


**American Fire
Sprinkler Association**

Storage Occupancies

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AMERICAN FIRE SPRINKLER ASSOCIATION


Bob Caputo, president of the American Fire Sprinkler Association (AFSA), is chair of the NFPA 24 and NFPA 291 technical committees and a member of multiple NFPA technical committees, including NFPA 13 and NFPA 25. Caputo is a contributor of the NFPA 13 and NFPA 25 Handbooks, and the NFPA Inspection Manual. A senior member of NFPA and AFSA faculties, Caputo has written and presented seminars worldwide on fire protection and life safety systems and is a regular speaker at AFSA and NFPA conventions. Caputo is an instructor at the National Fire Academy and an advisory board member at Oklahoma State University School of Fire Protection Engineering & Safety. Caputo's industry distinctions include "Fire Prevention Officer of the Year" from San Diego County in 1994, "Man of the Year" from Fire Protection Contractor magazine in 1997, and the Henry S. Parmelee award from AFSA in 2017. Caputo attended the University of Albuquerque, New Mexico, and is a U.S. Navy veteran and former volunteer firefighter.

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**IT'S A BIG WORLD.
LET'S PROTECT IT TOGETHER.**

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Navigating NFPA 13

2019 edition



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Sprinklers Installation Requirements

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Chapter 9 – Sprinkler Location Requirements

Chapter 10 - Standard Spray Uprights, Pendants, Sidewalls

Chapter 11 – Extended Coverage Uprights, Pendants, Sidewalls

Chapter 12 – Residential Sprinklers

Chapter 13 – CMSA Sprinklers

Chapter 14 – ESFR Sprinklers

Chapter 15 – Special Sprinklers






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Design and Discharge

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Chapter 19 – Design Approaches

Storage Chapters

Chapter 20 – General Requirements for Storage

Chapter 21 - CMDA


Chapter 22 – CMSA

Chapter 23 – ESFR


Chapter 24 – Alternative Designs

Chapter 25 – In-rack Sprinklers

Chapter 26 – Special Occupancies




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100th Anniversary of the Publication of the International Code of Maritime Law

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General Requirements




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General

- Topics covered
 - Commodity classification
 - Storage arrangements
 - Storage heights
 - Clearances
- Miscellaneous/Low-Piled
 - See chapter 4



10




Section 20.1

10

High-Piled vs. Low-Piled

High-Piled Storage	Section 4.3.1.5 & 4.3.6
<ul style="list-style-type: none">Class I through Class IV<ul style="list-style-type: none">12 ft or less in heightGroup A plastics<ul style="list-style-type: none">5 ft or less in heightUse miscellaneous criteria	<ul style="list-style-type: none">Not low-piledClass I through Class IV<ul style="list-style-type: none">Exceeding 12 ft in heightGroup A plastics<ul style="list-style-type: none">Exceeding 5 ft in height




Low-Piled Storage

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Miscellaneous Storage

12

- Storage height not exceeding 12 ft
- No more than:
 - No more than 10% building area
 - 4,000 sq. ft
 - Whichever is greater
- Separated by 25 ft
- Solid shelf requirements do not apply



Section 4.3.1.4




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Miscellaneous Storage

13

Table 4.3.1.7.7.1




13


Protection of Storage

14

- Identify the commodity
- Identify the method of storage
- Establish storage height
- Establish building height
- Select sprinkler technology
 - CMDA
 - CMSA
 - ESFR



Section 20.2

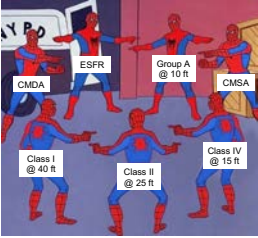


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Multiple Hazard Classification

- Select water supply based on duration of higher hazard classification
- Unless:
 - Higher hazard contained to 400 sq. ft




Section 20.2.3

15

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Classification of Commodities

- Consider
 - Product being stored
 - Primary packaging
 - Pallet
- Lab data permitted to classify commodity
- Design for the highest, all lower commodities are protected



Section 20.3.1

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Pallet Types

- Wood
- Metal
- Plastic
 - May increase commodity classification



Section 20.3.2.1


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Plastic Pallets

Unreinforced Plastic Pallets

Reinforced Plastic Pallets





20.3.2.2.1, 20.3.2.2.2, 20.3.2.2.3



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Plastic Pallets – No Increase

