



New In-rack Design Criteria in NFPA 13 and FM Data Sheet 8-9

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Outline

Background

- New Storage Criteria in NFPA 13: 2016 edition
- Testing of EC In-rack Sprinkler System

NFPA 13: 2019 edition

FM Data Sheet 8-9: July 2018 Interim Revision

Summary



Background New Storage Criteria in NFPA 13: 2016 edition



2013 Edition NFPA 13



~~2013 Edition~~
~~NFPA 13~~



2013 NFPA 13

No design criteria for
Expanded Expanded Group A Plastics
Stored in Racks



New in NFPA 13: 2016 edition

Design criteria for Exposed Expanded Group A plastics stored in racks

- Max. Ceiling Height: 12m
- Max. Storage Height: 11m
- Min. Aisle Width: 2.4m
- Vertical barriers at max. 5.0m and 11.5m² intervals
- Sprinkler: K25.2 (K360) ESFR Intermediate Temperature
- Design Criteria: 12 sprinklers at 4.1 bar
- Basic water demand: 8 750 lpm



FM Data Sheet 8-9

Table 11

Uncartoned Expanded Plastics

- Max. Ceiling Height: 12m
- Sprinkler: K25.2 (K360) QR Storage
- Design Criteria: 20 sprinklers at 5.2 bar
- Basic water demand: 16 420 lpm





Background Reliable Research on Extended Coverage In-rack Sprinkler System

Why In-rack Sprinklers?

