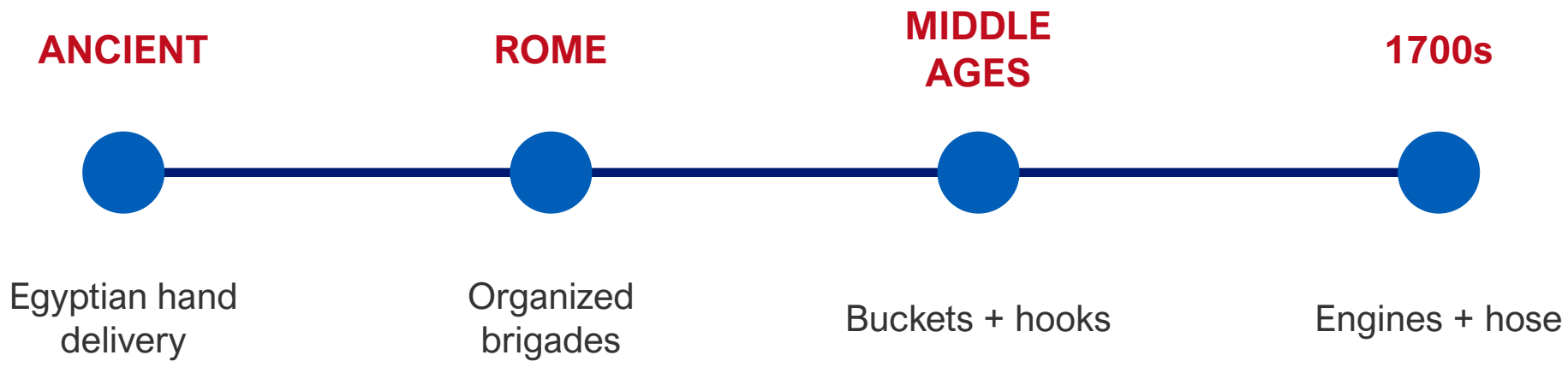
Ceiling level sprinkler system design criteria

Alternative In-Rack Sprinkler Designs

Storage according to new EN 12845-2

Agenda

Suppression started with water

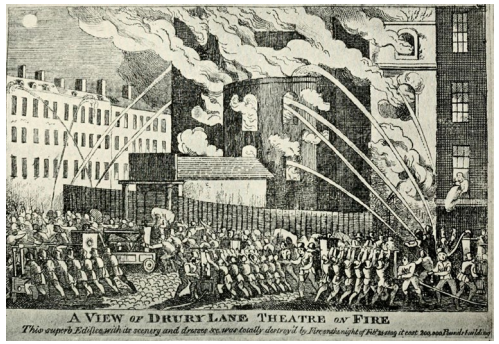


The core limitation remained: people had to detect, arrive and act.

History of fixed fire extinguishing systems – timeline:

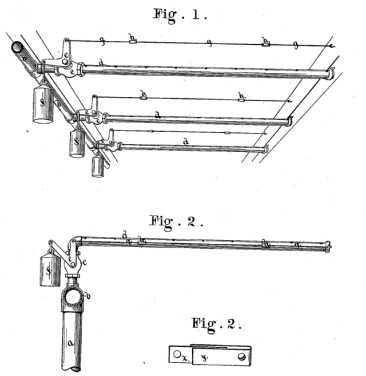
1806

Water-based permanent fire extinguishing system concept, Eng. John Carey, UK



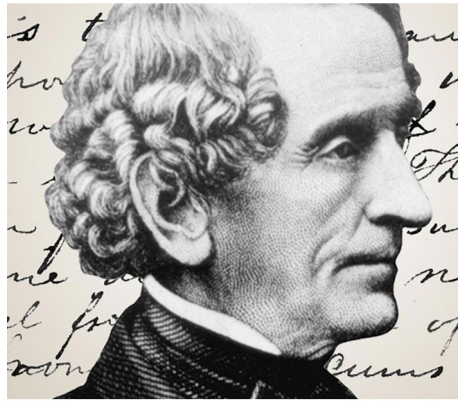
1812

Colonel William Congreve receives the patent rights for a permanent fire extinguishing system. The system is installed in the Theatre Royal building on Drury Lane in London, rebuilt after a fire in 1809.



1835

Preventing material losses was not a priority in business. That is, if your business has been affected by a fire, flood or other cataclysm, you have rebuilt it and hoped for a better tomorrow. Until Zachariah Allen, the owner of a textile spinning mill from Rhode Island, USA, appeared. FM Global

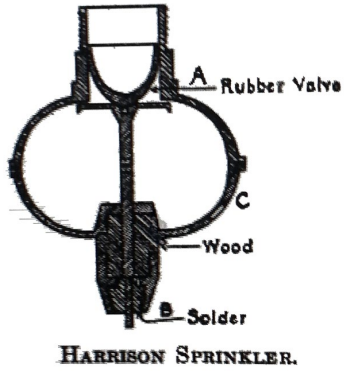


1835 <

Allen recruited other mill owners who shared his philosophy of loss prevention. Together, they joined forces to create a mutual insurance company that exclusively insured "low-risk" factories – creating the category of "high-risk real estate" (HPR). Other companies joined the group, which became known as Factory Mutuals.



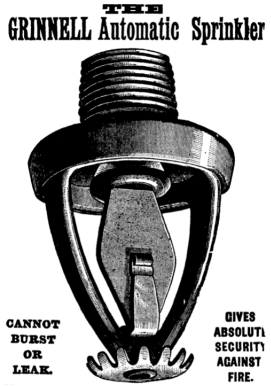
1864 First design of an automatic sprinkler – Major A. Stewart Harrison, United Kingdom



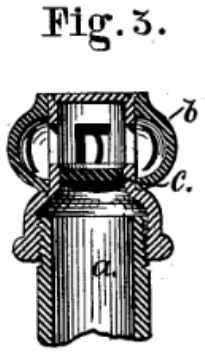
History of fixed fire extinguishing systems – timeline:

1872-1875

F. Henry S. Parmelee improves the design of the sprinkler by introducing a fuse joint. The sprinkler system is installed in its piano factories in Chicago and Boston.

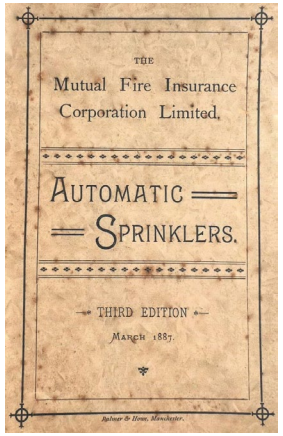


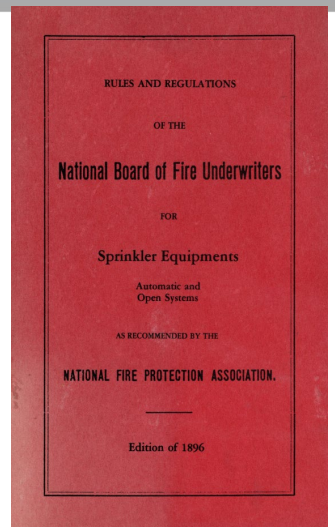
1882 – 1890 Frederick Grinnell develops Parmelee's design, introduces a deflector. More than 40 patents are granted. The first sprinkler with a glass bulb is created.



1884

The first systematic laboratory tests of the effectiveness of fire protection systems are carried out. The results were published by the Boston Manufacturers Mutual Insurance Company.





1896

Organization is renamed to "National Fire Protection Association". A report is published that becomes the first edition of NFPA 13 standard

And what does the history of Reliable look like over the years?

1896
Frank J. Fee of the year became Master Plumber and Runs a plumbing company on West 40th Street in New York City, known as Frank J. Fee Plumbing & Heating Contractor

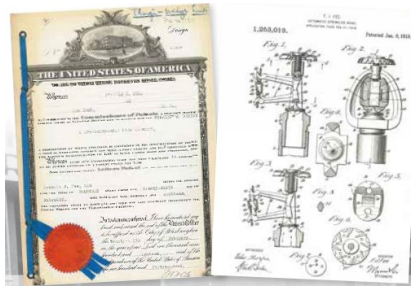


1901 - 1911

In the aftermath of tragic fires in the early twentieth century, such as the Iroquois Theatre Fire (Chicago, 1901) and the Triangle Shirtwaist Fire (New York, 1911), public outrage led to the passage of building codes and regulations mandating the use of automatic sprinkler systems in many manufacturing plants and public facilities.

1916

February 1916 – Frank J. Fee began designing automatic sprinkler equipment



1918

The first patent application was granted in January 1918, in February another patent was granted for fire sprinklers with a fuse connecting element

1920

January, 23rd 1920, The Reliable Automatic Sprinkler was founded



1927

Reliable placed its first print ad in
The Plumbers Trade Journal.

Reliable sprinklers over 100 years



The Issue "A" Sprinkler was produced for only 2 years: 1920 and 1921.



GXLO Extra Large Orifice Sprinkler (1988)

100 years of sprinkler designs

H22 ESFR Sprinkler (1998)



Product Brochure (1950s)



Issue "B"; Model C

FM Data Sheets Overview

- Free resources available on the **FM Globalwebsite**
- Organized into **15 series** covering key fire protection and risk management topics:
  - **Construction** (Series 1)
  - **Sprinklers & Water Supply** (Series 2-3)
  - **Alternative Protection Systems** (Series 4)
  - **Electrical & Mechanical Systems** (Series 5, 13)
  - **Boilers & Pressure Vessels** (Series 6, 12, 17)
  - **Special Hazards & Storage Protection** (Series 7, 8)
  - **Property Protection & Human Factors** (Series 9, 10)
  - **Controls, Instrumentation & Welding** (Series 11, 15)

Reliable
Safety & Flow Corporation

Essential FM Data Sheets standards for automatic sprinkler systems and its components

- ❑ 1-2 Earthquakes
- ❑ 1-10 Interaction of Sprinklers, Smoke and Heat Vents, and Draft Curtains
- ❑ 1-20 Protection Against Exterior Fire Exposure
- ❑ 1-21 Fire Resistance of Building Assemblies
- ❑ 2-0 Installation Guidelines for Automatic Sprinklers
- ❑ 2-1 Corrosion in Automatic Sprinkler Systems
- ❑ 2-81 Fire Protection System Inspection, Testing and Maintenance
- ❑ 3-0 Hydraulics of Fire Protection Systems
- ❑ 3-2 Water Tanks for Fire Protection
- ❑ 3-7 Fire Protection Pumps
- ❑ 3-26 Fire Protection for Nonstorage Occupancies
- ❑ 7-29 Ignitable Liquid Storage in Portable Containers
- ❑ 7-31 Storage of Aerosol Products
- ❑ 7-32 Ignitable Liquid Operations
- ❑ 7-112 Lithium-Ion Battery Manufacturing and Storage
- ❑ 8-1 Commodity Classification
- ❑ 8-9 Storage of Class 1, 2, 3, 4 and Plastic Commodities
- ❑ 8-34 Protection for Automatic Storage and Retrieval Systems

INSTALLATION GUIDELINES FOR AUTOMATIC SPRINKLERS

Table of Contents

Page

1.0 SCOPE 7
1.1 Hazards 7
1.2 Changes 7
1.3 Superseded Information 8
2.0 LOSS PREVENTION RECOMMENDATIONS 8
2.1 General Recommendations for the Installation of Sprinklers 8
2.1.1 How to Use This Data Sheet 8
2.1.2 Where Sprinklers Are Needed 10
2.1.3 Water Supplies for Sprinkler Systems 10
2.1.4 General Recommendations for Sprinkler Systems and their Components 11
2.1.5 Other Relevant Data Sheets 11
2.2 Sprinkler System Types 12
2.2.1 General Recommendations for Sprinkler System Types 12
2.2.2 Wet-Pipe Sprinkler Systems 20
2.2.3 Dry-Pipe Sprinkler Systems 20
2.2.4 Preaction Sprinkler Systems 21
2.2.5 Refrigerated-Area Sprinkler Systems 22
2.2.6 Vacuum Sprinkler Systems 24
2.2.7 Deluge Sprinkler Systems 24
2.2.8 Antifreeze Solution Sprinkler Systems 25
2.2.9 Exposure-Protection Sprinkler Systems 27
2.3 Sprinkler System Components 27
2.3.1 Control Valves 27
2.3.2 Check Valves 28
2.3.3 Waterflow Alarms 28
2.3.4 Inspector's and By-Pass Test Connections 28
2.3.5 Pressure Gauges 30
2.3.6 Fire Service Connections 30
2.3.7 Drain Valves 32
2.3.8 Pressure Relief Valves 32
2.3.9 Pressure Reducing Valves 32
2.3.10 Orifice Restriction Plates (i.e., Orifice Plates) 32
2.3.11 Automatic Breach Containment Valves 32
2.4 Sprinkler System Piping 32
2.4.1 Sprinkler System Pipe 32
2.4.2 Sprinkler System Pipe Connections and Assemblies 35
2.4.3 Sprinkler System Pipe Hanging and Bracing 37
2.5 Sprinklers 42
2.5.1 General Recommendations for Sprinklers 42
2.5.2 Nonstorage Pendent and Upright Sprinklers 56
2.5.3 Nonstorage Sidewall Sprinklers 93
2.5.4 Storage Sprinklers 105
2.5.5 Special Protection Sprinklers 145
2.6 Plan Review of Sprinkler Systems 145
2.6.1 General Recommendations for Plan Review of Sprinkler Systems 145
2.6.2 Working Drawings 146

©2021-2024 Factory Mutual Insurance Company. All rights reserved. No part of this document may be reproduced, stored in a retrieval system, or transmitted, in whole or in part, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without written permission of Factory Mutual Insurance Company.

General Recommendations for Sprinkler Systems and their Components

Install only new, FM Approved **(where available),** sprinkler system components.

Ensure the application of each component is in accordance with the following:

- Its listing in the Approval Guide, and
- The manufacturer's installation instructions, and
- The relevant occupancy-specific data sheet, and
- Any specific jurisdictional requirements

General Recommendations for Sprinkler Systems and their Components

- **Sprinklers and sprinkler escutcheons**
- Sprinkler system valves (alarm check, dry-pipe, deluge, etc.) and their accessories
- Sprinkler system control valves
- Check valves (check, backflow, etc.)
- Waterflow alarms
- Sprinkler system inspector's test connections
- Pressure gauges
- Fire service connections
- Drain valves
- Pressure relief valves
- Pressure reducing valves
- Sprinkler pipe
- Sprinkler pipe connections and pipe assemblies
- Sprinkler pipe hanging and bracing supports

Fire hazard classification according FM Guidelines



Fire hazard classification according FM

Non-storage (occupancy) hazards

- Hazard classes based on area's occupancy (office, production process etc.) – see FM DS 3-26

Storage hazards determined by:

- Commodity classification – FM DS 8-1
- Storage methods and special storage considerations – FM DS 8-9
- Storage height – FM DS 8-9
- Flue Spaces !!! – see 2.2.3.2 FM 8-9
- Building's ceiling height
- Special applications ?? (example automatic storage FM DS 8-34, flammable liquid 7-29)

Occupancy hazards (non-storage areas) – ESFR sprinklers !!