Sprinklers 16.8-K or Larger

Listed






Photo Credit: RASCO

Section 20.3.2.2.4 & 20.3.2.3

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Slave Pallets

▪ Figure A.3.3.154.1

▪ Flat, combustible pallets


▪ Class I through IV

▪ Maximum 25 ft

▪ CMDA sprinklers

▪ Increase density by 20%

▪ Unless in-racks are used




Section 20.3.2.5


20

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Open-Top Containers

- Entirely or partially open
- Collects water
- Outside the scope of storage chapters
 - OK for miscellaneous/low-piled storage





Section 20.3.3

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Commodity Classes



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Class I

- Noncombustible products
 - Directly on wood pallets
- Single layer corrugated cartons, with or without pallets
- Shrink-wrapped or paper-wrapped, with or without pallets





Section 20.4.1

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Class I Examples



Section A.20.4.1

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Class II

- Noncombustible products
 - In slatted wood crates
 - Solid wood boxes
 - Multiple-layered corrugated cartons
 - Or equivalent packaging material
 - With or without pallets



Section 20.4.2

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Class II Examples




Section A.20.4.2


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Class III

- Combustible products
 - Wood
 - Paper
 - Natural Fibers
 - Group C plastics
- Contained in
 - Cartons
 - Boxes
 - Crates
 - Pallets






Section 20.4.3

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Cartoned Class III

Figure 20.4.3.3(a)




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Exposed Class III Commodities

Figure 20.4.3.3(b)



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Class III Examples




Section A.20.4.3

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Class IV

- Group B plastics
- Free-flowing Group A plastics
- 5-15% wt. nonexpanded Group A, cartoned
- 5-15% vol. expanded Group A, cartoned
- 5-15% wt. nonexpanded Group A, exposed



Section 20.4.4

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Cartoned Class IV

Figure 20.4.3.3(a)

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Exposed Class IV Commodities

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Figure 20.4.3.3(b)



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Class IV Examples

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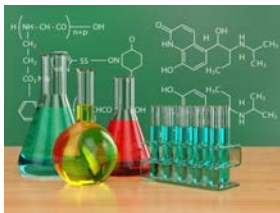
Section A.20.4.4

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Group A Plastics

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- Based on list of materials in standard
- Subdivided into expanded/non expanded



Section 20.4.5.1 & 20.4.5.2

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Cartoned Group A Expanded Plastics

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Figure 20.4.3.3(a)

36

Exposed Group A Expanded Plastics

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Section 20.4.5.3

37

Cartoned Group A Nonexpanded Plastics

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Figure 20.4.3.3(a)

38

Exposed Group A Nonexpanded Plastics

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Figure 20.4.3.3(b)



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Group A and Group C Plastics

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- Based on list of materials in standard
- Group B protected as Class IV
- Group C protected as Class III

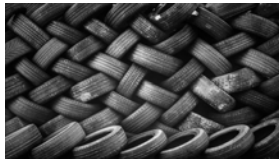
Figure 20.4.8



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Special Commodities

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Sections 20.4.9, 20.4.10, 20.4.11, & 20.4.12



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Special Commodities






Sections 20.4.9, 20.4.10, 20.4.11, & 20.4.12


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Mixed Commodities

- Not based on overall mix/distribution
- Based on highest classified commodity
 - Up to 10 pallet of higher classification permitted
 - Up to 5 pallets of Class IV or Group A (Class I or II)
 - Max 40,000 sq. ft area
 - Randomly dispersed, nonadjacent






Section 20.4.13

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Mixed Commodities

III	II	II	II	III	II	II	III
II	II	III	II	II	II	II	II
III	II	II	II	II	III	II	II
II	II	II	III	II	II	II	III



CLASS II COMMODITY


Section 20.4.13

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Mixed Commodities

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IV	III	III	III	IV	III	III	III
III	III	IV	III	III	III	III	III
III	III	III	III	III	IV	III	III
IV	III	III	III	III	III	III	IV