Tall Buildings
High Hazards
Water Savings



Concepts

1. Virtual Floor
2. Extended Coverage In-rack Sprinkler System
 - N-RACK-EC[®]

Virtual Floor



Extended
Coverage
IRAS
N-RACK-EC®



In-rack Sprinklers

STANDARD IN-RACK SPRINKLERS



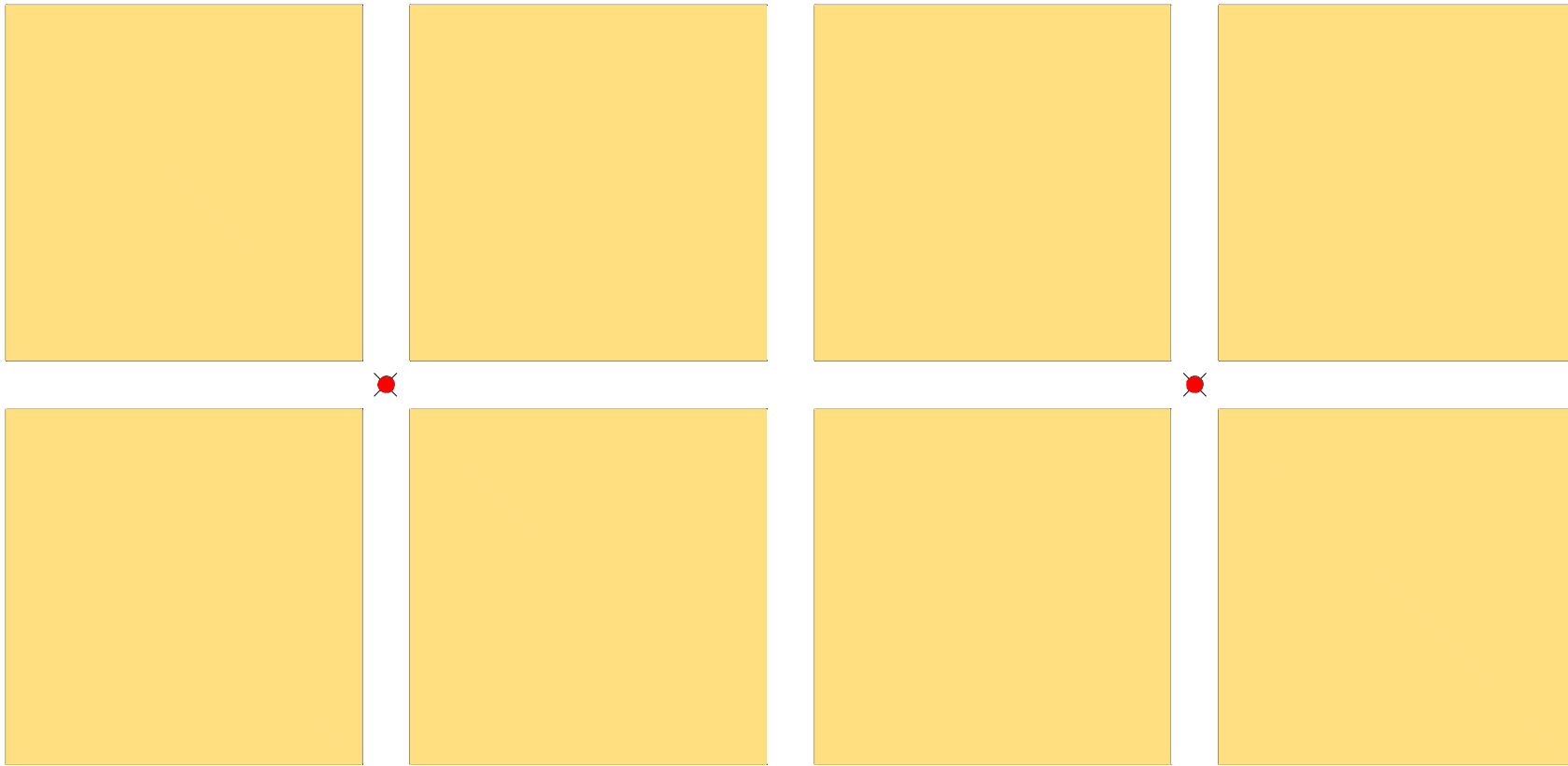
EXTENDED COVERAGE IN-RACK SPRINKLERS
K25.2 (K360) PENDENT





Extended Coverage IRAS

Tested Double-row Rack Layout



Extended Coverage IRAS Test

Exposed Expanded Group A Plastics

12m ceiling

11m storage

Ceiling level sprinkler system

- K16.8 (K240) ESFR @ at 3.5 bar

In-rack sprinkler system

- K25.2 (K360) EC Pendent
 - 520 lpm per sprinkler
 - Intermediate temperature
- 1 level at 9.1m





Extended Coverage IRAS Test

Multiple-row Racks up to 4.7m Deep



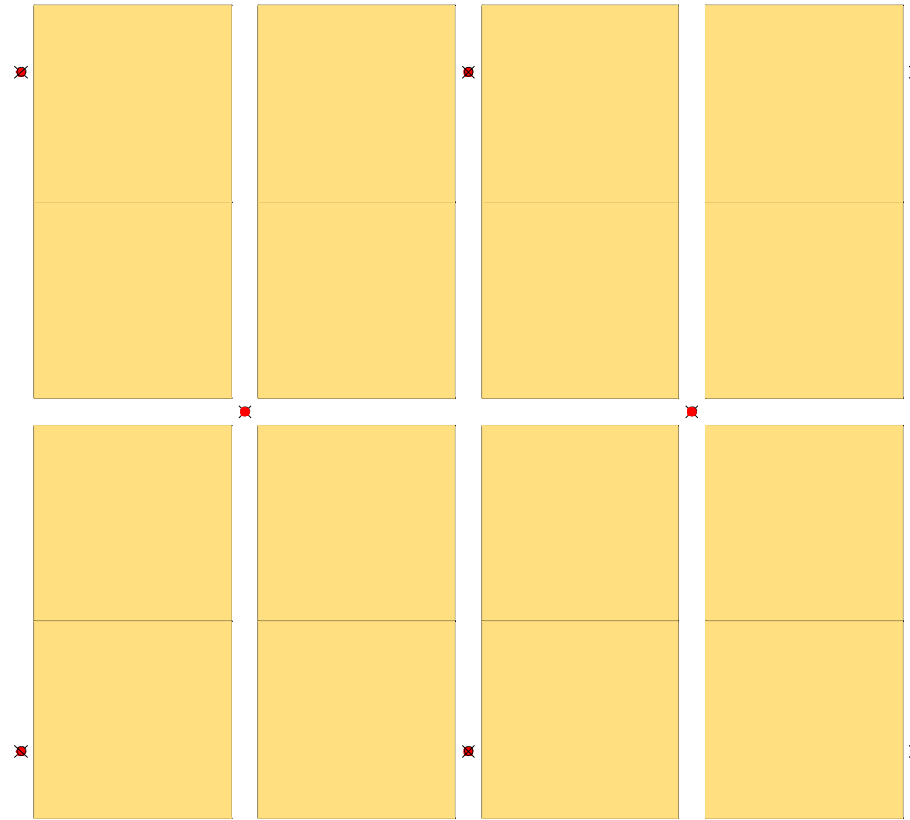
Extended Coverage IRAS Test

Multiple-row Racks up to 4.7m Deep



Extended Coverage IRAS

Tested Multiple-row Rack Layout



Extended Coverage IRAS Test

Cartoned Unexpanded Group A Plastics

14.6m ceiling

13.1m storage

Ceiling

- K25.2 (K360) EC Pendent @ 2.1bar

In-rack

- K25.2 (K360) EC Pendent
 - 520 lpm per sprinkler
 - Intermediate temperature
- 1 level at 30 ft