Low-Piled Storage Protection

- Applies when **storage area exceeds ordinary storage limits** but remains within **low-piled storage height limits**.
- Includes **solid-pile, palletized, shelf, and bin-box storage**.
- Protection must follow **Table 2.3.3.1** and **FM Data Sheet 2-0 sprinkler installation requirements**.
- For **ceiling heights below 30 ft (9 m)**, use the **FM Data Sheet 8-9 solid-pile storage protection tables**.

Table 2.3.3.1. Sprinkler Protection Guidelines for Low-Piled Storage

Wet System, Pendent Sprinklers, 160°F (70°C), Number of AS @ psi (bar)

Commodity	Max. Ceiling Height, ft (m)	Quick-Response						Standard-Response				
		K11.2 (K160)	K14.0 (K200)	K16.8 (K240)	K22.4 (K320)	K25.2 (K360)	K25.2EC (K360EC)	K11.2 (K160)	K14.0 (K200)	K19.6 (K280)	K25.2 (K360)	K25.2EC (K360EC)
Up to CEP Note 1	30 (9)	25 @ 7 (0.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	25 @ 15 (1)	25 @ 15 (1)	6 @ 52 (3.5)	25 @ 7 (0.5)	25 @ 7 (0.5)	25 @ 16 (1.1)	25 @ 7 (0.5)	
	45 (14)	25 @ 16 (1.1)	25 @ 10 (0.7)	25 @ 7 (0.5)	25 @ 15 (1)	25 @ 15 (1)	6 @ 52 (3.5)					
	60 (18)	25 @ 16 (1.1)	25 @ 10 (0.7)	25 @ 7 (0.5)	25 @ 15 (1)	25 @ 15 (1)	6 @ 52 3.5)					
UUP	30 (9)	25 @ 50 (3.4)	10 @ 62 (4.3)	10 @ 43 (3)	14 @ 24 (1.7)	14 @ 19 (1.3)	12 @ 38 (2.6)	25 @ 50 (3.4)	25 @ 32 (2.2)	25 @ 16 (1.1)	25 @ 10 (0.7)	25 @ 50 (3.4)
	45 (14)		10 @ 62 (4.3)	10 @ 43 (3)	14 @ 24 (1.7)	14 @ 19 (1.3)						
	60 (18)				10 @ 50 (3.4)	10 @ 40 (2.8)						

Wet System, Upright Sprinklers, 160°F (70°C), Number of AS @ psi (bar)

Commodity	Max. Ceiling Height, ft (m)	Quick-Response						Standard-Response				
		K11.2 (K160)	K14.0 (K200)	K14.0EC (K200 EC)	K16.8 (K240)	K25.2EC (K360EC)		K11.2 (K160)	K16.8 (K240)		K25.2 (K360)	
Up to CEP Note 1	30 (9)	25 @ 7 (0.5)	25 @ 7 (0.5)	6 @ 73 (5)	25 @ 7 (0.5)	6 @ 52 (3.5)		25 @ 7 (0.5)	25 @ 7 (0.5)		25 @ 7 (0.5)	
	45 (14)	25 @ 16 (1.1)	25 @ 10 (0.7)		25 @ 7 (0.5)	6 @ 52 (3.5)						
	60 (18)	25 @ 16 (1.1)	25 @ 10 (0.7)		25 @ 7 (0.5)	6 @ 52 (3.5)						
UUP	30 (9)	25 @ 50 (3.4)	10 @ 62 (4.3)		10 @ 43 (3)	12 @ 38 (2.6)		25 @ 50 (3.4)	25 @ 22 (1.5)		25 @ 10 (0.7)	
	45 (14)		10 @ 62 (4.3)		10 @ 43 (3)							
	60 (18)											

[1] Protect Class 1-3 commodities stored up to 10 ft (3 m) high using the guidelines for CEP commodities stored under a 30 ft (9 m) ceiling.

Even up to 18 m height !

Hazard categories for storage areas

Commodity class FM DS 8-9

FM Global's standard commodities are ranked from the lowest hazard (noncombustible) to the highest hazard (uncartoned expanded plastic), as follows:

- Class 1
- Class 2
- Class 3
- **Class 4/Cartoned unexpanded plastic (CUP)**
- **Cartoned expanded plastic (CEP)**
- **Uncartoned unexpanded plastic (UUP)**
- **Uncartoned expandeed plastic (UEP)**

Hazard categories for storage areas - Classification FM DS 8-1

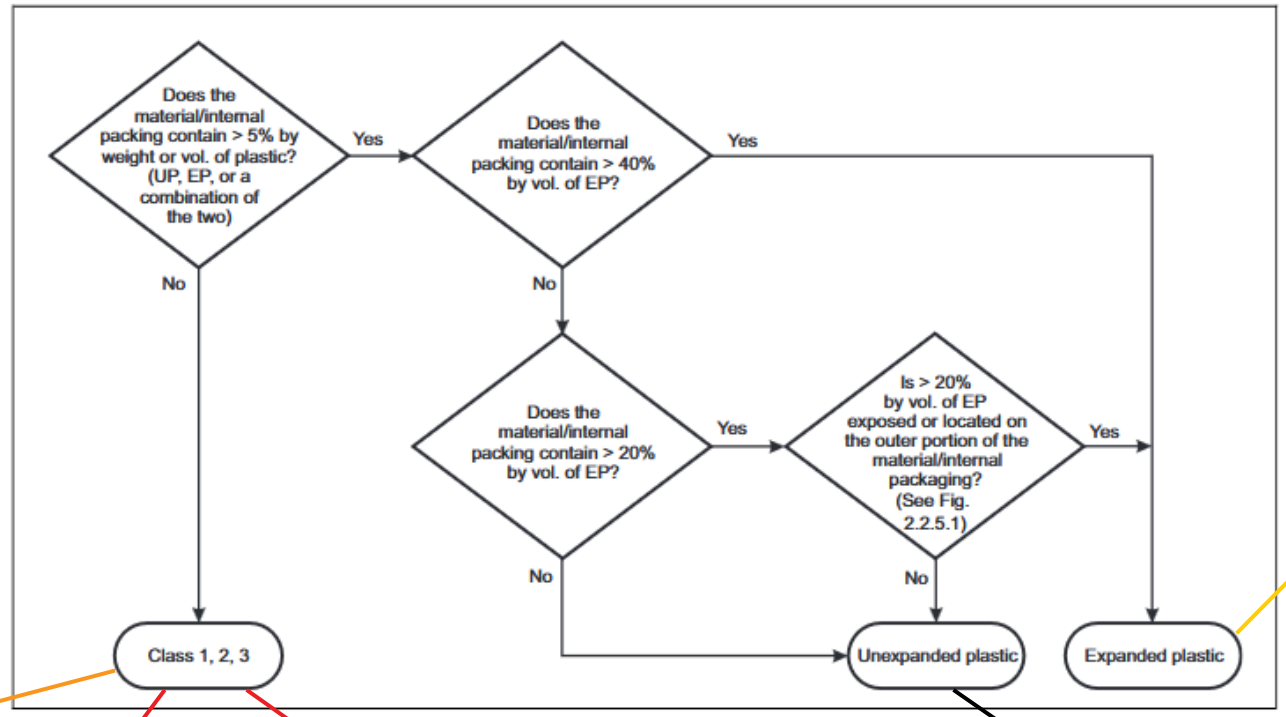


Fig. 2.2.7. Classify cartoned commodities containing plastic

Expanded Plastic



Class 1



Class 2



Class 3





Class 4/**unexpanded plastic**

Table 2.3. Examples of Material Classification

Cartoned Unexpanded Plastic Commodity



Photo courtesy of FM

Storage configurations addressed in FM

- **Palletized storage**
- **Solid-Piled storage**
- Shelf storage (depth up to 0.75 m or up to 1.5 m, with tier height does not exceeds 0.6 m)
  - Back-to-back shelf storage (double row shelf storage with vertical barier, depth up to 1500 mm)
- Bin-Box storage
  - The depth of the solid storage up to 3.0 m, and, the height between tiers up to 1.5 m,
  - The horizontal distance between solid vertical barriers, installed perpendicular to the loading aisle up to 1.2 m.
- **Open-frame rack storage**
  - Single row - up to 1.8 m deep, as defined by minimum 1.2 m wide aisles
  - Double row - up to 3.6 m deep, as defined by minimum 1.2 m wide aisles
  - Multiple row - The rack depth of more than 3.6 m is the determinant.
    Can be drive-in, drive-through, flow-through, push-back or double-dee
- Racks with solid shelves
- Portable racks
- Other specific configurations addressed individually (ie. rolled paper)





Storage configuration - flue spaces single row racks

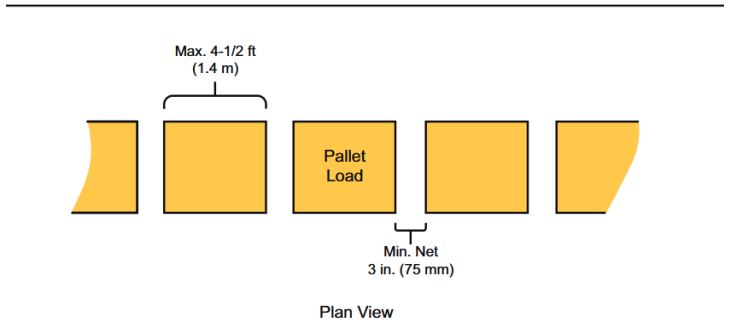


Fig. 2a. Acceptable transverse flue space arrangement for single-row racks, Option 1

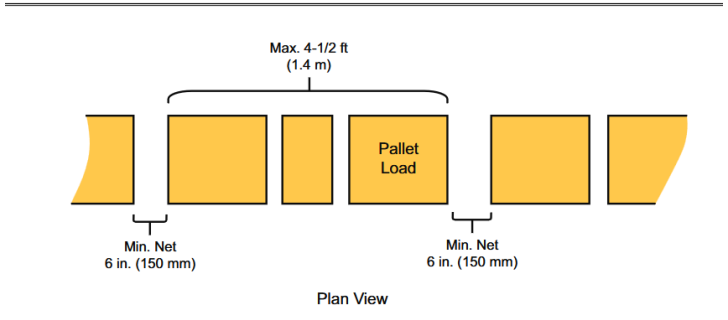


Fig. 2c. Acceptable transverse flue space arrangement for single-row racks, Option 3

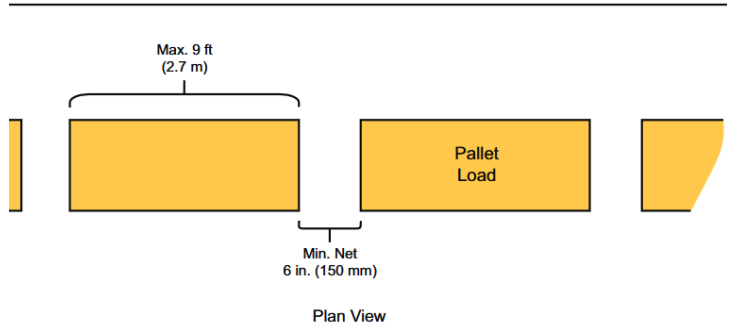


Fig. 2b. Acceptable transverse flue space arrangement for single-row racks, Option 2