CLASS III COMMODITY


Section 20.4.13

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Mixed Commodities

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IV	II	II	II	IV	II	II	II
II	II	IV	II	II	II	II	II
II	II	II	II	II	IV	II	II
IV	II	II	II	II	II	II	IV

CLASS IV COMMODITY


Section 20.4.13

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Mixed Commodities

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IV	II	II	II	A	II	II	IV
II	II	IV	II	II	II	II	II
A	II	II	II	II	A	II	II
II	II	II	A	II	II	II	IV

GROUP A PLASTIC



Section 20.4.13

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Ranking Commodities

- 1) Class I
- 2) Class II
- 3) Class III
- 4) Class IV
- 5) Cartoned nonexpanded plastic
- 6) Cartoned expanded plastic
- 7) Exposed nonexpanded plastic
- 8) Exposed expanded plastic




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Storage Arrangements





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Rack Types

- Moveable Racks
 - Protected as multiple-row rack
- Portable Racks
 - Protected as multiple-row racks




Section 20.5.1 & 20.5.2

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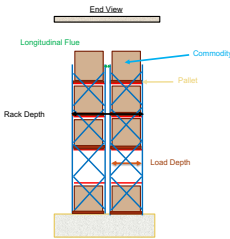
Rack Storage



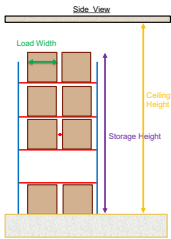
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Rack Definitions


End View



Side View



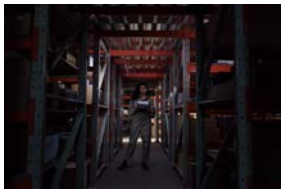
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Shelving

- Solid shelves if:
 - Less than 50% open
 - Or placement of loads block required flue space
 - Greater than 20 ft² in an area
- Open rack if not



Section 20.5.3.1

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Double-Row Racks

- Solid shelf if longitudinal flue not provided
- Open if
 - No solid shelves
 - Longitudinal flue
 - Storage ≤ 25 ft
 - Transverse flues every 5 ft or less




Section 20.5.3.1.2



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Multiple-Row Racks



- Considered solid shelf unless:
 - Transverse flues spaced ≤ 5 ft
 - Longitudinal flues spaced ≤ 5 ft
- OR**
- Transverse flues spaced ≤ 5 ft
 - Rack depth ≤ 20 ft
 - Aisles ≥ 3.5 ft
 - Longitudinal flue not required

Section 20.5.3.1.3



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Slatted Shelves

- Determine if they are open
- Special design requirements in Chapter 26



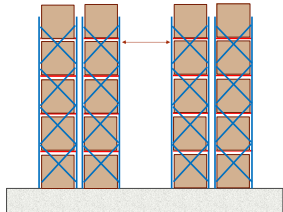
Section 20.5.3.2



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Aisles

- Horizontal dimension
- Between face of loads in racks under consideration




Section 3.3.4 & 20.5.3.3

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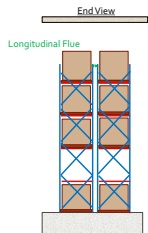
Flues



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Longitudinal Flue Space

- Double-row and multiple-row racks:
 - ≤ 25 ft. in height- No flue required
- Double-row racks:
 - > 25 ft. in height- 6 in. nominal required



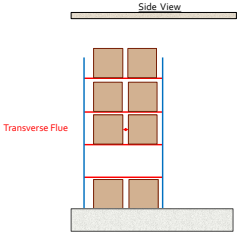
Section 20.5.3.4.1

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Transverse Flue Space


- Single, Double and Multiple-row Racks:
 - Nominal 6 in. flue between loads and at rack uprights
 - Random variations in width or vertical alignment permitted



Transverse Flue

Side View

Section 20.5.3.4.2



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Building Construction and Storage Heights




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Ceiling Slope

- Not to exceed 2 in 12 unless modified by specific sections in Chapters 20-25



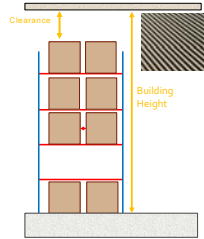
Section 20.9.1



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Building Height and Clearance

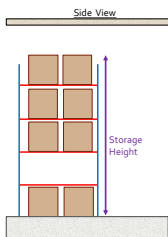
- Measured to underside of the roof deck or ceiling
- Corrugated Metal Deck
 - 3 in. or less
 - Greater than 3 in.
- Insulation
 - Rigid, no sag
 - Sag, 6 in. or less
 - Sag, greater than 6 in.