Cartoned Unexpanded Group A Plastic Commodity

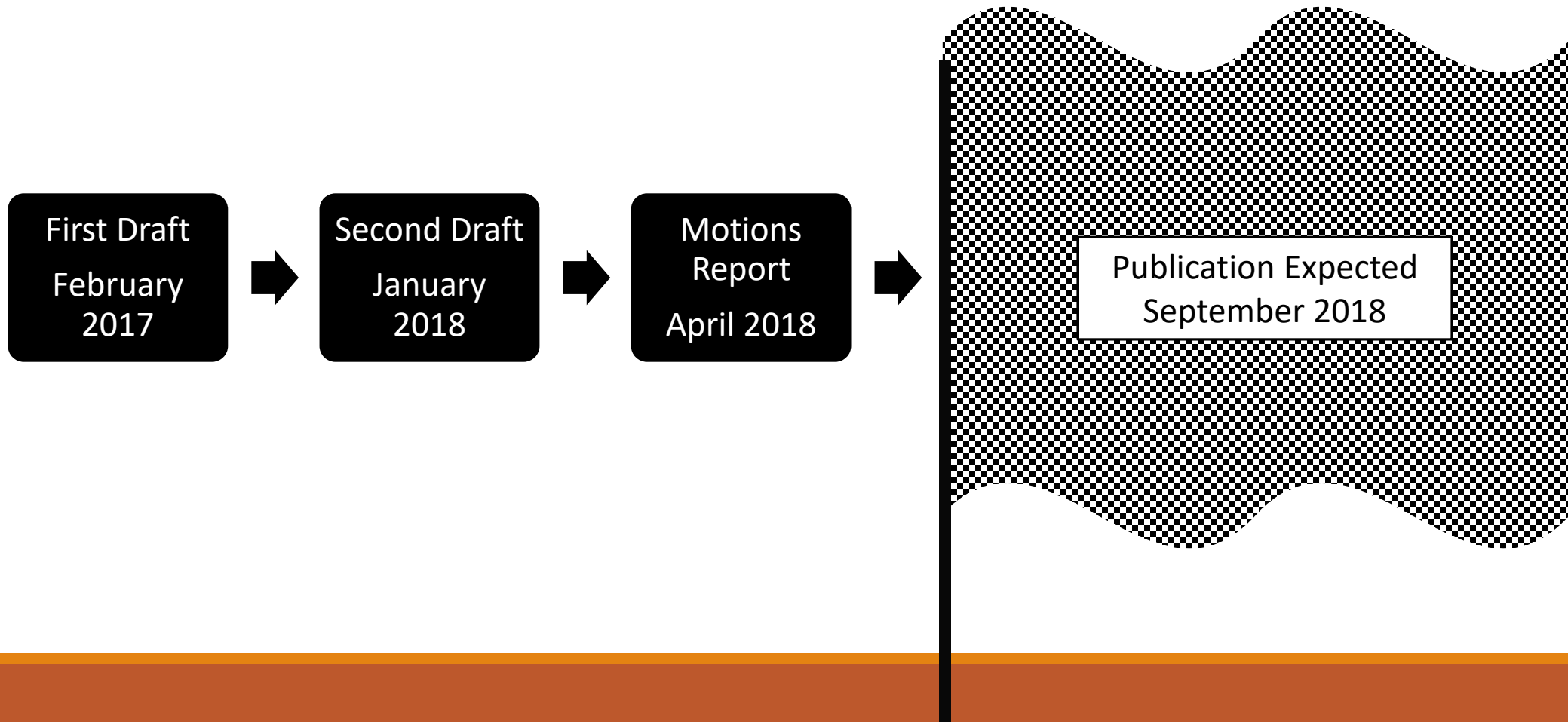


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NFPA 13: 2019 Edition

2019 NFPA 13



Reorganized Storage Chapters

Ch. 20

- General Requirements for Storage

Ch. 21

- Protection of High Piled Storage Using CMDA Sprinklers

Ch. 22

- CMSA Requirements for Storage Applications

Ch. 23

- ESFR Requirements for Storage Applications

Ch. 24

- Alternative Sprinkler System Designs

Ch. 25

- Protection of Rack Storage Using In-Rack Sprinklers

2019 NFPA 13 New Storage Protection Criteria

1. In-rack Sprinklers



ESFR

2019 NFPA 13 New Storage Protection Criteria

2. In-rack Sprinklers



K25.2EC (K36) Pendent



1. ESFR In-rack Sprinklers

ESFR In-Rack

Max. Vertical Spacing of In-rack Levels



12m

- Class I – IV Commodity
- Cartoned Unexpanded Plastic Commodity



9.1m

- Cartoned Expanded Plastic Commodity
- Uncartoned Plastic Commodity

ESFR In-rack Hydraulic Design



Max. Vertical Spacing of In- rack Levels	Commodity	Min. K-factor	Min. Flow per In-rack Sprinkler
m		gpm/psi ^{1/2} (lpm/bar ^{1/2})	lpm
9.1	Class I-IV Cartoned Unexpanded Plastics	14.0 (200)	250
	Cartoned Expanded Plastics	14.0 (200)	380
	Uncartoned Plastics	22.4 (320)	455
12	Class I-IV Cartoned Unexpanded Plastics	22.4 (320)	455