Storage configuration - flue spaces double row racks

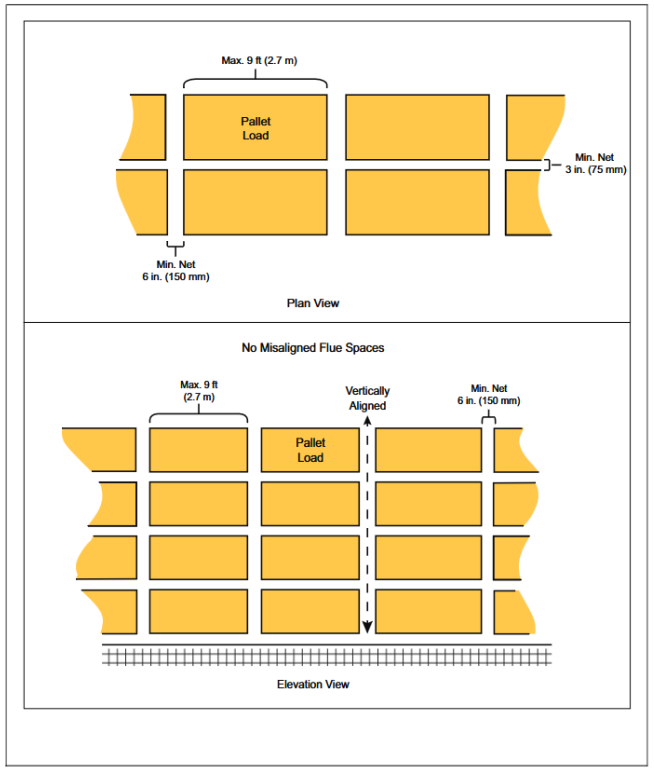


Fig. 2e. Acceptable flue space arrangement for double-row racks, Option 2

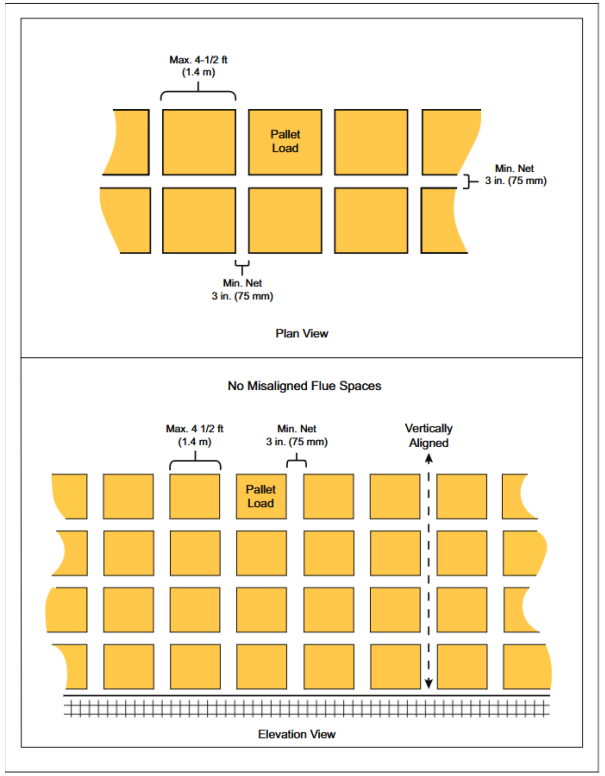


Fig. 2d. Acceptable flue space arrangement for double-row racks, Option 1

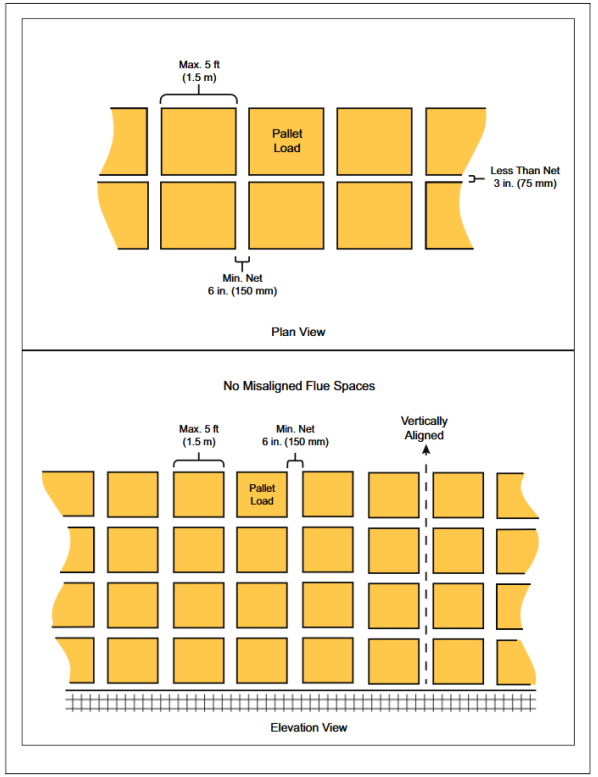


Fig. 2f. Acceptable flue space arrangement for double-row racks, Option 3

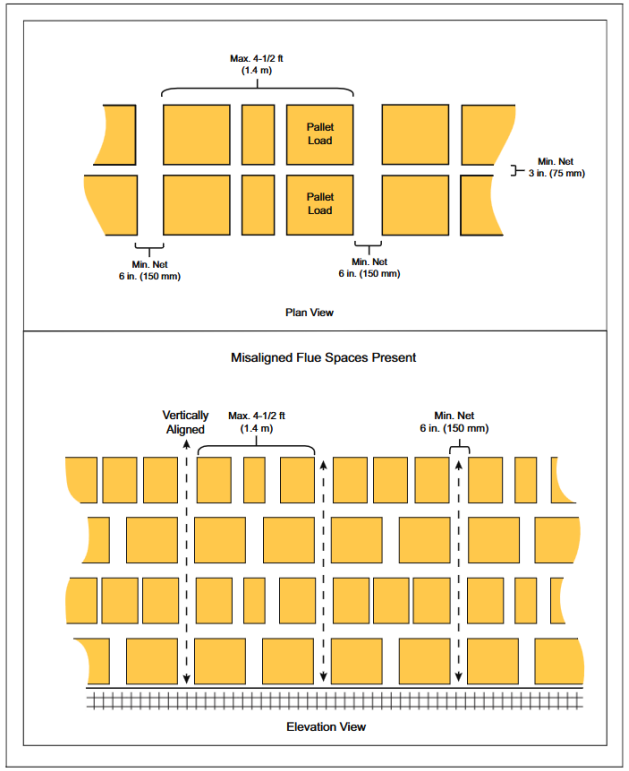


Fig. 2g. Acceptable flue space arrangement for double-row racks, Option 4

Storage configuration - flue spaces multiple row racks

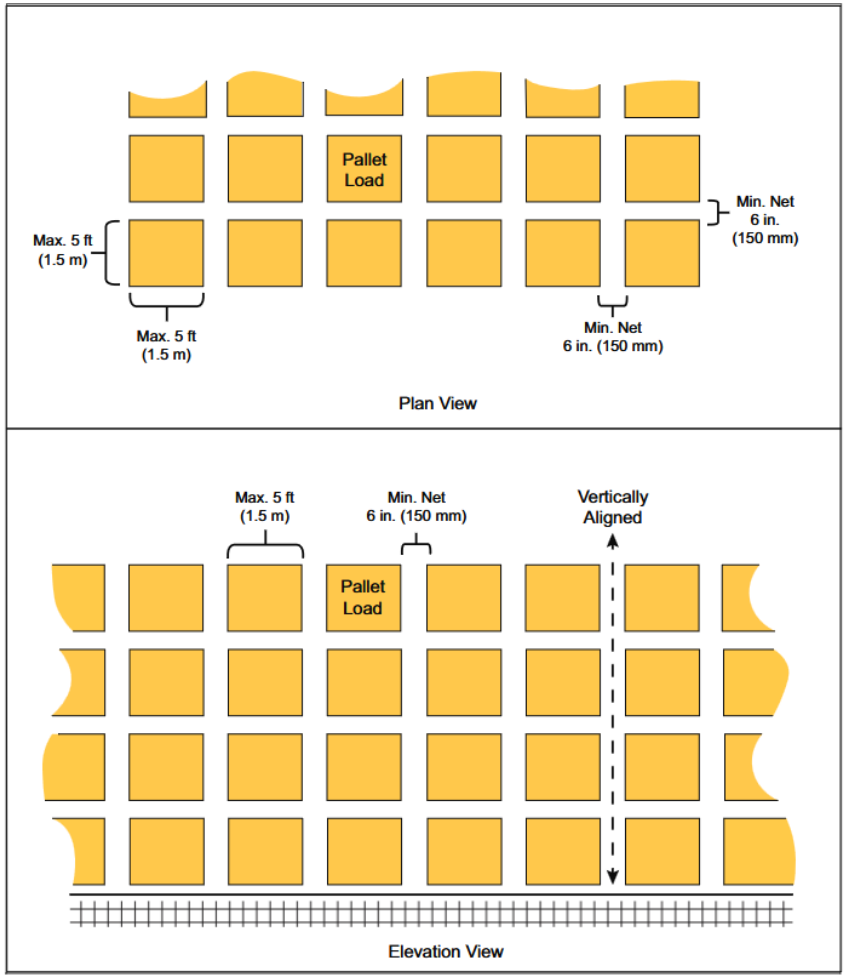


Fig. 2h. Acceptable transverse flue space arrangement for open-frame multiple-row racks, Option 1

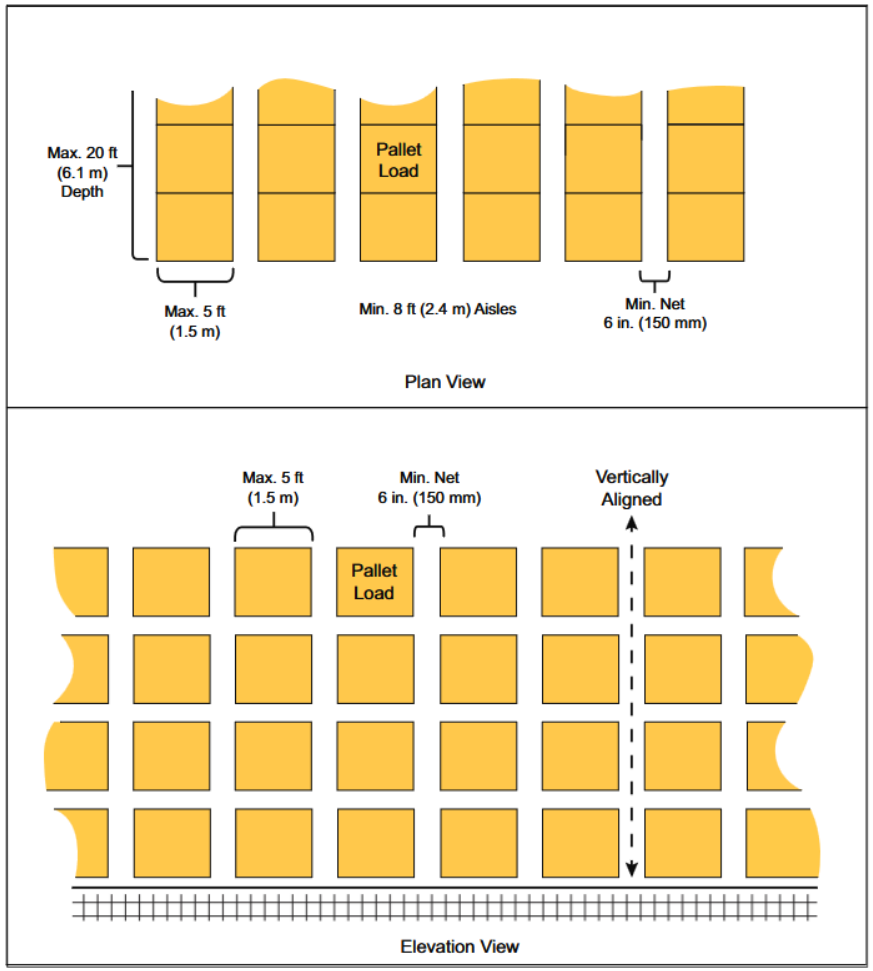


Fig. 2i. Acceptable transverse flue space arrangement for open-frame multiple-row racks, Option 2

Storage configuration - flue spaces

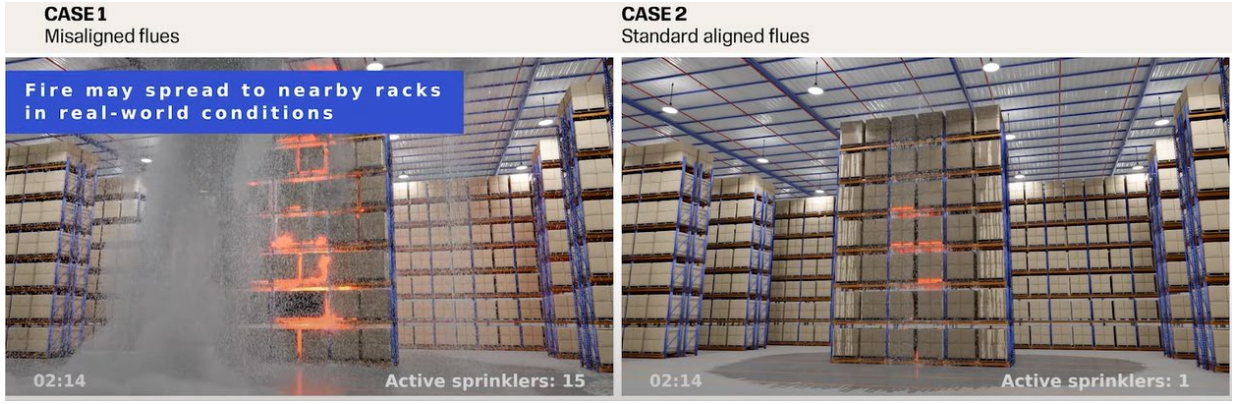




Obstructed flue spaces

- Delayed venting of heat
- Increased horizontal flame spread
- Delayed operation of ceiling sprinklers
- Delayed ceiling sprinkler water penetration to the fire







Ceiling level sprinkler system design criteria

Ways of determining the design criteria

Main goal: Delivering sufficient amount of water over the maximum expected area of fire



Source: Online article "Resolving ESFR Sprinkler Obstruction Challenges"Garner A. Palenske, Associate Principal, San Diego

Sprinkler system strategies

The fire protection recommendations in data sheet are based on testing, loss experience, and engineering judgment. Not every situation has been tested, nor has every potential solution been identified.

Table 18. Relationship Between the Number of Sprinklers that Operate During a Storage Fire and Fire Control

Number of Sprinklers that Operate During a Fire	*Percentage of Fires Controlled*
1	14%
2 or fewer	32%
3 or fewer	41%
4 or fewer	49%
5 or fewer	54%
10 or fewer	77%
25 or fewer	98%

- ❑ Ceiling-level sprinklers only - the average number of sprinklers that opened during a storage fire was eight.
- ❑ Combination of ceiling-level and in-rack sprinklers, the average number of sprinklers that opened during a storage fire was three ceiling-level sprinklers and three in-rack sprinklers.

Fire control: A condition in which equilibrium has been achieved between burning commodity and sprinkler system discharge such that ceiling level temperatures do not increase, and horizontal fire spread has been eliminated (in-rack balanced with ceiling sprinkler system).

Fire suppression: The conditions for fire control have been met and fire on most of the vertical surfaces of burning commodities has been extinguished resulting in a significant reduction in the fire's heat release rate (in-rack not balanced with ceiling sprinkler system).

Sprinkler types

Sprinkler type	Application	Design criteria	Strategy (mode of operation)
Standard Spray sprinklers, sidewall sprinklers	Non-storage	Density/Area	Fire control
CMDA	Storage	Density/Area	Fire control
CMSA	Storage	Specific application	Fire control
ESFR	Storage	Specific application	Fire suppression

From March 2010 - The terms “Control Mode Density Area (CMDA),” “Control Mode Specific Application (CMSA),” and “Suppression Mode” are no longer used to describe sprinklers.

CMDA Sprinklers

A term used to describe standard sprinklers in storage areas, used based on spray density/area coverage. Introduced in 2010 to distinguish them from CMSA sprinklers (formerly large-droplet sprinklers).



GQR112 Series Sprinklers



Model GSR112 Series Sprinklers



GL112 Series Sprinklers



GXLO Series Sprinklers



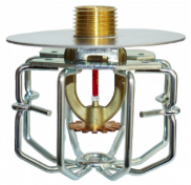
G VELO Pendent Sprinklers



J168 Upright Sprinklers



N252EC CMDA/CMSA Pendent Sprinklers



Intermediate Level Sprinklers

CMDA SPRINKLERS

CONTROL the Size of the Fire by:

- Pre-wetting Adjacent Combustibles
- Controlling Ceiling Gas Temperature to Avoid Structural Damage
- **LITTLE** Fire Plume Penetration



CMSA Sprinklers

A term used to describe storage sprinklers designed for a specific K-factor and pressure. Previously referred to as large-droplet sprinklers. Introduced in 2010 to distinguish them from CMDA sprinklers. Sprinklers must be clearly listed as CMSA sprinklers.



LB11 Horizontal Sidewall Storage Sprinkler



N252EC CMDA/CMSA Pendent Sprinklers

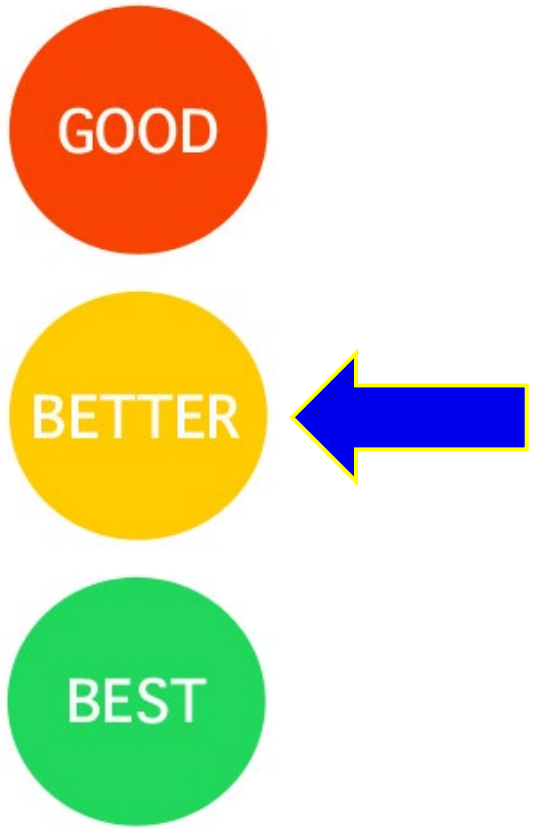


- FOR USE IN “ALTERNATIVE SPRINKLER SYSTEM DESIGNS” NFPA 13 **ONLY (CHAPTER 24)**
- CMSA FOR USE IN CHAPTER 22 ARE EITHER 11.2K, 16.8K OR 19.6K; **RELIABLE DOES NOT MANUFACTURE ANY**

CMSA SPRINKLERS

CONTROL the Size of the Fire by:

- Pre-wetting Adjacent Combustibles
- Controlling Ceiling Gas Temperature to Avoid Structural Damage
- **SOME** Fire Plume Penetration



ESFR Sprinklers

The only protection strategy is early and complete fire extinguishment.
Small calculation area, very large water discharge.
Installation details such as obstructions and ceiling structure are essential.
The warehouse configuration must be compatible with this type of protection.