Section 20.9.2

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Storage Height



- Based on routine or periodic storage height, whichever is more demanding
- Above door storage calculated from the base of storage above the door

Section 20.9.3.1 & 20.9.3.2

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Clearance to Ceiling

Section 20.9.4.1




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Maximum Clearance for CMDA Protection

66

Table 20.9.4.2




66

Excessive Clearance - Class I through Class IV

67

Table 20.9.4.3




67

Excessive Clearance - Plastic and Rubber

68

Table 20.9.4.4



68



69


Roof Vents and Draft Curtains




69

Roof Vents

- Manual operation
- Automatic
 - Activation temperature higher than sprinklers
- ESFR Sprinklers
 - Automatic
 - Activation temperature higher than sprinklers
 - Standard Response



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Section 20.9.5.1 & 20.9.5.2


70

Draft Curtains

- Not permitted within ESFR
- Permitted at breaks in ESFR systems
 - ESFR/ESFR
 - ESFR/Control Mode
 - Different hazards



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Section 20.9.5.3


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Draft Curtains


- ESFR and Standard Response Sprinkler Break:
 - Non-combustible construction
 - At least 2 ft. in depth
 - Clear aisle of at least 4 ft. below the draft curtain






Section 20.9.5.3


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Clearance from Deflector to Storage




73

Clearance from Deflector to Storage

- Minimum 18 in.
- Superseded by other standards/chapters
- Less with fire testing
- Minimum 36 in.
 - Rubber tires
 - CMSA
 - ESFR





Section 20.9.6


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Unsprinklered Combustible Concealed Space

- Minimum 3000 sq. ft design area for adjacent spaces
- Unless
 - Construction meets 1 of 9 exceptions
 - Fire-resistant barrier installed equal to water supply duration





Section 20.10

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Adjacent Hazards

- Separated by draft curtains
 - Over an aisle
 - 24 in clear on both sides
- Partition capable of delaying heat
- Change in elevation of 24 in
 - More demanding must be in higher ceiling
- If not, extend more demanding design 15 ft






Section 20.13


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Hose Connections

- Small (1 1/2 inch) Hose Connections
 - Where required by AHJ
- Not required for I-V commodities stored ≤ 12 ft. in height






Section 20.14

77

78

Hose Allowance and Water Supply Duration

Table 20.15.2.6




78


79

Multiple Adjustments

- Compounded based on the original area of operation
- Minimum 3,000 sq. ft for combustible concealed space applied after



Section 20.16




79


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System Types

- Wet Systems Required
- Dry or Preaction permitted
 - Subject to freezing
 - Special conditions
 - Increase 30%
 - Even for single interlock



Section 20.16.2



80

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Special Design Considerations

Idle Pallets

Rubber Tire Storage (Columns)




Sections 20.17 & 20.18

81

[illegible]

82

83

Vertical Spacing and Location

- CMDA
 - 20 sq. ft to 64 sq. ft
 - Every 6 ft
- CMDA
 - Over 64 sq. ft
 - Every level
- CMSA/ESFR
 - Every level





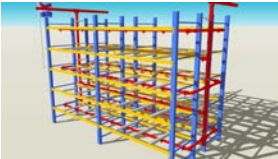
Section 20.19.3

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Horizontal Location and Spacing

- Class I through Class IV
 - 10 ft max
- Group A plastics
 - 5 ft max
- Partial solid shelves
 - Extend at least 4 ft
 - End at flue space



Section 20.19.4

84



Installation of CMDA, CMSA, and ESFR Sprinklers

Intermediate Design School

85




85

86

Basic Requirements

1. Installed throughout
2. Maximum protection area
3. Satisfactory performance
4. Allowable omissions
5. Laboratory testing
6. Laboratory testing




Section 9.1


86

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Allowable Omissions




- Non-combustible concealed spaces
- 16 examples with combustibile construction
 - May require increase in design area
 - Check general storage chapter
- Other special areas