ESFR In-rack Hydraulic Design

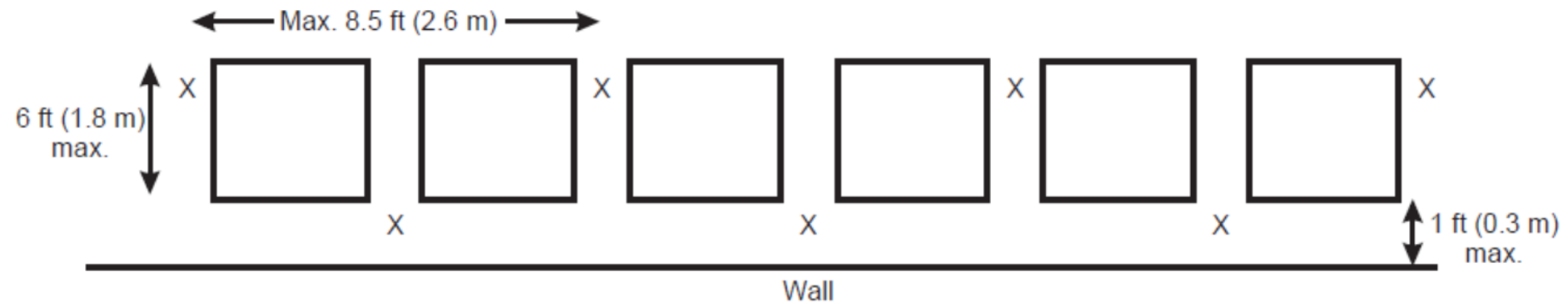
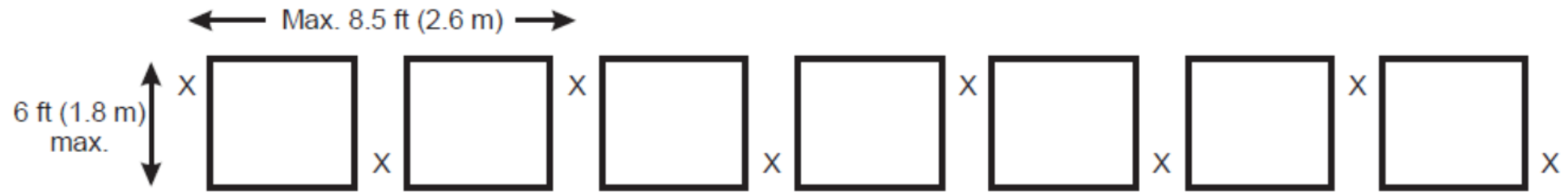
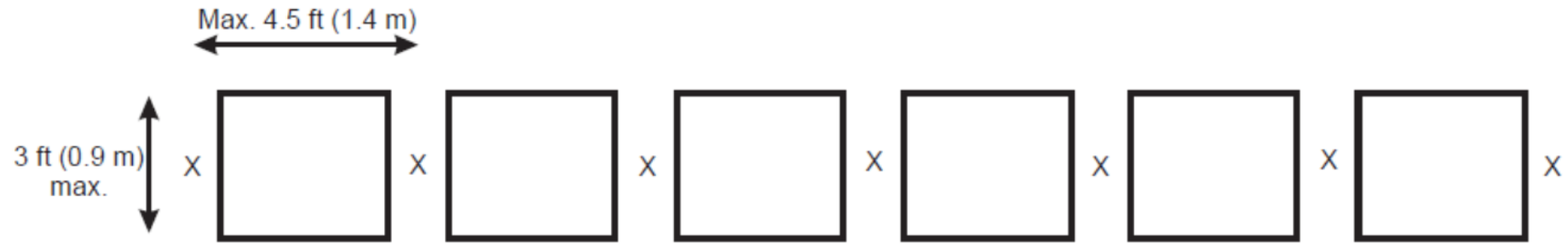


Rack Configuration	Number of Sprinklers in In-rack Hydraulic Design	
	Class I-IV Commodity and Cartoned Plastics	Uncartoned Plastics