M336 ESFR Pendent Sprinklers



N28T6 & N28T3 Specific Application ESFR Pendent Sprinklers



JL14 & JL17 ESFR Pendent Sprinklers



P22 ESFR Pendent Sprinklers



P25 ESFR Pendent Sprinklers

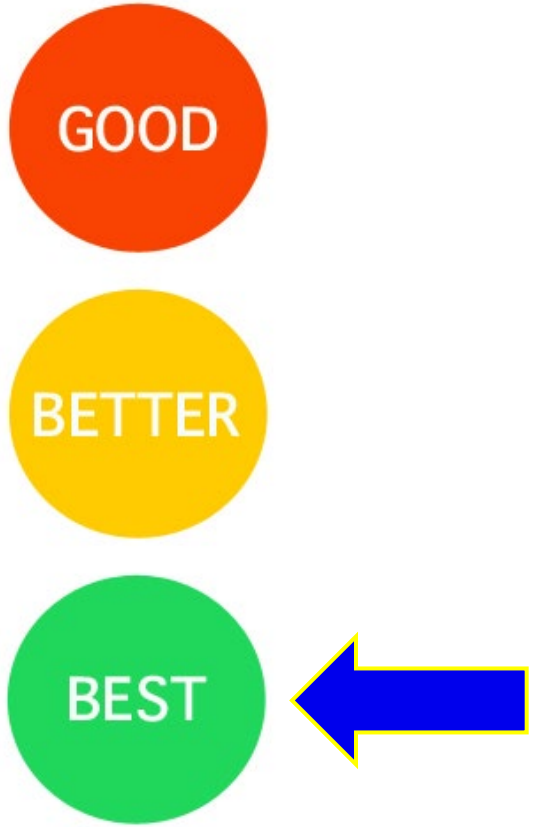


N25 ESFR Pendent Sprinklers

ESFR SPRINKLERS

SUPPRESS the Fire by:

- Using Fast Response and Large Quantity of Water
- Sharply Reduce Heat Release Rate
- Prevent Re-growth of Fire
- **Penetrate Fire Plume to the Burning Fuel**



The table below shows a **comparison table of ESFR Sprinklers with FM Approval** across different **manufacturers** and **K-factors**.

Manufacturer	K200 (14.0)	K240 (16.8)	K320 (22.4)	K360 (25.2)	K400 (28)	K480 (33.6)
Reliable	RA1812	RA1914	R601	RA0912	R603, R604	R610
Viking	VK500, VK502 (dry pendent)	VK503, VK504 (dry pendent)	VK506	VK510, VK512 (dry pendent)	VK514	–
Tyco	TY6236 (with bulb)	TY7126, TY7236, TY7229 (upright, pendent, dry pendent)	TY8223	TY9226	–	TY9286
Victaulic	–	–	V4808	V4804	–	–

Design criteria for storage occupancies – FM DS 8-9

Solid-Piled, Palletized, Shelf, or Bin-Box Storage Arrangement	**Class 1, 2 and 3 Commodities**	**Table 2**
	Class 4 and Cartoned Unexpanded Plastic Commodities	Table 3
	Cartoned Expanded Plastic Commodities	Table 4
	Uncartoned Unexpanded Plastic Commodities	Table 5
	Uncartoned Expanded Plastic Commodities	Table 6
Open-Frame Rack Storage Arrangements	Class 1, 2 and 3 Commodities	Table 7
	Class 4 and Cartoned Unexpanded Plastic Commodities	Table 8
	Cartoned Expanded Plastic Commodities	Table 9
	Uncartoned Unexpanded Plastic Commodities	Table 10
	Uncartoned Expanded Plastic Commodities	Table 11

The ceiling-level designs listed within these tables are provided to either (1) achieve suppression like performance, or (2) when suppression like performance is not available offer the lowest allowable pressure for design purposes.

Design criteria for storage occupancies – FM DS 8-9

- Currently, FM Approved ceiling-level Storage sprinklers have K-factor values ranging from 160 to 480.

- Following sprinklers are not FM Approved as ceiling-level Storage sprinklers
  - K115 and smaller
  - On-Off type sprinklers
  - ECLH type sprinklers (Extended Coverage Light Hazard)
  - ECOH type sprinklers (Extended Coverage Ordinary Hazard)

- Quick-response thermal sensing element only in wet-pipe and antifreeze solution sprinkler.

- Normal-response thermal sensing element possible for all systems.

Design criteria for storage occupancies – FM DS 8-9 - Reliable

- Currently, FM Approved Reliable ceiling-level Storage sprinklers have K-factor values ranging from 160 (GXLO, GQR112 and GL112) to 480.

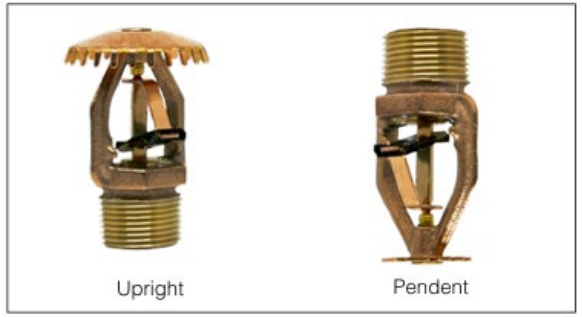




Model P22 ESFR Sprinkler

Model P22 ESFR Pendent Sprinkler — Table A

Model	Nominal K-factor gpm/psi$^{1/2}$ (L/min/bar$^{1/2}$)	Approvals	Sprinkler Identification Number (SIN)
P22	22.4 (320)	FM, CE	R601



Upright Pendent

Model GL112 Series Sprinklers

Model GL112 Specification — Table A

Style	Sprinkler Identification Number (SIN)	Listings and Approvals	Sensitivity	K-Factor
Upright	R3226	FM	Quick Response	11.2 (160 metric)
Pendent	R3216	FM		

Models JL14 & JL17 ESFR Pendent Sprinklers — Table A

Model	Nominal K-factor gpm/psi$^{1/2}$ (L/min/bar$^{1/2}$)	Approvals	Sprinkler Identification Number (SIN)
JL14	14.0 (200)	cULus, FM, VdS, LPCB, CNBOP-PIB, CE	RA1812
JL17	16.8 (240)	cULus, FM, VdS, LPCB, CNBOP-PIB, CE	RA1914



Model M336 ESFR Sprinkler

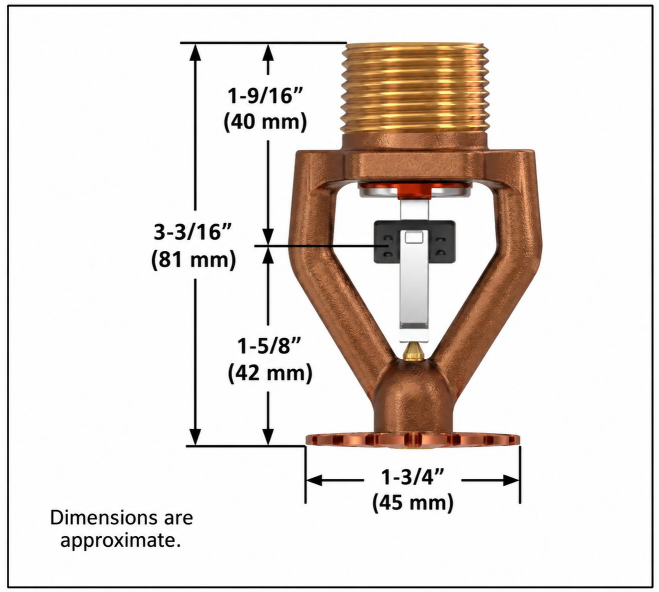
Model M336 ESFR Pendent Sprinkler — Table A

Model	Nominal K-factor gpm/psi$^{1/2}$ (L/min/bar$^{1/2}$)	Approvals	Sprinkler Identification Number (SIN)
M336	33.6 (480)	FM, CE	R610

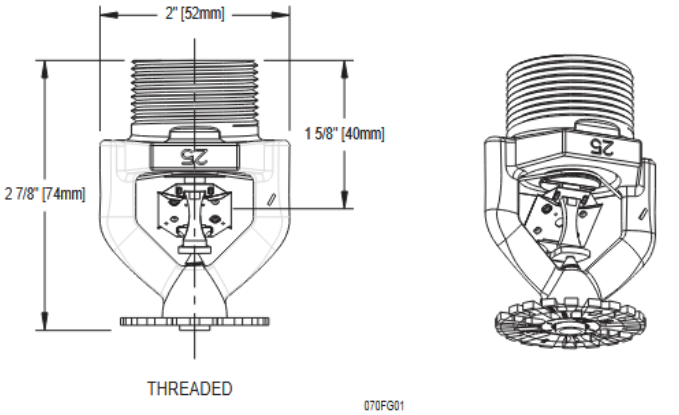
Ceiling level sprinkler system design criteria

K320/360 – same sprinkler different values, depend on the manufacturer

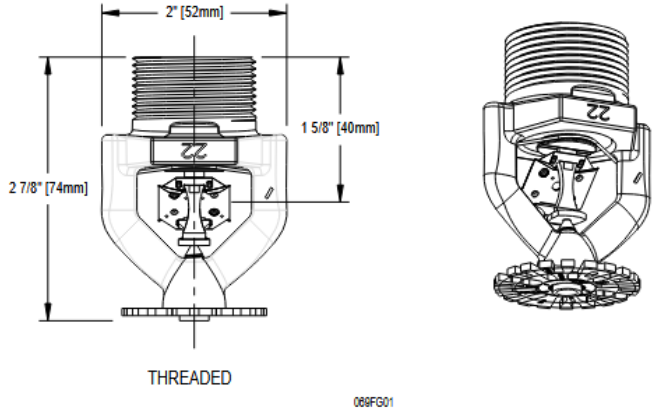
<u>Maintain a minimum 3 ft (0.9 m) clearance between the top of the storage and the deflectors of standard-coverage ceiling-level sprinklers</u>



Model P25 Sprinkler Dimensions and Components

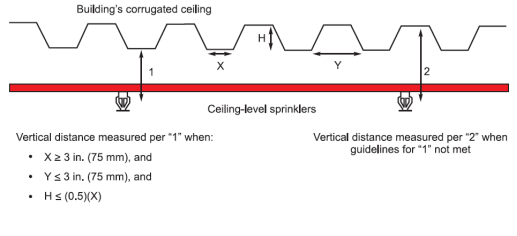


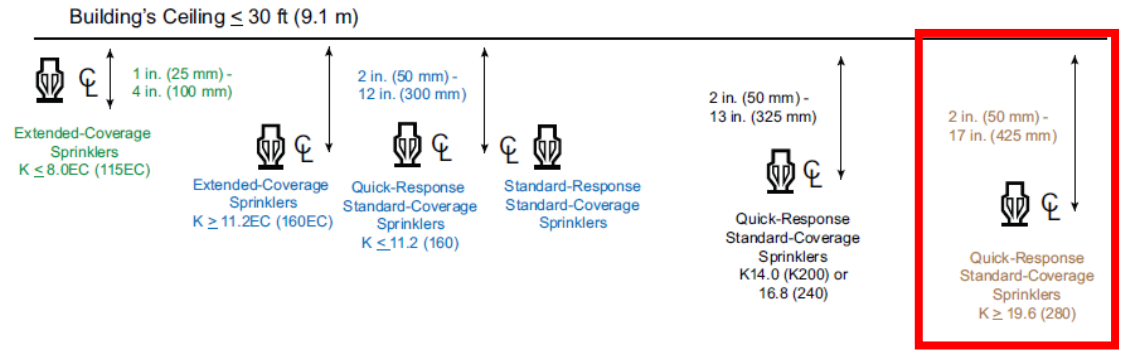
Model P22 Sprinkler Dimensions and Components

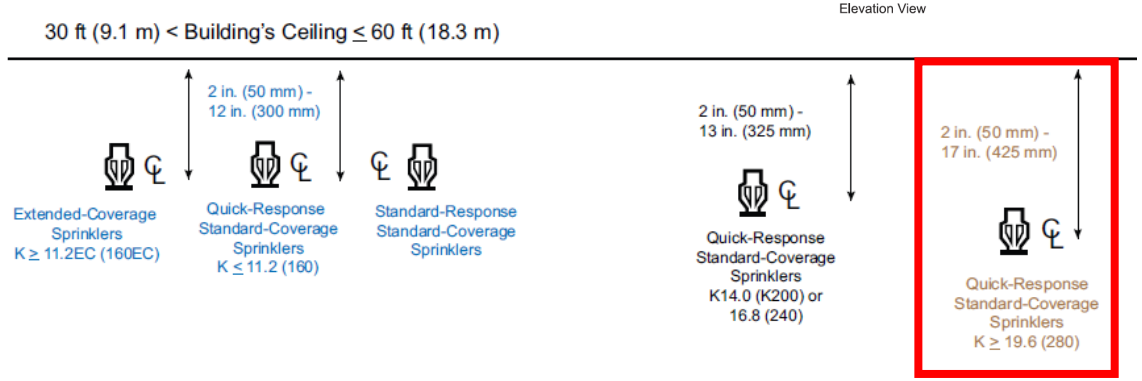


Sprinkler Position, Location, Spacing

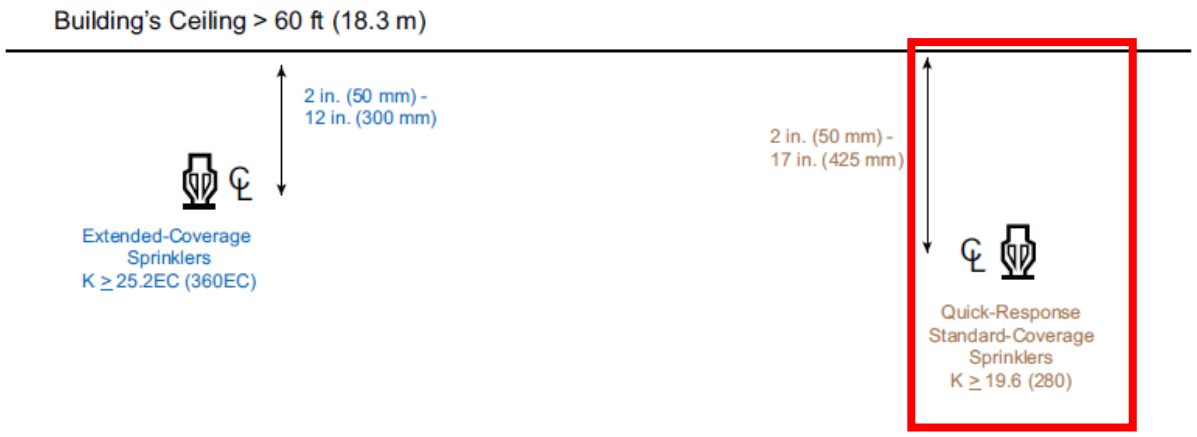
Deflector Position – storage sprinklers







Elevation View



Elevation View

Ceiling slope ≤ 5° - does not effect sprinkler installation requirements

Ceiling slope ≤ 10° - locate the centerline of the sprinkler's thermal element below the peak of the ceiling