Section 9.2

87

88



Heat Sources





88

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Storage Occupancies

- High-temperature sprinklers permitted throughout
 - Ordinary hazard
 - Extra hazard
 - Storage occupancies
- High-temperature not available in certain sprinkler types





Section 9.4.2.3

89

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Temperature Ratings

- Ordinary/Intermediate throughout except...
 - Uncovered Steam main, heating coil, or radiator (uncovered)
 - Low pressure blowoff valve (within 7 ft)
 - Under Skylights
 - Unventilated concealed space/attic
 - Unventilated show windows w/ high powered lights
 - Commercial cooking equipment/ducts
 - Heating ducts producing less than 100 °F
 - Coolers/Freezers with auto-defrost

Section 9.4.2.5

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Unit Heaters

- 7 ft radius around center
- 20 ft arc 30° out from front edges

Figure 9.4.2.5

91

92

Maximum Protection Areas

$$A_s = S \times L$$

- Where:
 - S is the distance between sprinklers on the branch line (2x distance to wall)
 - L is the distance between sprinklers perpendicular to the branch line (2x distance to wall)
- Maximum 400 sq. ft or listing


Section 9.5.2.1 & 9.5.2.2


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Maximum Distances

- As permitted
- Sprinklers
 - Centerline-Centerline
- Walls
 - ½ Max Allowable
 - Perpendicular






Section 9.5.3.1 & 9.5.3.2


93

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Deflector Position

- Parallel to floor (2 in 12)
- Parallel to roof (sloped)
- Corrugated Metal Deck
 - 3 in. or less
 - Greater than 3 in.
- Insulation
 - Rigid, no sag
 - Sag, 6 in. or less
 - Sag, greater than 6 in.






Section 9.5.4


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Obstruction Zones

Sprinkler Discharge Pattern Development	Sprinkler Discharge Reaching Hazard
▪ Less than or equal to 18 in.	▪ Greater than 18 in.
▪ Beam, soffit, 3x (4x) rule	▪ Greater than 4 ft wide






Section 9.5.5

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Obstruction Zones

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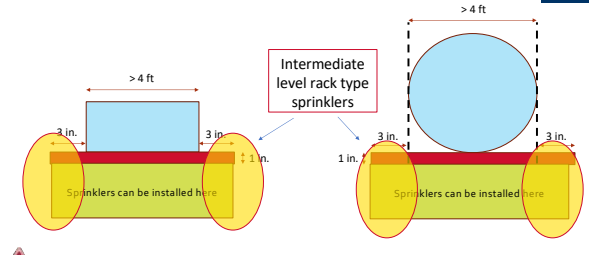
Section 9.5.5



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Positioning Below Obstructions

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Intermediate level rack type sprinklers

Sprinklers can be installed here

Sprinklers can be installed here

Section 9.5.5.3.1.2



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Installation of CMDA Sprinklers

Chapters 9, 10, & 11

98


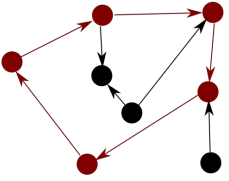


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Control Mode Density Area (CMDA)

- Spray Sprinklers
- Installation requirements based on respective chapter:
 - Chapter 9 – General Requirements
 - Chapter 10 – SSU/SSP and Sidewall
 - Chapter 11 – Extended Coverage
 - Chapter 15 – Special Sprinkler




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Maximum Spacing and Area of Coverage

Table 10.2.4.2.1(d)




100

101

Maximum Spacing and Area of Coverage (EC)

Table 11.2.2.1.2



101

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Special Sprinklers

- Maximum protection area
 - 196 sq. ft



Section 15.2.2

102



103

Installation of CMSA Sprinklers

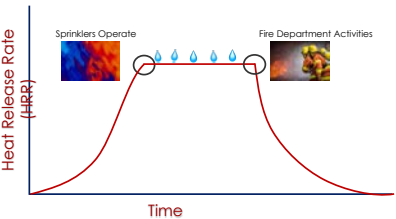
Chapter 13



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Control Mode



Heat Release Rate (HRR)


Time

Sprinklers Operate

Fire Department Activities


104

CMSA Spray Pattern VK598 K25 CMSA @ 60 psi



Video Credit: The Viking Group, Inc.