Single-row racks up to 0.9m deep	4	4
Single-row racks up to 1.8m deep	5	5
Double- and Multiple-row racks	6	6 & 6

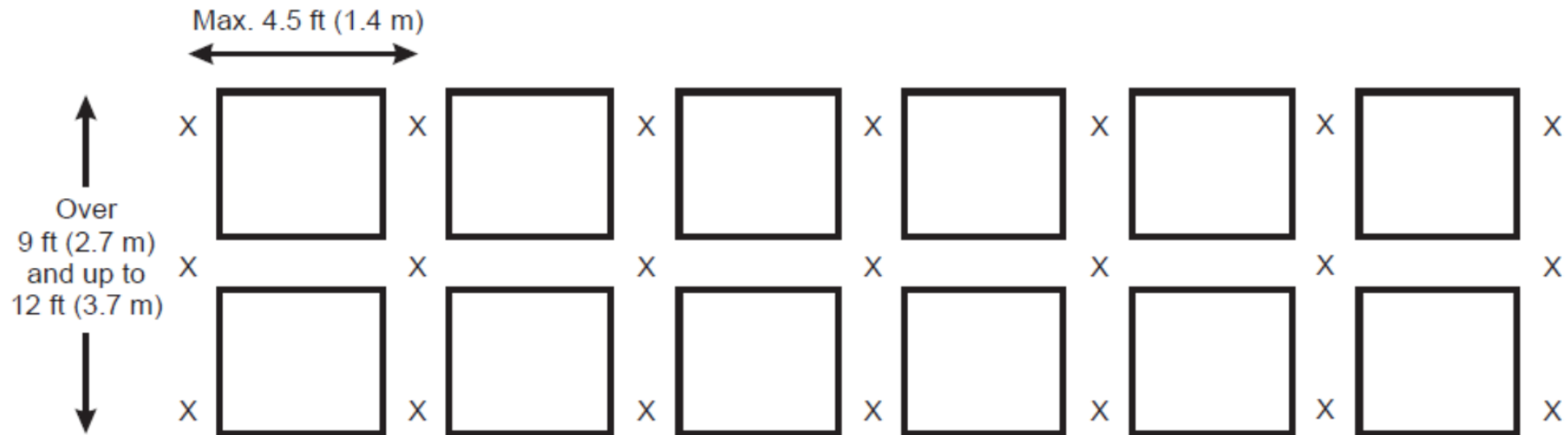
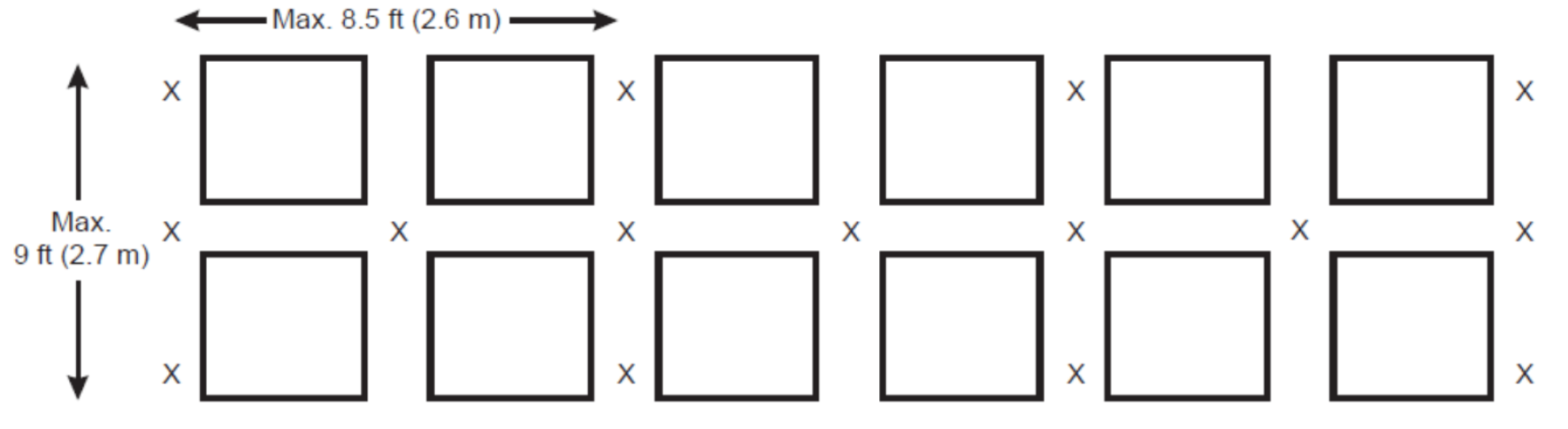
Not balanced with ceiling sprinkler system.