Reliable
Safety & Flow Corporation

Design criteria for storage occupancies. On the example of the most frequently used table in storage areas. FM DS 8-9

Table 8. Ceiling-Level Protection Guidelines for Class 4 and Cartoned Unexpanded Plastic Commodities in Open-Frame Rack Storage Arrangements with Minimum 4 ft (1.2 m) Aisles

Protection of Class 4 and Cartoned Unexpanded Plastic Commodities in Open-Frame Storage Racks; No. of AS @ psi (bar)																				
Max. Ceiling Height, ft (m)	Wet System, 160°F (70°C) Nominally Rated, Pendent Sprinklers										Wet System, 160°F (70°C) Nominally Rated, Upright Sprinklers							Dry System, 280°F (140°C) Nominally Rated, Upright Sprinklers		
	Quick Response						Standard Response				Quick Response				Standard Response			Standard Response		
	K11.2 (K160)	K14.0 (K200)	K16.8 (K240)	K22.4 (K320)	K25.2 (K360)	K25.2EC (K360EC)	K11.2 (K160)	K14.0 (K200)	K19.6 (K280)	K25.2 (K360)	K11.2 (K160)	K14.0 (K200)	K16.8 (K240)	K25.2EC (K360EC)	K11.2 (K160)	K16.8 (K240)	K25.2 (K360)	K11.2 (K160)	K16.8 (K240)	K25.2 (K360)
10 (3.0)	12 @ 7 (0.5)	9 @ 7 (0.5)	9 @ 7 (0.5)	9 @ 20 (1.4)	9 @ 20 (1.4)	6 @ 20 (1.4)	12 @ 7 (0.5)	9 @ 7 (0.5)	9 @ 16 (1.1)	9 @ 7 (0.5)	12 @ 7 (0.5)	9 @ 7 (0.5)	9 @ 7 (0.5)	6 @ 20 (1.4)	12 @ 7 (0.5)	9 @ 7 (0.5)	9 @ 7 (0.5)	16 @ 7 (0.5)	16 @ 7 (0.5)	16 @ 7 (0.5)
15 (4.5)	15 @ 16 (1.1)	12 @ 16 (1.1)	12 @ 11 (0.8)	9 @ 20 (1.4)	9 @ 20 (1.4)	6 @ 20 (1.4)	15 @ 16 (1.1)	12 @ 16 (1.1)	9 @ 16 (1.1)	10 @ 7 (0.5)	15 @ 16 (1.1)	12 @ 16 (1.1)	12 @ 11 (0.8)	6 @ 20 (1.4)	15 @ 16 (1.1)	12 @ 11 (0.8)	10 @ 7 (0.5)	20 @ 16 (1.1)	20 @ 7 (0.5)	20 @ 7 (0.5)
20 (6.0)	12 @ 30 (2.1)	12 @ 18 (1.2)	12 @ 13 (0.9)	9 @ 20 (1.4)	9 @ 20 (1.4)	6 @ 22 (1.5)	12 @ 30 (2.1)	12 @ 18 (1.2)	9 @ 16 (1.1)	12 @ 7 (0.5)	12 @ 30 (2.1)	12 @ 18 (1.2)	12 @ 13 (0.9)	6 @ 22 (1.5)	12 @ 30 (2.1)	12 @ 13 (0.9)	12 @ 7 (0.5)	20 @ 30 (2.1)	20 @ 13 (0.9)	20 @ 7 (0.5)
25 (7.5)	15 @ 65 (4.5)	9 @ 35 (2.4)	9 @ 24 (1.7)	9 @ 20 (1.4)	9 @ 20 (1.4)	6 @ 22 (1.5)	15 @ 65 (4.5)	15 @ 42 (2.9)	9 @ 16 (1.1)	12 @ 10 (0.7)	15 @ 65 (4.5)	12 @ 50 (3.5)	12 @ 35 (2.4)	6 @ 22 (1.5)	15 @ 65 (4.5)	15 @ 29 (2.0)	12 @ 20 (1.4)	20 @ 65 (4.5)	20 @ 29 (2.0)	20 @ 13 (0.9)
30 (9.0)		12 @ 50 (3.5)	12 @ 35 (2.4)	9 @ 20 (1.4)	9 @ 20 (1.4)	6 @ 30 (2.1)			9 @ 16 (1.1)	12 @ 15 (1.0)				6 @ 30 (2.1)			12 @ 20 (1.4)			30 @ 20 (1.4)
35 (10.5)		12 @ 75 (5.2)	12 @ 52 (3.6)	12 @ 29 (2.0)	12 @ 23 (1.6)	6 @ 60 (4.1)[a]			15 @ 25 (1.7)	9 @ 30 (2.1)				8 @ 40 (2.8)						
40 (12.0)		12 @ 75 (5.2)	12 @ 52 (3.6)	9 @ 50 (3.5)	9 @ 40 (2.8)					9 @ 30 (2.1)										

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

Green-highlighted protection schemes provide effective fire protection while potentially minimizing overall property damage and resource use. These designs require a **250 gpm (950 L/min) hose stream demand** and **1-hour duration**.

Design criteria for storage occupancies. Ceiling-Only Sprinkler Protection Recommendations for Ceiling Heights Over 12.0 m. FM DS 8-9

- **The ceiling sprinkler system must be wet pipe.**
- Pre-action sprinkler systems designed to meet a wet sprinkler system design do not qualify for these designs
- Class 1, 2, 3, 4 and Cartoned Unexpanded Plastics.
- **Acceptable storage arrangements include open-framed racks.**
- For ceiling sprinkler designs indicated as 9 sprinklers – hydraulic calculations 3 x 3;
- For ceiling sprinkler designs indicated as 10 sprinklers
  - For ceiling slopes up to 5 degrees – 3 x 3 + 1
  - For ceiling slopes over 5 degrees – 4 x 2 + 2

Table 17b. Quick-Response, Standard-Coverage Pendent Storage Sprinkler Ceiling-Only Designs for Ceiling Heights Over 40 ft (12.2 m)

Storage Arrangement	*Commodity*	*Max. Ceiling Height, ft (m)*	*Ceiling Sprinkler K-Factor*	*Max. Vertical Distance from Ceiling to Sprinkler's Thermal Element, in. (mm)**	*Min. Aisle Width, When Protecting Racks ft (m)***	*Sprinkler System Design*		
						Ceiling Sprinkler System, No. of AS @ psi (bar)	Hose Demand, gpm (L/min)	System Duration, min
Solid-Piled, Palletized, Bin-Box, Shelf, and Open-Frame Racks**	Class 1, 2, 3, 4 and Cartoned Unexpanded Plastics	50 (15.2)	22.4 (320)	13 (325)	6 (1.8)	10 @ 63 (4.3)	250 (950)	60
			25.2 (360)	13 (325)	6 (1.8)	10 @ 50 (3.5)		
				17 (425)	6 (1.8)	10 @ 75 (5.2)		
			28.0*** (400***)	13 (325)	6 (1.8)	10 @ 40 (2.8)		
			33.6 (480)	17 (425)	6 (1.8)	9 @ 55 (3.8)		
		55 (16.8)	28.0 (400)	13 (325)	8 (2.4)	9 @ 80 (5.5)		
			33.6 (480)	17 (425))	6 (1.8)	9 @ 55 (3.8)		

* See the guidelines in Section 2.3.3.3.2 if the ceiling has obstructed type construction.

** See the guidelines in Section 2.2.3.2 to confirm that any multiple-row racks being protected in accordance with this table meet the requirements to be considered open-frame.If the multiple-row racks are not provided with adequate longitudinal flue spaces, the minimum aisle width for them is 8 ft (2.4 m) and is not overruled by the values indicated in the Min. Aisle Width column.

*** The design of 10 AS @ 40 psi (2.8 bar) can be reduced to 9 AS @ 40 psi (2.8 bar) when the water supply can also provide a minimum pressure of 80 psi (5.5 bar) from the most remote 4 sprinklers (2 sprinklers on 2 lines).

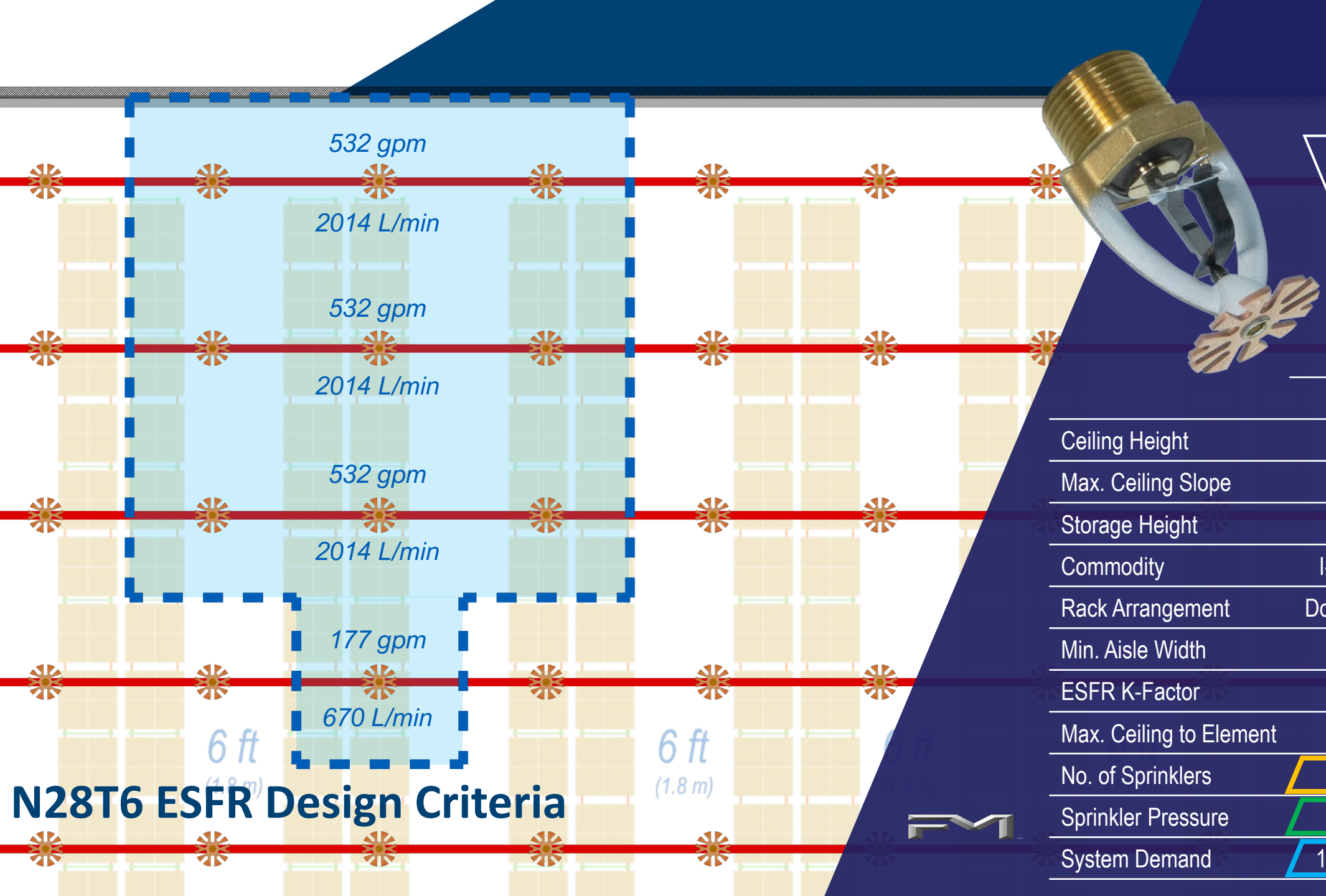
Model N28 Series ESFR Pendents

- **K-Factor: 28.0** (400 metric)
- **Fast-response fusible alloy solder link:**
  - 165°F or 212°F (74°C or 100°C)
- **Approvals:**
  - cULus Listed specific application
    - Specific application
  - FM Approved
    - Quick Response Storage Sprinkler for use in Data Sheet 8-9
    - Quick Response Non-Storage Sprinkler
- **Maximum working pressure:**
  - 175 psi (12 bar)
- **Installation wrench:**
  - W5
- **Technical Bulletin 082**