105



105


System Types

- Permitted types
 - Wet
 - Dry
 - Preaction
- Install sprinklers in accordance with listing



Section 13.2.2


106



106


Temperature Ratings

- Based on general requirements
- Wet Systems
 - Ordinary-temperature
 - Intermediate-temperature
 - High-temperature
- Dry System
 - High-temperature only



Section 13.2.3

107




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Occupancy and Hazard

- QR CMSA Sprinklers
 - Light Hazard
 - Ordinary Hazard
- SR CMSA Sprinklers
 - Ordinary Hazard



Section 13.2.4

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Maximum Protection Area and Spacing

Construction Type	Protection Area (ft ²)	Maximum Spacing (ft)
Noncombustible unobstructed	130	12
Noncombustible obstructed	130	12
Combustible unobstructed	130	12
Combustible obstructed	100	10
Rack storage combustible obstructed	100	10
Rack storage unobstructed and noncombustible obstructed	100	12

Table 13.2.5.2.1

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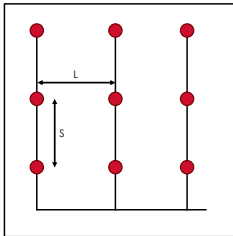
Minimum Protection Area of Coverage

- Maximum: 130 sq. ft
- Minimum: 80 sq. ft

$$A_s = S \times L$$

Where:

- S is the distance between sprinklers on the branch line (2x distance to wall)
- L is the distance between sprinklers perpendicular to the branch line (2x distance to wall)



Section 13.2.5.2.2 & 13.2.5.2.3

110




CMSA Sprinkler Spacing





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Distance From Walls

- Maximum
 - 1/2 allowable distance between sprinklers
- Minimum
 - 4 in.






Section 13.2.6.2 & 13.2.6.3

112

Minimum Distance Between Sprinklers

- Minimum 8 ft
- Baffles permitted in 2022 edition
 - Meet obstruction rules
 - Solid and rigid
 - At least 8 in. long, 6 in. high
 - Extend 2-3 in. above uprights
 - Even with pendants







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Section 13.2.6.4

113




CMSA Deflector Position





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Distance Below Ceilings

- Unobstructed Construction
 - Minimum: 3 in.
 - Maximum: 8 in.
- Obstructed Construction
 - Option 1
 - Minimum: 6 in.
 - Maximum: 12 in.








Section 13.2.7.1

115

Distance Below Ceilings

- Obstructed Construction
 - Option 2
 - 1 to 6 in below solid member
 - Up to 22 in. maximum
- Open wood joist
 - K-11.2 → 50 psi
 - K-16.8 → 22 psi






Section 13.2.7.1


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Distance Below Ceilings

- Obstructed Construction
- Option 3
 - Concrete tees
 - Less than 7 ft 6 in. on center
 - More than 3 ft on center
 - 1 in. below stem





Section 13.2.7.1

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Obstructions to CMSA Discharge




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General Requirements

- Obstructions to sprinkler discharge pattern development
 - Continuous or noncontinuous obstructions
 - Up to 36 in. below deflector
 - Apply beam rule or 3x rule
- Solid continuous obstructions
 - Apply beam rules regardless of position





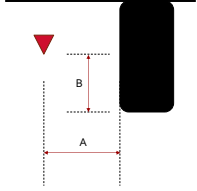
Section 13.2.8.2.1

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CMSA Beam Rule

Minimum Distance from Sprinklers to Side of Obstruction (A)	Maximum Allowable Distance of Deflector Above Bottom of Obstruction (B)
Less than 3 ft.	0
3 ft.	15
3 ft. 6 in.	3
4 ft.	5 1/2
4 ft. 6 in.	8
5 ft.	10
5 ft. 6 in.	12
6 ft.	15
6 ft. 6 in.	18
7 ft.	22
7 ft. 6 in.	26
8 ft.	31



Section 13.2.8.1.2


120

121

CMSA 3 Times Rule

- Obstructions 8 in. or less
- Locate sprinkler 3X the greatest distance

Figure 13.2.8.2.1.3




121

122

Branch Lines

- Upright sprinklers
 - Attached to pipe 4 in. or less
 - Offset 12 in. horizontally
 - Sprigged 12 in. vertically



Section 13.2.8.2.2

122



123

Obstructions that Prevent Sprinkler Discharge from Reaching the Hazard




123

Obstruction Below the Sprinkler Deflector

124

Minimum Distance to side of Obstructions (A)	Maximum Distance of Deflector Above Bottom of Obstruction (in.) (B)
1 ft 6 in.	6 in.
3 ft	12 in.
4 ft	18 in.
5 ft	24 in.
5 ft 6 in.	30 in.
6 ft	36 in.