Treat highest in-rack sprinkler system as a “virtual floor” when selecting ceiling sprinkler system.

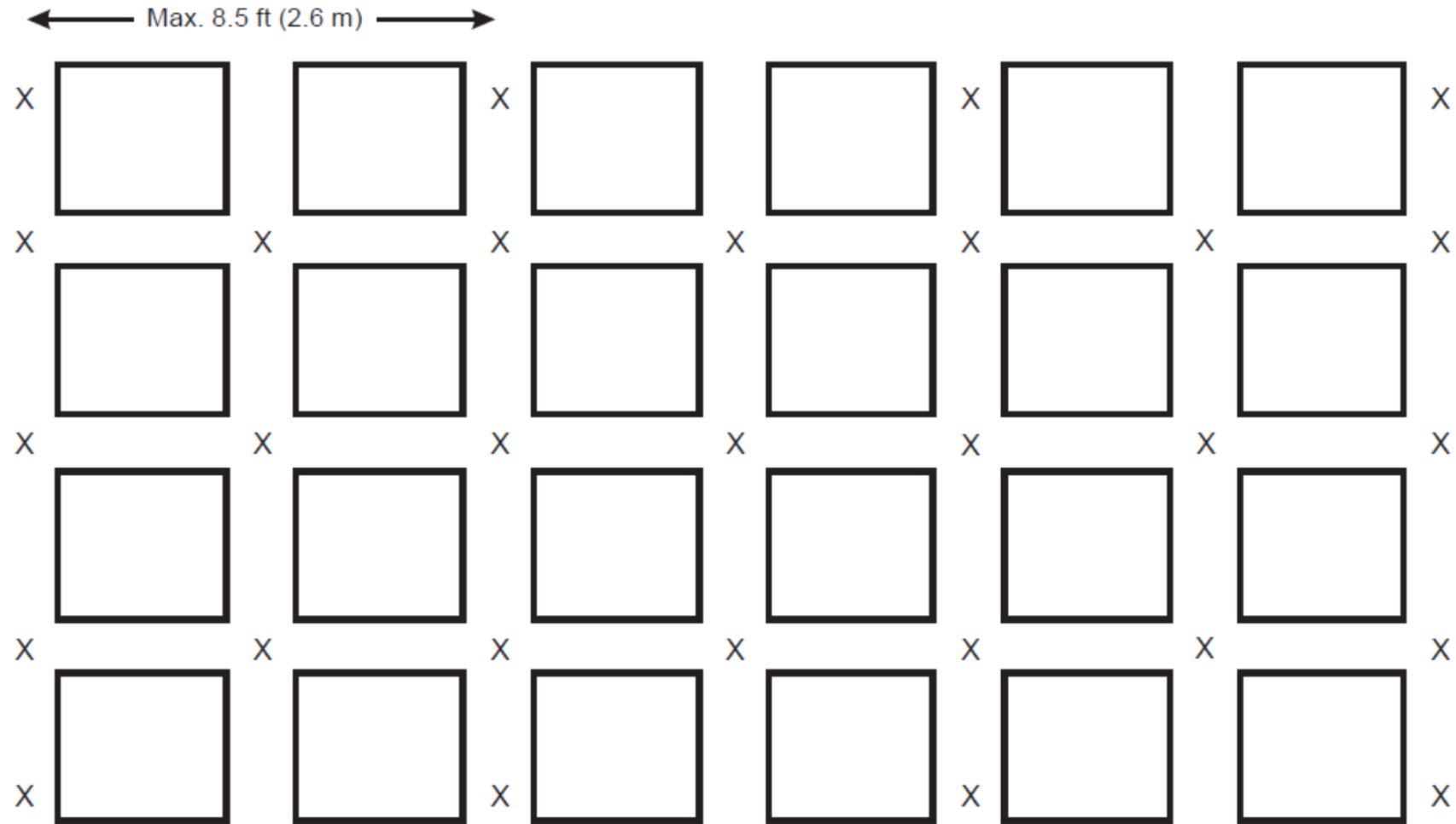
ESFR In-rack: Single-row Racks



ESFR In-rack: Double-row Racks



ESFR In-rack: Multiple-row Racks





2. K25.2EC (K360) Pendent In-rack Sprinklers



EC In-rack

Vertical Spacing of In-rack Levels



9.1m

- Class I – IV Commodity
- Cartoned Plastic Commodity



6.1m

- Uncartoned Plastic Commodity



EC In-rack Horizontal Barriers

Located at each in-rack level

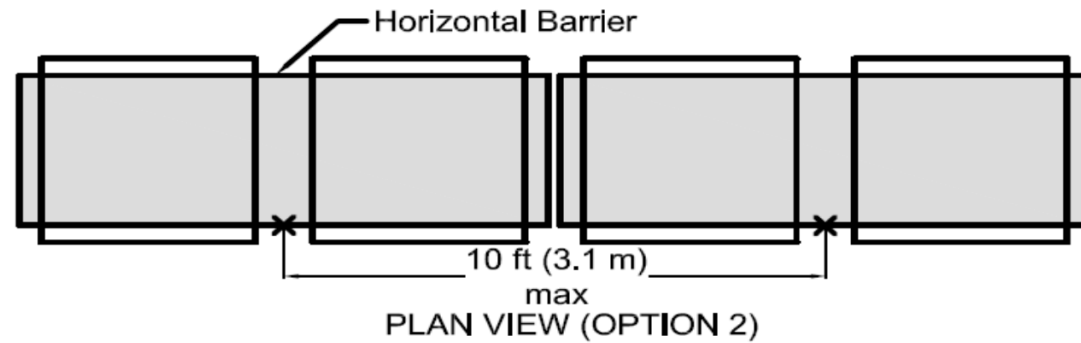
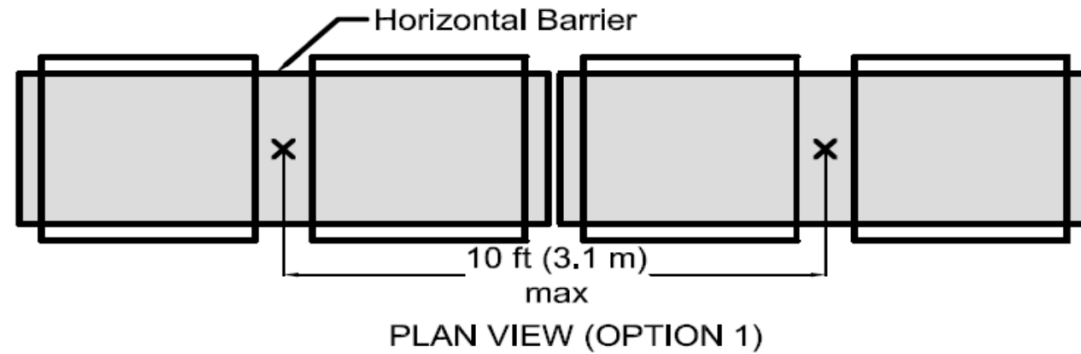
Min. 10mm plywood or 0.7mm metal

Cover flue spaces

- 75mm max. gap permitted at uprights
- 75mm max. gap permitted at rack members, pipe drops, etc.