Model N28T3 ESFR

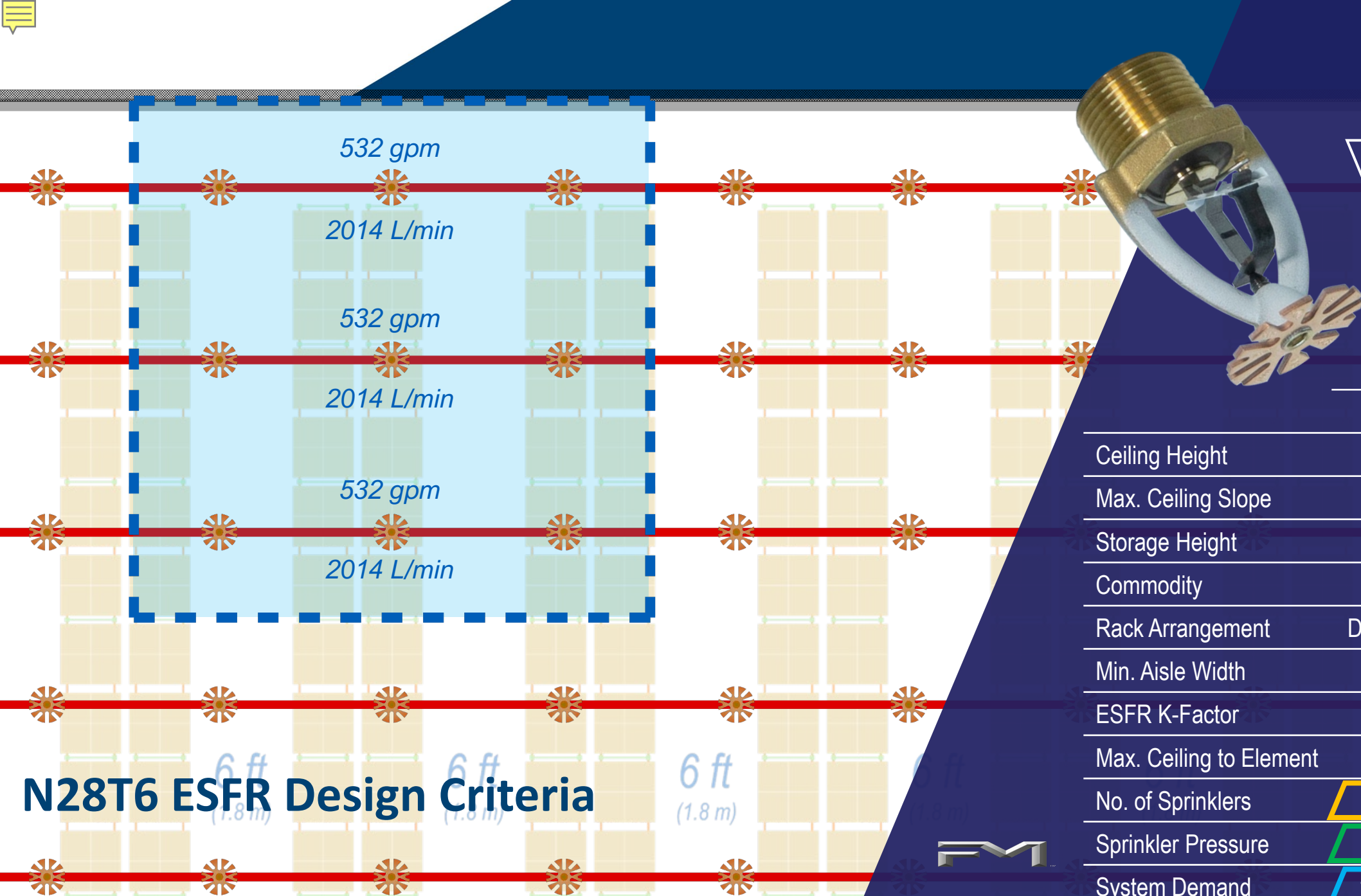
Model N28T6 ESFR



N28T6 ESFR Design Criteria

Model
N28T6 ESFR

	U.S.	Metric
Ceiling Height	50 ft	15.2 m
Max. Ceiling Slope	1:12	1:12
Storage Height	45 ft	13.7 m
Commodity	I-IV, CUP	I-IV, CUP
Rack Arrangement	Double-Row	Double-Row
Min. Aisle Width	6 ft	1.8 m
ESFR K-Factor	28.0	400 metric
Max. Ceiling to Element	13 in.	325 mm
No. of Sprinklers	10	10
Sprinkler Pressure	40 psi	2.8 bar
System Demand	1771 gpm	6704 L/min



N28T6 ESFR Design Criteria

Model
N28T6 ESFR

	U.S.	Metric
Ceiling Height	50 ft	15.2 m
Max. Ceiling Slope	2:12	2:12
Storage Height	45 ft	13.7 m
Commodity	I-IV, CUP	I-IV, CUP
Rack Arrangement	Double-Row	Double-Row
Min. Aisle Width	6 ft	1.8 m
ESFR K-Factor	28.0	400 metric
Max. Ceiling to Element	13 in.	325 mm
No. of Sprinklers	9	9
Sprinkler Pressure	40 psi	2.8 bar
System Demand	1594 gpm	6034 L/min



501 gpm

1897 L/min

501 gpm

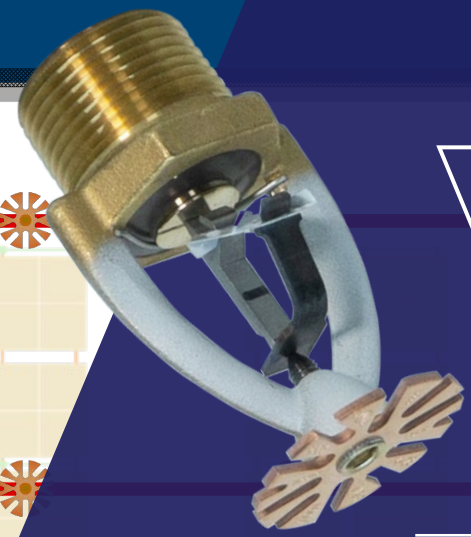
1897 L/min

6 ft (1.8 m)

6 ft (1.8 m)

6 ft (1.8 m)

N28T6 ESFR Design Criteria

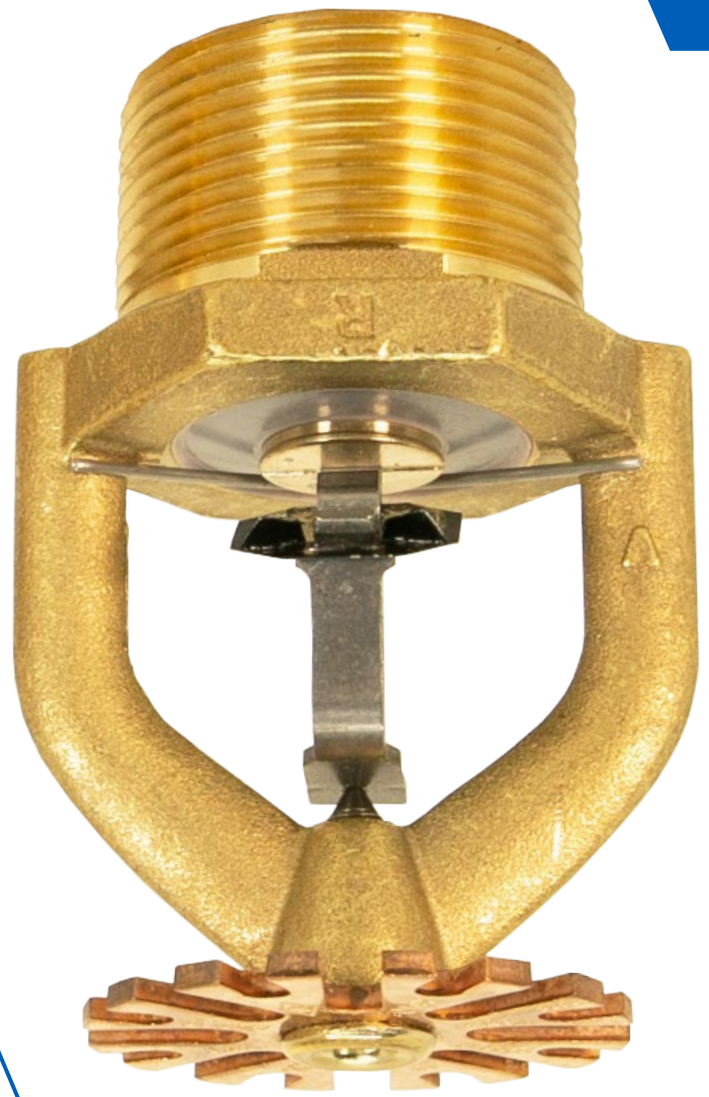


Model
N28T6 ESFR

	U.S.	Metric
Ceiling Height	50 ft	15.2 m
Max. Ceiling Slope	2:12	2:12
Storage Height	45 ft	13.7 m
Commodity	I-IV, CUP	I-IV, CUP
Rack Arrangement	Double-Row	Double-Row
Min. Aisle Width	6 ft	1.8 m
ESFR K-Factor	28.0	400 metric
Max. Ceiling to Element	13 in.	325 mm
No. of Sprinklers	4	4
Sprinkler Pressure	80 psi	5.5 bar
System Demand	1002 gpm	3793 L/min

SIN R610

- **K-Factor: 33.6** (480 metric)
- **Fast-response fusible alloy solder link:**
  - 165°F or 212°F (74°C or 100°C)
- **Approvals:**
  - FM Approved
    - Quick Response Storage Sprinkler for use in Data Sheet 8-9
    - Quick Response Non-Storage Sprinkler
- **Maximum working pressure:**
  - 175 psi (12 bar)
- **Installation wrench:**
  - W17
- **Technical Bulletin 087**

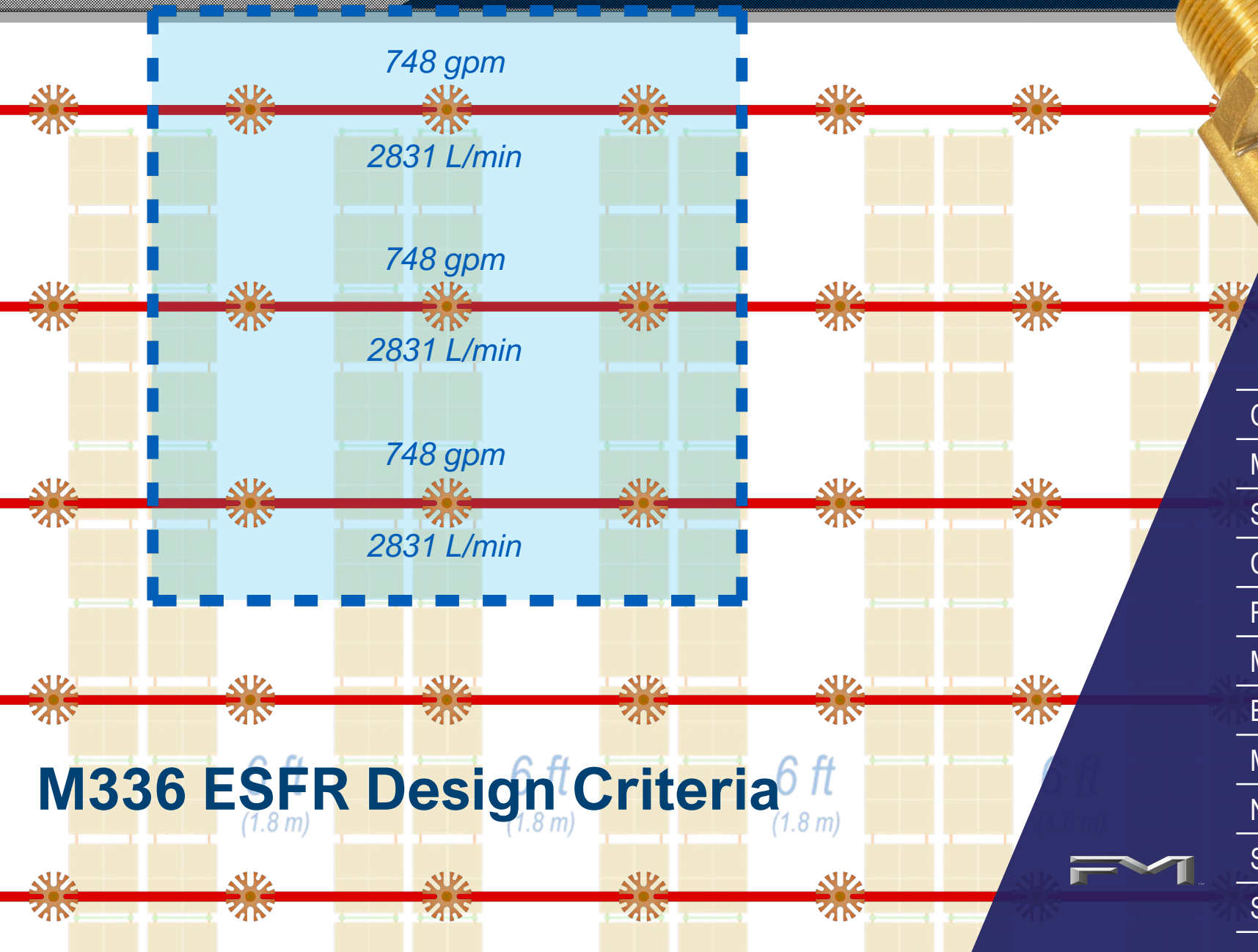


Model M336
ESFR

Model M336 ESFR Pendent

Built for Those Who Build™

Reliable
Safety & Flow Corporation



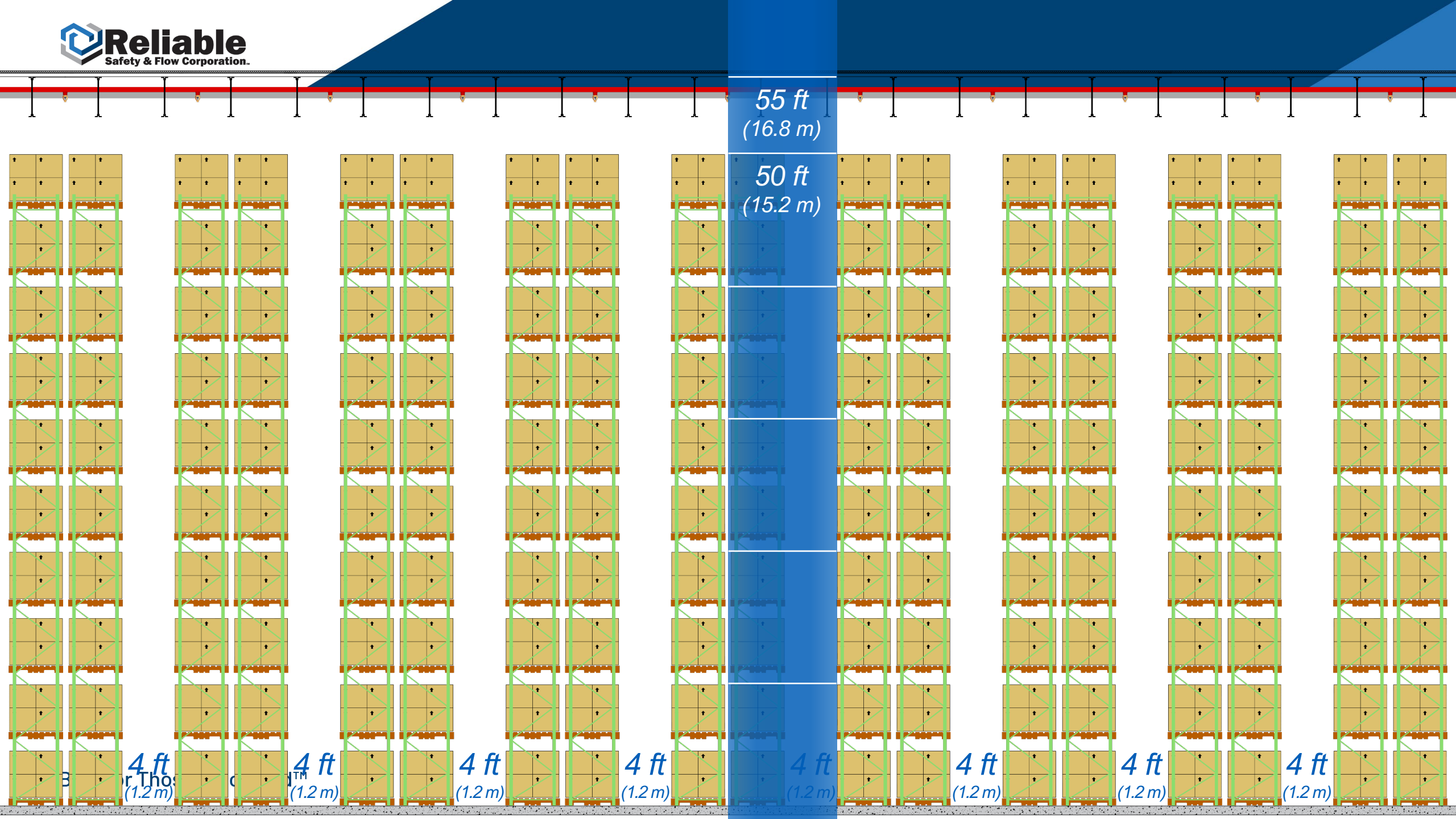
M336 ESFR Design Criteria



Model
M336 ESFR

	U.S.	Metric
Ceiling Height	55 ft	16.8 m
Max. Ceiling Slope	2:12	2:12
Storage Height	50 ft	15.2 m
Commodity	I-IV, CUP	I-IV, CUP
Rack Arrangement	Double-Row	Double-Row
Min. Aisle Width	6 ft	1.8 m
ESFR K-Factor	33.6	(480 metric)
Max. Ceiling to Element	17 in.	(425 mm)
No. of Sprinklers	9	9
Sprinkler Pressure	55 psi	3.8 bar
System Demand	2243 gpm	8491 L/min