Figure 13.2.8.3.2.




124


Sprinklers Under Open Grating

125

- Shields shall be installed on overhead sprinklers under open grates.




Section 13.2.8.3.3



125

Obstruction More Than 24 in. Below Sprinklers


Figure 13.2.8.3.4



126

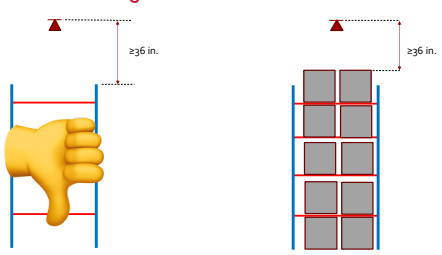
Parallel or Directly Below a Branch Line

Figure 13.2.8.3.5



127


Clearance to Storage



≥36 in.

≥36 in.

Section 13.2.9



128



129

Installation of ESFR Sprinklers

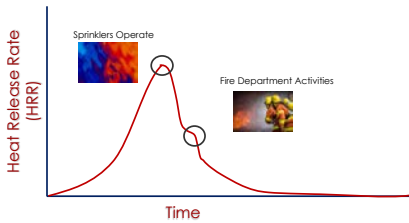
Chapter 14



129

Early Suppression

130




Heat Release Rate (HRR)

Time

Sprinklers Operate

Fire Department Activities




130

CMSA and ESFR Comparison


131

ESFR- VK510

ESFR- VK598



Video Credit: The Viking Group, Inc.




131

132

System Types

- Permitted types
 - Wet pipe
 - Unless specifically listed for dry or preaction
- Install sprinklers in accordance with listing




Section 14.2.2

132

133

Construction Types

- Horizontal ceilings
 - Pitch ≤ 2 in 12
- Unobstructed
- Obstructed
 - Solid members exceed 12 in.
 - Installed in each channel
 - Maintain minimum spacing in the channel




Section 14.2.3 & 14.2.4

133

134

Draft Curtains

- Adjacent systems with SR sprinklers
- Separated by draft curtain
 - Minimum 2 ft depth
 - Minimum 4 ft clear aisle
 - Centered below draft curtain




Section 14.2.5


134

135

Temperature Rating

- Ordinary- or intermediate-temperature unless...
- See general requirements
- High-temperature?






Section 14.2.6

135

136

Temperature Ratings

- Ordinary/Intermediate throughout except...
 - Uncovered Steam main, heating coil, or radiator (uncovered)
 - Low pressure blowoff valve (within 7 ft)
 - Under Skylights
 - Unventilated concealed space/attic
 - Unventilated show windows w/ high powered lights
 - Commercial cooking equipment/ducts
 - Heating ducts producing less than 100 °F
 - Coolers/Freezers with auto-defrost




Section 9.4.2.5

136

137

Unit Heaters

- 7 ft radius around center
- 20 ft arc 30° out from front edges






Figure 9.4.2.5

137

138

Occupancy Hazard

- ESFR storage designs permitted to protect
 - Light hazard
 - Ordinary hazard
- In light/ordinary hazard
 - Use SSU/SSP spacing
 - Use SSU/SSP obstructions



Section 14.2.7

138



139

Protection Areas per ESFR Sprinkler



139

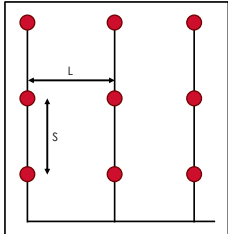
140

Area of Coverage

$$A_s = S \times L$$

Where:

- S is the distance between sprinklers on the branch line (2x distance to wall)
- L is the distance between sprinklers perpendicular to the branch line (2x distance to wall)