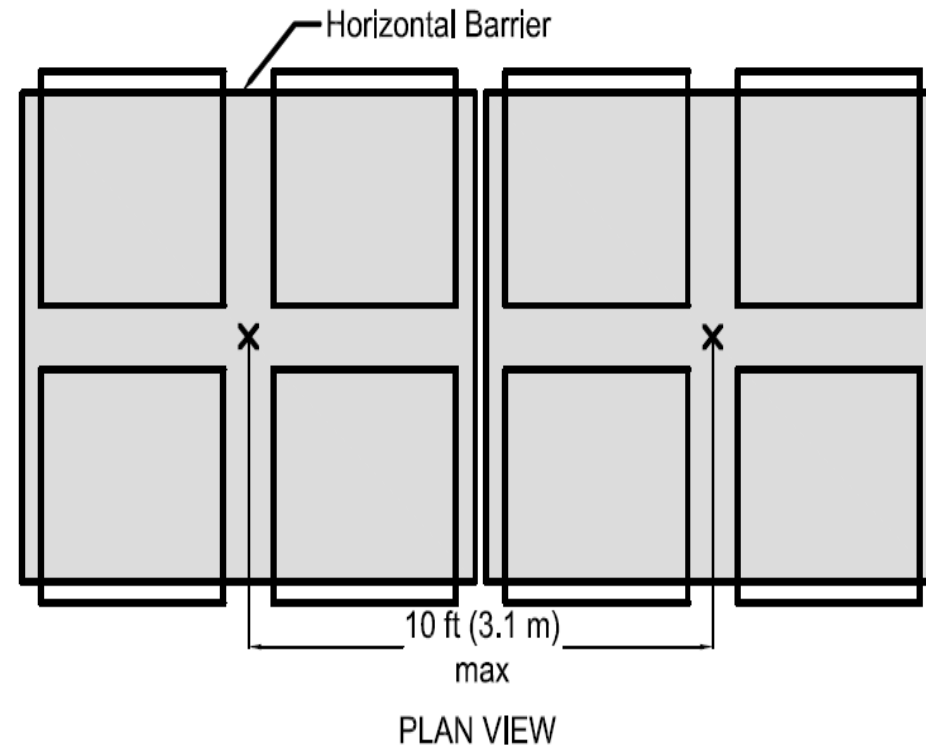


EC In-rack Single-row Rack Layout



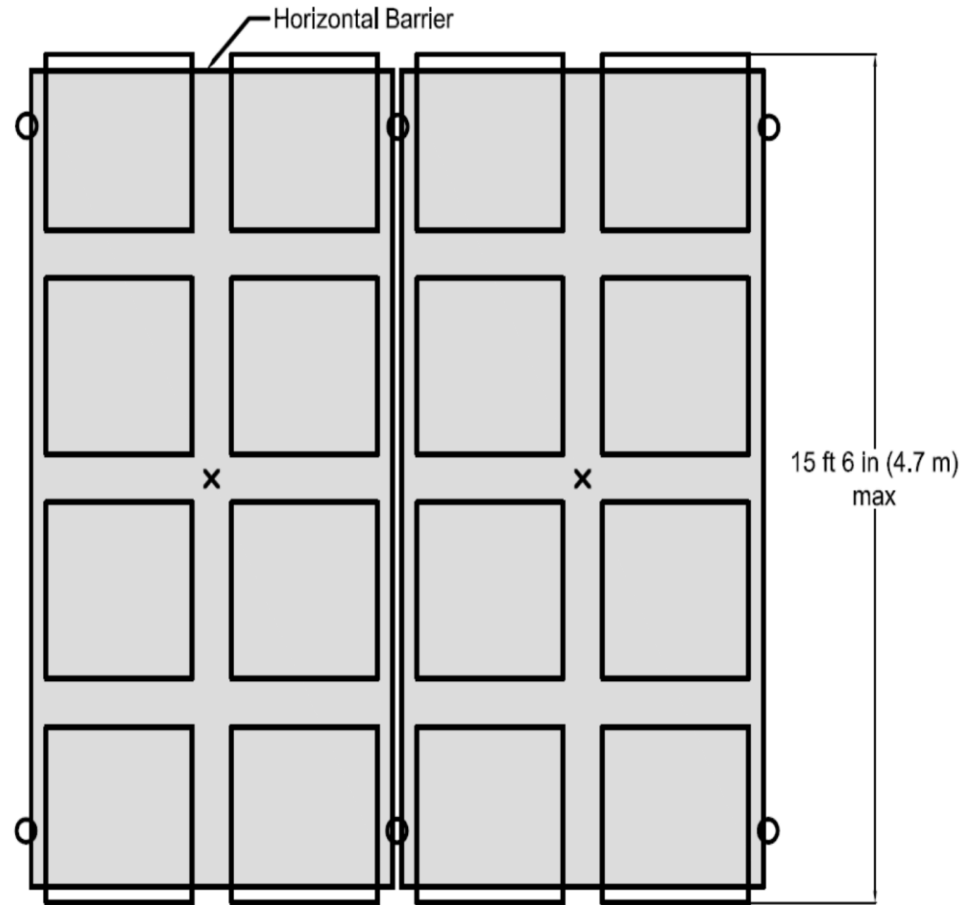


EC In-rack Double-row Rack Layout





EC In-rack Multiple-row Rack Layout





EC In-rack Hydraulic Design

520 lpm per sprinkler

Single- and double-row racks

- 4 sprinklers

Multiple-row racks (up to 4.7m deep)

- 8 sprinklers (3 at each face and 2 in-between)

Not balanced with or added to ceiling sprinkler system demand

Installation Example 1

Scenario: Change of commodity in existing warehouse with 12m ceiling height

- Ceiling height: 12m
- Storage height: 10.7m
- Ceiling sprinkler system: K16.8 (K240) ESFR sprinklers
- Storage racks: Double-row 2.4m deep
- Old commodity: Cartoned Unexpanded Group A plastics
- New commodity: Exposed Expanded Group A plastics



Example 1: Existing 12m Building with Commodity Change

	Option 1	Option 2	Option 3	Ceiling Only
Ceiling sprinklers	Existing* K16.8 (K240) ESFR	Existing* K16.8 (K240) ESFR	Existing* K16.8 (K240) ESFR	New K25.2 (K360) ESFR
Ceiling sprinkler design criteria	Existing* 12 at 3.5bar	Existing* 12 at 3.5bar	Existing* 12 at 3.5bar	12 at 4.1bar
In-rack sprinklers	K8.0+ (K115+) QR	K22.4+ (K320+) ESFR	K25.2EC (K360EC) Pendent	None
In-rack sprinkler design criteria	8 at 230 lpm	10 at 450 lpm	4 at 520 lpm	None
No. In-rack Sprinklers per Rack Bay	10 (5 on 2 levels)	5	1	None
Basic sprinkler demand	5 400 lpm (existing)	5 400 lpm (existing)	5 400 lpm (existing)	8 750 lpm
Barriers	Horizontal	None	Horizontal	Vertical