Reliable
Safety & Flow Corporation
55 ft
(16.8 m)
50 ft
(15.2 m)
6 ft
(1.8 m)
6 ft
(1.8 m)
6 ft
(1.8 m)
6 ft
(1.8 m)
6 ft
(1.8 m)
6 ft
(1.8 m)
6 ft
(1.8 m)
6 ft
(1.8 m)


Reliable
Safety & Flow Corporation
55 ft
(16.8 m)
50 ft
(15.2 m)
4 ft
(1.2 m)
4 ft
(1.2 m)
4 ft
(1.2 m)
4 ft
(1.2 m)
4 ft
(1.2 m)
4 ft
(1.2 m)
4 ft
(1.2 m)
4 ft
(1.2 m)

Reliable®

Model M336 ESFR
Pendent Sprinklers

175 psi (12 bar) rated

Features

- FM Approved as a quick-response storage sprinkler
- Robust fusible link operating element

Product Description

The Reliable Model M336 is an Early Suppression Fast Response (ESFR) fire sprinkler with a nominal K-factor of 33.6 (480 metric). The sprinkler uses a levered fusible alloy solder link in either a 165°F (74°C) or a 212°F (100°C) temperature rating. These sprinklers are designed to respond quickly to growing fires and will deliver a heavy water discharge to suppress a fire. Suppression is considered a higher level of control characterized by a sharp reduction in heat release rate along with preventing regrowth of the fire.

FM Approvals classifies the Model M336 as a quick-response storage sprinkler when used in accordance with FM Property Loss Prevention Data Sheets. Sprinkler has successfully completed the test program with 4 ft (1.2m) aisles.

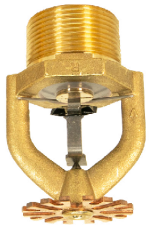
Installation

Model M336 sprinklers are intended for installation in accordance with FM Loss Prevention Data Sheets 2-0 and 8-9, as well as the requirements of any Authorities Having Jurisdiction.

Caution: When handling sprinklers, hold sprinklers only by the frame arms and do not apply any force on the link assembly.

For grooved sprinklers, align the sprinkler frame arms and the pads of the coupling, to prevent inadvertent contact with the operating element during coupling installation. Install the coupling in accordance with the manufacturer's installation instructions. Failure to follow these installation instructions may results in leaks or inadvertent operation of sprinklers.

Important! Reliable fire sprinklers must be handled, stored, and installed in accordance with the guidelines in Caution Sheet 310 and this bulletin. Failure to follow these instructions may result in unintended operation or nonoperation of the fire protection system.



Model M336 ESFR Sprinkler

For threaded sprinklers only, use the Model W17 sprinkler wrench (see Figure 3) for removal and installation. Any other type of wrench may damage the sprinkler. After applying a thread sealant to the male sprinkler threads, Model M336 sprinklers should be tightened between 35-45 lb·ft (47-61 N·m) torque. Exceeding the maximum recommended torque may cause leakage or impairment of the sprinkler. Damaged sprinklers must be replaced immediately.

Failure to follow these installation instructions may results in leaks, inadvertent operation, or non-operation of sprinklers.

Model M336 ESFR Pendent Sprinkler — **Table A**

Model	Nominal K-factor gpm/psi$^{1/2}$ (L/min/bar$^{1/2}$)	Approvals	Sprinkler Identification Number (SIN)
M336	33.6 (480)	FM	R610

www.reliablesprinkler.com

55 ft
(16.8 m)

50 ft
(15.2 m)

4 ft (1.2 m)

4 ft (1.2 m)

4 ft (1.2 m)

4 ft (1.2 m)

4 ft (1.2 m)

4 ft (1.2 m)

4 ft (1.2 m)

Reliable®

Model M336 ESFR
Pendent Sprinklers

175 psi (12 bar) rated

Features

- FM Approved as a quick-response storage sprinkler
- Robust fusible link operating element

Product Description

The Reliable Model M336 is an Early Suppression Fast Response (ESFR) fire sprinkler with a nominal K-factor of 33.6 (480 metric). The sprinkler uses a levered fusible alloy solder link in either a 165°F (74°C) or a 212°F (100°C) temperature rating. These sprinklers are designed to respond quickly to growing fires and will deliver a heavy water discharge to suppress a fire. Suppression is considered a higher level of control characterized by a sharp reduction in heat release rate along with preventing regrowth of the fire.

FM Approvals classifies the Model M336 as a quick-response storage sprinkler when used in accordance with FM Property Loss Prevention Data Sheets. Sprinkler has successfully completed the test program with 4 ft (1.2m) aisles.

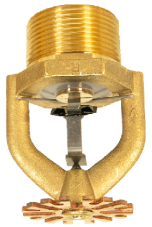
Installation

Model M336 sprinklers are intended for installation in accordance with FM Loss Prevention Data Sheets 2-0 and 8-9, as well as the requirements of any Authorities Having Jurisdiction.

Caution: When handling sprinklers, hold sprinklers only by the frame arms and do not apply any force on the link assembly.

For grooved sprinklers, align the sprinkler frame arms and the pads of the coupling, to prevent inadvertent contact with the operating element during coupling installation. Install the coupling in accordance with the manufacturer's installation instructions. Failure to follow these installation instructions may results in leaks or inadvertent operation of sprinklers.

Important! Reliable fire sprinklers must be handled, stored, and installed in accordance with the guidelines in Caution Sheet 310 and this bulletin. Failure to follow these instructions may result in unintended operation or nonoperation of the fire protection system.



Model M336 ESFR Sprinkler

For threaded sprinklers only, use the Model W17 sprinkler wrench (see Figure 3) for removal and installation. Any other type of wrench may damage the sprinkler. After applying a thread sealant to the male sprinkler threads, Model M336 sprinklers should be tightened between 35-45 lb·ft (47-61 N·m) torque. Exceeding the maximum recommended torque may cause leakage or impairment of the sprinkler. Damaged sprinklers must be replaced immediately.

Failure to follow these installation instructions may results in leaks, inadvertent operation, or non-operation of sprinklers.

Model M336 ESFR Pendent Sprinkler — **Table A**

Model	Nominal K-factor gpm/psi$^{1/2}$ (L/min/bar$^{1/2}$)	Approvals	Sprinkler Identification Number (SIN)
M336	33.6 (480)	FM	R610

www.reliablesprinkler.com

55 ft
(16.8 m)

50 ft
(15.2 m)

4 ft (1.2 m) | 4 ft (1.2 m) | 4 ft (1.2 m) | 4 ft (1.2 m) | 4 ft (1.2 m) | 4 ft (1.2 m) | 4 ft (1.2 m) | 4 ft (1.2 m)

Reliable®

Model M336 ESFR Pendent Sprinklers

175 psi (12 bar) rated

Features

- FM Approved as a quick-response storage sprinkler
- Robust fusible link operating element

Product Description

The Reliable Model M336 is an Early Suppression Fast Response (ESFR) fire sprinkler with a nominal K-factor of 33.6 (480 metric). The sprinkler uses a levered fusible alloy solder link in either a 165°F (74°C) or a 212°F (100°C) temperature rating. These sprinklers are designed to respond quickly to growing fires and will deliver a heavy water discharge to suppress a fire. Suppression is considered a higher level of control characterized by a sharp reduction in heat release rate along with preventing regrowth of the fire.

FM Approvals classifies the Model M336 as a quick-response storage sprinkler when used in accordance with FM Property Loss Prevention Data Sheets. Sprinkler has successfully completed the test program with 4 ft (1.2m) aisles.

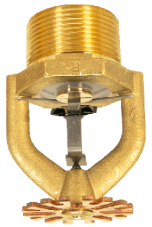
Installation

Model M336 sprinklers are intended for installation in accordance with FM Loss Prevention Data Sheets 2-0 and 8-9, as well as the requirements of any Authorities Having Jurisdiction.

Caution: When handling sprinklers, hold sprinklers only by the frame arms and do not apply any force on the link assembly.

For grooved sprinklers, align the sprinkler frame arms and the pads of the coupling, to prevent inadvertent contact with the operating element during coupling installation. Install the coupling in accordance with the manufacturer's installation instructions. Failure to follow these installation instructions may results in leaks or inadvertent operation of sprinklers.

Important! Reliable fire sprinklers must be handled, stored, and installed in accordance with the guidelines in Caution Sheet 310 and this bulletin. Failure to follow these instructions may result in unintended operation or nonoperation of the fire protection system.



Model M336 ESFR Sprinkler

For threaded sprinklers only, use the Model W17 sprinkler wrench (see Figure 3) for removal and installation. Any other type of wrench may damage the sprinkler. After applying a thread sealant to the male sprinkler threads, Model M336 sprinklers should be tightened between 35-45 lb·ft (47-61 N·m) torque. Exceeding the maximum recommended torque may cause leakage or impairment of the sprinkler. Damaged sprinklers must be replaced immediately.

Failure to follow these installation instructions may results in leaks, inadvertent operation, or non-operation of sprinklers.

Model M336 ESFR Pendent Sprinkler — **Table A**

Model	Nominal K-factor gpm/psi$^{1/2}$ (L/min/bar$^{1/2}$)	Approvals	Sprinkler Identification Number (SIN)
M336	33.6 (480)	FM	R610

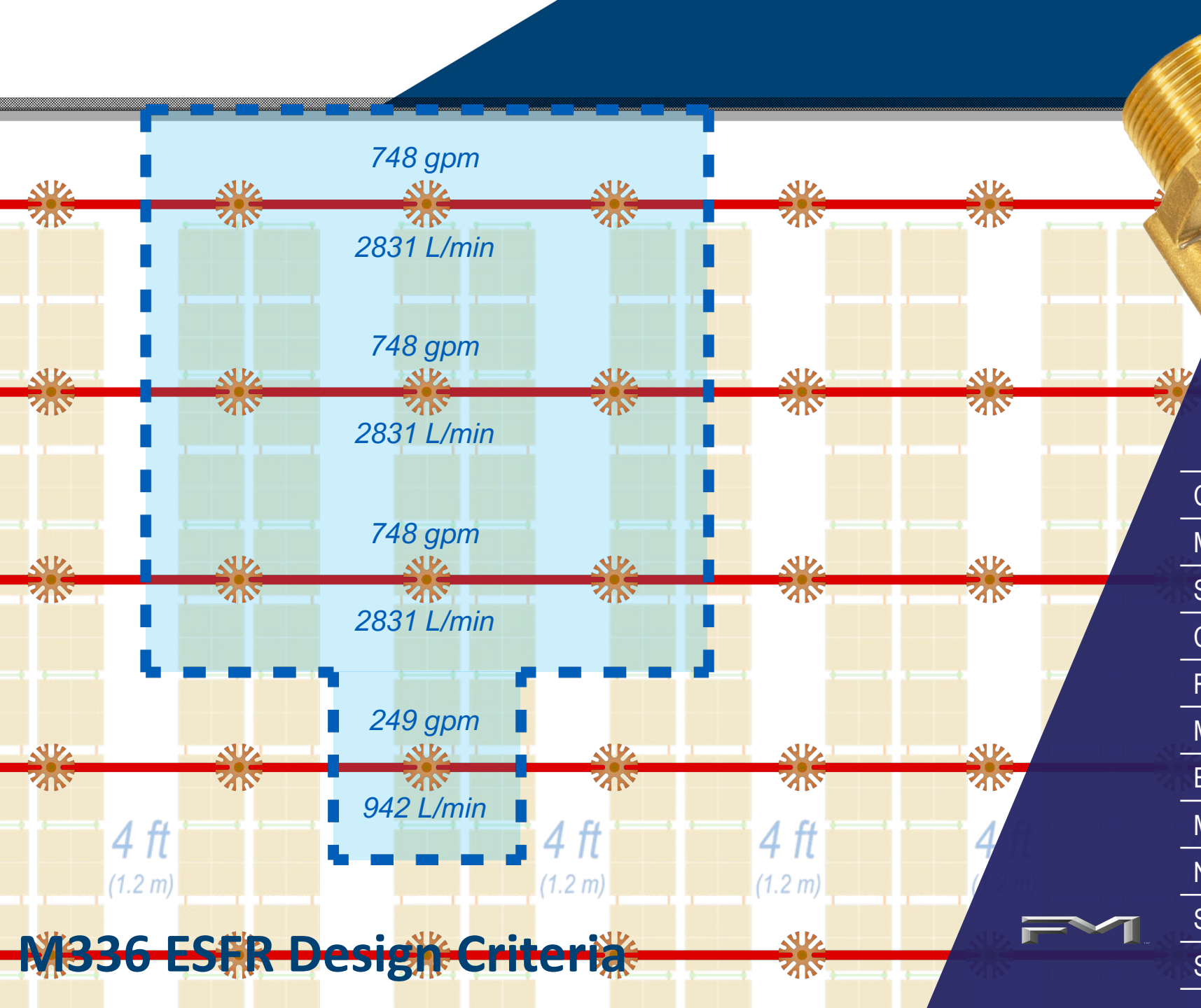
www.reliablesprinkler.com

55 ft (16.8 m)

50 ft (15.2 m)

FM Approvals classifies the Model M336 as a quick-response storage and non-storage sprinkler when used in accordance with FM Global Property Loss Prevention Data Sheets. Sprinkler has successfully completed the test program with 4 ft (1.2m) aisles.

4 ft (1.2 m) 4 ft (1.2 m) 4 ft (1.2 m) 4 ft (1.2 m) 4 ft (1.2 m) 4 ft (1.2 m) 4 ft (1.2 m) 4 ft (1.2 m)



M336 ESFR Design Criteria



Model
M336 ESFR

	U.S.	Metric
Ceiling Height	55 ft	16.8 m
Max. Ceiling Slope	1:12	1:12
Storage Height	50 ft	15.2 m
Commodity	I-IV, CUP	I-IV, CUP
Rack Arrangement	Double-Row	Double-Row
Min. Aisle Width	4 ft	1.2 m
ESFR K-Factor	33.6	480 metric
Max. Ceiling to Element	17 in.	425 mm
No. of Sprinklers	10	10
Sprinkler Pressure	55 psi	3.8 bar
System Demand	2492 gpm	9434 L/min

Ceiling level sprinkler system design criteria

Design criteria for storage occupancies. Ceiling-Only Sprinkler Protection Uncartoned Unexpanded Plastics: Ceiling Heights up to 13.5 m. FM DS 8-9

- Maximum 7.5 m high solid-piled, palletized, shelf, or bin-box storage of commodity hazards.
- The ceiling sprinkler system must be wet pipe.
- Pre-action sprinkler systems designed to meet a wet sprinkler system design do not qualify for these designs.
- Commodity up to Uncartoned Unexpanded Plastics.
- Sprinklers are quick response, 70ºC nominally rated, minimum K360.
- The sprinkler design is a minimum of 12 sprinklers operating at a minimum pressure of 4.1 bar.
- Hose demand of 950 L/min.
- Sprinkler system duration of 60 minutes.

In-rack sprinkler system designs in FM DS 8-9

Alternative In-Rack Sprinkler Designs



- Not for protection of open-top containers, unless they are located on the bottom tier level.
- Only for open-frame racks.
- Wet-pipe systems only.
- **Use minimum K320 sprinklers or minimum K200 when the required flow for the commodity being 380 L/min or less.**
- The maximum horizontal distance between face sprinklers and the face of the storage rack, or the outer edge of the pallet load is 450 mm.
- Locate all in-rack sprinklers within the footprint of the rack structure.
  - In-rack sprinklers protecting the flue space created between a single-row rack structure and a wall located within 300 mm horizontally of the rack structure can be positioned outside the footprint of the single-row rack structure

In-rack sprinkler system designs in FM DS 8-9

Alternative In-Rack Sprinkler Designs.

The maximum vertical distance between in-rack sprinkler levels:

- ❑ Cartoned expanded plastics as well as uncartoned plastics – 9 m
- ❑ Class 1 through 4 and cartoned unexpanded plastics – 12 m

Design the in-rack sprinkler system for the single most hydraulically remote in-rack sprinkler tier level

Table 15. Number of Sprinklers in the In-Rack Sprinkler System Design

IRAS Installation Figure Used	*Number of In-Rack Sprinklers in the In-Rack Sprinkler System Design*	
	Class 1 through 4 and Cartoned Plastics and Uncartoned Unexpanded Plastics	Uncartoned Expanded Plastics
Single-row racks up to 3 ft (0.9 m) deep (Fig. 19a)	4	4
Single-row racks up to 6 ft (1.8 m) deep (Fig. 19b)	5	5
Single-row racks up to 6 ft (1.8 m) deep against wall (Fig. 19c)	5	5
Double-row racks up to 9 ft (2.7 m) deep (Fig. 20a)	6	6 & 4*
Double-row racks up to 12 ft (3.6 m) deep (Fig. 20b)	6	6 & 4*
Multiple-row racks (Fig. 21)	6	6 & 4*

* The number of in-rack sprinklers in the design consists of 6 in-rack sprinklers in the most remote storage rack as well as the most remote 4 in-rack sprinklers in an adjacent storage rack when the aisle width is less than 8 ft (2.4 m). If the aisle width is 8 ft (2.4 m) or greater, the design does not have to account for the 4 in-rack sprinklers in an adjacent storage rack.

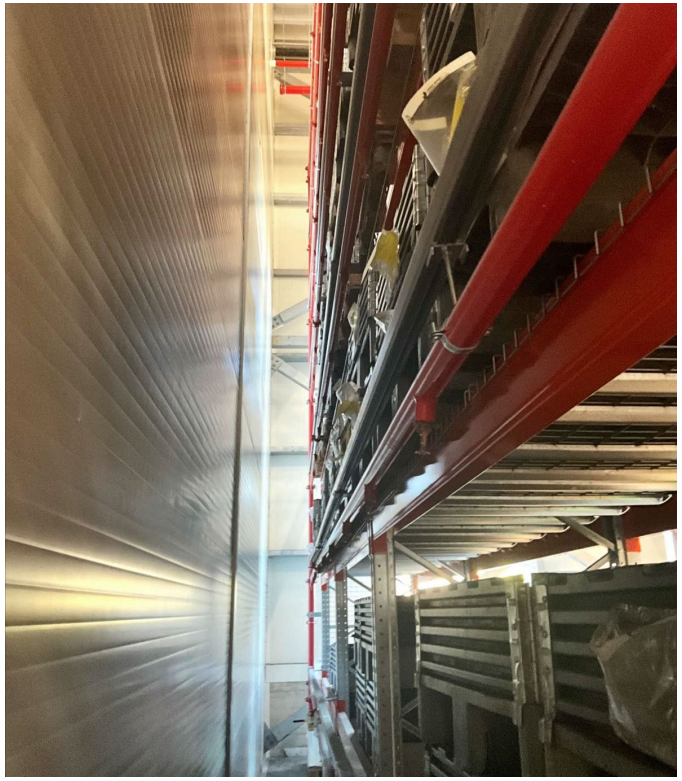
Table 16. Minimum Flow in the In-Rack Design

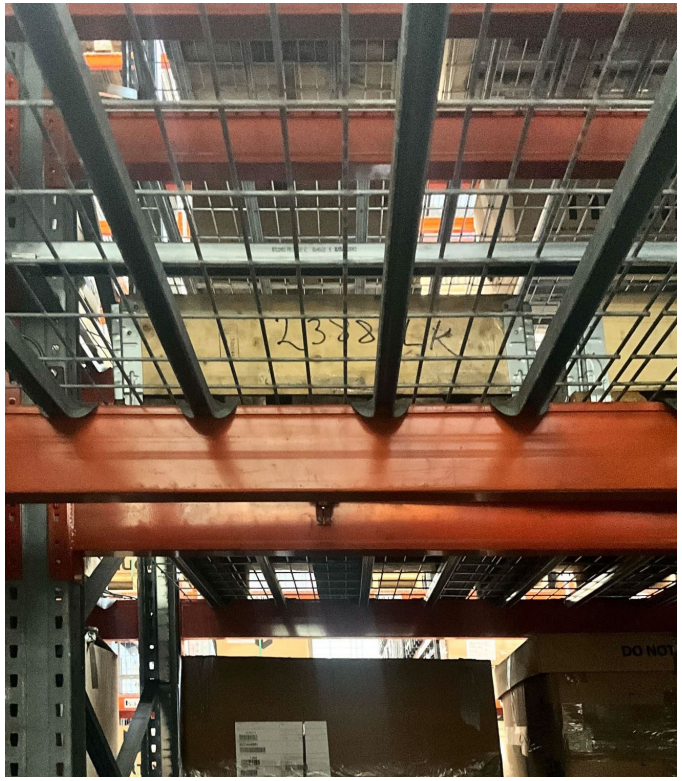
Max. Vertical IRAS Installation, ft (m)	*Commodity Hazard*	*Min. K-factor*	*Min. Flow, from Most Remote In-Rack Sprinkler, gpm (L/min)*
30 (9.0)	Class 1 through 4 and Cartoned Unexpanded Plastic	14.0 (200)	65 (250)
	Cartoned Expanded Plastic	14.0 (200)	100 (380)
	Uncartoned Plastics	22.4 (320)	120 (455)
40 (12)	Class 1 through 4 and Cartoned Unexpanded Plastic	22.4 (320)	120 (455)

- ❑ The water supply must be capable of providing the required design for the in-rack sprinkler system independent of the design requirements of the ceiling sprinkler system. It is not necessary to hydraulically Balance both of the systems.
- ❑ Water supply to provide the required in-rack sprinkler system demand and hose stream allowance for a minimum of 60 minutes.
- ❑ Hose stream allowance of 950 L/min.

WHY we are so afraid of the in-rack sprinklers ?

WE COULD PLAY A GAME LIKE THIS NOW: WHERE'S THE SPRINKLER? HIDE &SEEK
SOME USERS ARE SO AFRAID OF DAMAGING THEIR SPRINKLERS DURING MANUAL LOADING OF THE RACK THAT THEY ASK CONTRACTORS TO "HIDE" THEIR SPRINKLERS. WILL THESE SPRINKLERS ACTUALLY HELP, OR ARE THEY JUST A FAKE?







EN 12845 -2
Fixed firefighting systems – Automatic sprinkler systems – Part 2:
Design and installation of ESFR and CMSA sprinkler systems



CLASSIFICATION OF GOODS – STORAGE CLASSES

Future: 5 classes

- HHS 1 (low combustible)
- HHS 2 (limited amount of plastic)
- HHS 3 (cartoned unexpanded plastic)
- HHS 4 (exposed unexpanded plastic & expanded cartoned plastic)
- HHS 5 (expanded exposed plastic)

- Currently four classes
- ➢ High Hazard Storage (HHS 1,2,3,4)

➢ Consistent with large scale fire test configuration , ESFR and CMSA design

➢ To clearly identify differences between exposed plastic and cartoned plastic

EN 12845-2 BACKGROUND AND DEVELOPMENT

Annex N and Annex P of EN 12845 do not provide a sound basis for design of ESFR and CMSA systems

→

Separate standard can focus on storage protection with ESFR and CMSA

→

Can be introduced more quickly and updated more regularly

→

Latest sprinklers

↓

Latest proven solutions

→

Because the standard is separate, there is no need to browse other publications, which can be more accessible and encouraging for designers.

→

ESFR guidance based on fire tests conducted at FM or UL reserch centres

ESFR DESIGN OPTIONS OPERATING AT LEAST 12 HEADS

- All ESFR design solutions in Table 7, 8 and 9 are based on 12 heads operating
- Includes K400 and K480 sprinklers - With special notes to be applied (aisles)
- Includes expanded plastics (HHS 5) design subject to additional criteria, such as:
  - Vertical barriers
  - Minimum aisle widths
  - Sprinkler location to ceiling
- Rubber tyre requirements in Table 8
- Rolled paper storage requirements in Table 9
  Has some 16 and 25 head designs

Table 7 — Minimum operating pressure for at least 12 ESFR sprinklers ceiling-only design for HHS

Goods Category	Max. ceiling/ roof height	Max. storage height	Pendent orientation nom. k-factors minimum operating pressure in bar for 12 sprinklers in operation						Upright orientation nom. k-factors minimum operating pressure in bar	
	m	m	K200	K240	K320	K360	K400 [c d]	K480 [c]	K200	K240
HHS1 to 3	7,6	6,1	3,4	2,4	1,7	1,0	-	-	3,4	2,4
	9,1	7,6	3,4	2,4	1,7	1,0	-	-	3,4	2,4
	10,7	9,1	5,2	3,6	2,4	1,4	-	-	5,2	3,6
	12,2	10,7	-	3,6	2,8	1,7	-	-	-	-
	13,7	12,2	-	-	2,8	2,8	-	-	-	-
	15,2	13,3	-	-	-	-	2,8 [e]	3,8 [e]	-	-
	16,8	14,9	-	-	-	-	5,5 [f]	3,8 [e]	-	-
HHS4	7,6	6,1	3,4	2,4	5,2	4,1	-	-	-	-
	9,1	7,6	3,4	2,4	5,2	4,1	-	-	-	-
	10,7	9,1	-	-	5,2	4,1	-	-	-	-
	12,2	10,7	-	-	5,2	4,1	-	-	-	-
HHS5	9,1	7,6	-	-	-	2,0 [a]	-	-	-	-
	12,2	10,7	-	-	-	4,1 [a b]	-	-	-	-

[a] This option applies only when all requirements for exposed expanded plastics in combination with Table 7 (see below) are applied including vertical barriers.

[b] This option applies to palletised and solid pile storage in a closed array.

[c] No multiple row racks.

[d] Maximum ceiling to sprinkler to deflector measurement of 325 mm.

[e] Minimum aisle width of 1,8 m.

[f] Minimum aisle width of 2,4 m.

ESFR designs with fewer than 12 heads

Ceilings up to 12.2m high

- Some design options with only 9 and 10 heads operating

Ceilings higher than 12.2m

- Large K Factor sprinklers – K320 – K480
- Limited to HHS 3
- Fewer than 12 sprinklers operating

Table 10 — ESFR design with special requirements up to 12,2 m ceiling height

Goods category	Max. ceiling height m	Max. storage height m	Minimum operating pressure as number of sprinklers at pressure in bar			
			K200	K240	K320	K360
HHS1 to HHS3	7,6	6,1	9 @ 2,4	9 @ 1,7	9 @ 1,4	9 @ 1,4
	9,1	7,6	12 @ 3,5	12 @ 2,4	9 @ 1,4	9 @ 1,4
	10,7	9,1	-	-	12 @ 2,0	12 @ 1,6
	12,2	10,7	12 @ 5,2	12 @ 3,6	9 @ 3,5	9 @ 2,8
HHS4	7,6	6,1	10 @ 3,5	10 @ 2,4	10 @ 1,7	10 @ 1,4
	9,1	7,6	15 @ 3,5	15 @ 2,4	10 @ 3,5	10 @ 2,8
	12,2	10,7	-	-	12 @ 5,2	12 @ 4,1
HHS5	7,6	6,1	12 @ 5,2	12 @ 3,6	9 @2,2	9 @ 1,7
	9,1	7,6	12 @ 6,9	12 @ 4,8	12 @ 3,5	12 @ 2,8
	12,2	10,7	-	-	-	20 @ 5,2

Table 11 — ESFR design with special requirements up to 16,8 m ceiling height

Goods category	Max. ceiling height m	Max. storage height m	Ceiling to element distance mm	Min. aisle width m	Minimum operating pressure as number of sprinklers at pressure in bar			
					K320	K360	K400	K480
HHS1 to HHS3	15,2	13,7	325	1,8	10 @ 4,3	10 @ 3,5	10 @ 2,8 [a]	-
			425	1,8	-	10 @ 5,2	-	9 @ 3,8
	16,8	15,2	325	2,4	-	-	9 @ 5,5	-
			425	1,8	-	-	-	9 @ 3,8

[a] The design for 10 sprinklers at 2,8 bar may be reduced to 9 sprinkler at 2,8 bar if the water supply is able to provide a minimum pressure of 5,5 bar from the most remote 4 sprinklers (2 sprinklers on 2 ranges).

EN 12845-2 - Chalenges

FLUE SPACES

- All the flue spaces shall be no less than 150 mm - In the warehousing world, this means eliminating some pallet spaces.

FIRE TESTS

- Sprinklers must be tested for the stored goods, storage height, and storage type.
  → Not all configurations are described in EN 12259-13

UPDATES

- An amendment to EN 12845-2 will be prepared shortly.

1850	1920	2026
ASC® Engineered Solutions	Reliable®	Reliable Safety & Flow Corporation™
A comprehensive flow management portfolio – grooved couplings, hangers, valves, fittings, fabrication. Portfolio of brands unified as ASC in 2019.	A century of fire protection sprinklers, valves, and accessories made in the USA. Multi-generational customer relationships across the trade.	Two American manufacturing heritages, unified under one name and one promise. One team, one mission, one accountable partner.



Thank you for your attention

Kamil Świetnicki

Product Technology Manager, Europe

Reliable Fire Sprinkler (Polska) Sp. z o.o.

kswietnicki@reliablesprinkler.com