*Based on design criteria from FM Global Data Sheet 8-9

Installation Example 2

Scenario: New Tall Storage Building

- Ceiling height: 32m
- Storage height: 29m
- Storage racks: Double-row 2.4m deep
- Commodity: Cartoned Unexpanded Group A plastics (CUP)



Example 2: New 32m Building with CUP Commodity

	Option 1	Option 2	Option 3a	Option 3b
Ceiling sprinklers	K25.2EC (K360EC)	K25.2EC (K360EC)	K25.2EC (K360EC)	K22.4 (K320) ESFR
Ceiling sprinkler design criteria	6 at 2.1bar	6 at 2.1bar	6 at 2.1bar	12 at 2.7bar
In-rack sprinklers	K8.0+ QR	K22.4+ (K320+) ESFR	K25.2EC (K360EC) Pendent	K25.2EC (K320EC) Pendent
In-rack sprinkler design criteria	8 at 230 lpm	6 at 450 lpm	4 at 520 lpm	4 at 520 lpm
No. In-rack Sprinklers per Rack Bay	35 (5 on 7 levels)	10 (5 on 2 levels)	3 (1 on 3 levels)	2 (1 on 2 levels)
Basic sprinkler demand	3 100 lp	3 100 lpm	3 100 lpm	6 400 lpm
Barriers	Horizontal	None	Horizontal	Horizontal

FM Data Sheet 8-9

July 2018

Interim Revision

FM Global
Property Loss Prevention Data Sheets

8-9

March 2010

Interim Revision July 2018

Page 1 of 87

STORAGE OF CLASS 1, 2, 3, 4 AND PLASTIC COMMODITIES

FM Data Sheet 8-9

July 2018 Interim Revision

1.1 Changes

July 2018. Interim revision. a new Section 2.3.6.8 has been created to address the installation and design guidelines for protection scheme using quick-response K25.2EC (K360EC) pendent sprinklers as in-rack sprinklers in combination with horizontal barriers to protect open-frame rack storage of commodity hazards up to and including cartoned unexpanded plastics when the in-rack sprinkler protection was installed 30 ft (9.0 m) above floor level.

“ . . . using quick-response K25.2EC (K360EC) pendent sprinklers as in-rack sprinklers ””



EC In-rack in FM Data Sheet 8-9 Commodities

Class I – IV

Cartoned nonexpanded
group A plastic

Containers must be
closed top





EC In-rack in FM Data Sheet 8-9 Racks

Open frame racks

Single-, double- or multiple-
row

Horizontal barriers at each
in-rack level

- Extend across longitudinal flue
- Not required at transverse flues with uprights



EC In-rack in FM Data Sheet 8-9

Horizontal Sprinkler Spacing

Linear: 2.1m to 2.5m

Area: 4.6m² to 6.3m²

Linear spacing may be 1.3m or less when area spacing is 1.6m² or less

Must be spaced at least 0.9m from rack uprights within single-row racks and double-row racks up to 2.4m wide

Exception: Where the max. linear spacing is 1.3m and max. area spacing is 1.6m²



EC In-rack in FM Data Sheet 8-9

Rows of Sprinklers per Level

Rack Type	No. Rows of Sprinklers per In-rack Level
Single-row	1
Double-row up to 2.7m deep	1
Double-row more than 2.7m deep	2
Multiple-row	Use horizontal spacing rules and provide sprinklers within 450mm of each rack face



EC In-rack in FM Data Sheet 8-9

Vertical Spacing

Max. Vertical Distance between in-rack sprinklers:
9.0m

Max. distance from deflector to horizontal barrier:
175mm

Min. clearance from storage to deflector: 225mm



EC In-rack in FM Data Sheet 8-9

Design Criteria: 605 lpm per sprinkler

Rack type	Rack depth	Aisle width	No. of IRAS in Design
Single-row	Up to 1.8m	Up to 1.2m	6 total; 3 in most remote rack and 3 in nearest adjacent rack
		Over 1.2m	3 in most remote rack
Double-row	Up to 9.7m	Up to 1.2m	8 total; 4 in most remote rack and 4 in nearest adjacent rack
		Over 1.2m	4 in most remote rack
	Over 9.7m	Any	8 total; 4 on each rack face in most remote rack
Multiple-row	Any	Any	8 total; 4 along the rack face and the nearest 4 sprinklers in the most remote rack



Ceiling Sprinkler Design Criteria

The “Virtual Floor”

Consider the top level of in-rack sprinklers as a floor when selecting the ceiling sprinkler system design criteria.



EC In-rack in FM Data Sheet 8-9

Water Demand

Hose stream allowance: 950 lpm

Water supply duration: 60 minutes

In-rack sprinkler system not balanced with or added to ceiling level sprinkler demand when overhang of commodity beyond horizontal barrier is max. 75mm.

Summary

2019 NFPA 13

Anticipated publication September 2018

New in-rack design criteria using ESFR sprinklers or
K25.2EC (K360EC) Pendent sprinklers

FM Data Sheet 8-9 July 2018 Revision

New in-rack design criteria for K25.2EC (K360EC) QR
Pendent Sprinklers

Designing “Independent” In-rack Sprinkler Systems

USE THE “VIRTUAL FLOOR”
FOR EXTENDED COVERAGE AT THE CEILING



Thanks for your attention!!!!