Section 14.2.8.1

140

141

Maximum Protection Areas and Maximum Spacing of ESFR Sprinklers

Construction Type	Ceiling/Roof Heights Up to 30 ft		Ceiling/Roof Heights Over 30 ft	
	Protection Area (ft ²)	Spacing (ft)	Protection Area (ft ²)	Spacing (ft)
Noncombustible unobstructed	100	12	100	10
Noncombustible obstructed	100	12	100	10
Combustible unobstructed	100	12	100	10
Combustible obstructed	N/A	N/A	N/A	N/A


Table 14.2.8.2.1


141

142

Shifting Sprinklers on a Branch Line

- Permits sprinkler to exceed 100 sq. ft
 - Move sprinklers on a BL
 - Move up to 1 ft
 - $\Delta_s \leq 110$ sq. ft
 - Average floor area covered by adjacent sprinklers ≤ 100 sq. ft
 - Maintain pattern
 - 12 ft max still applies




Section 14.2.8.2.3 & 14.2.9.1(3)


142

143

Shifting Branch Lines

- Permits sprinkler to exceed 100 sq. ft
 - Move a single BL
 - Can't move is sprinkler was shifted
 - Move up to 1 ft
 - $\Delta_s \leq 110$ sq. ft
 - Average floor area covered by adjacent sprinklers and branch lines ≤ 100 sq. ft
 - Maintain pattern
 - 12 ft max still applies




Section 14.2.8.2.4 & 14.2.9.1(4)

143

ESFR "Shift" Rule

144

Figure A.14.2.8.2.3




144

ESFR "Shift" Rule

145

Figure A.14.2.8.2.3




145

Minimum Protection Area of Coverage


146

- Minimum 64 sq. ft
- Unless
 - Sprinklers installed in channels of solid structure



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Section 14.2.8.3





146

147

Distance from Walls

- Maximum
 - ½ allowable distance between sprinklers
- Minimum
 - 4 in.






Section 14.2.9.2 & 14.2.9.3


147

148

Minimum Distance Between Sprinklers

- Minimum 8 ft
- Unless installed above solid structural members
- Baffles permitted in 2022 edition
 - Meet obstruction rules
 - Solid and rigid
 - At least 8 in. long, 6 in. high
 - Extend 2-3 in. above uprights
 - Even with pendants





Section 14.2.9.4

148



ESFR Deflector Position



149

Distance Below Ceilings

- Pendants
- K-14.0, K-16.8, and K-28.0
 - Maximum 14 in.
 - Minimum 6 in.



Photo Credit: Victaulic

Section 14.2.10.1.1

150 150

150

Distance Below Ceilings

- Pendants
- K-22.4, K-25.2, and K-33.6
 - Maximum 18 in.
 - Minimum 6 in.



Photo Credit: Victaulic

Section 14.2.10.1.2

151

151

Distance Below Ceilings

- Uprights
- K-14.0 and K-16.8
 - Maximum 12 in.
 - Minimum 3 in.



Photo Credit: JCI

Section 14.2.10.1.3

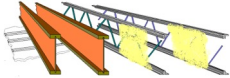
152

152

153

Obstructed Construction

- Branch lines permitted to be perpendicular to beams
- Sprinklers must be in bays
 - Above bottom of structural member
 - Not under beams



Section 14.2.10.1.4

153

154



Obstructions to ESFR Sprinkler Discharge

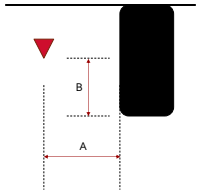


154

155

ESFR Beam Rule

Minimum Distance from Sprinklers to Side of Obstruction (A)	Maximum Allowable Distance of Deflector Above Bottom of Obstruction (B)
Less than 1 ft	0
1 ft	1½
1 ft 6 in.	3
2 ft	5 ½
2 ft 6 in.	8
3 ft	10
3 ft 6 in.	12
4 ft	15
4 ft 6 in.	18
5 ft	22
5 ft 6 in.	26
6 ft	31



Section 14.2.11.1.1

155

156

Isolated Obstructions Below Elevation of Sprinklers

156

Isolated Obstruction Options

157

1. Install sprinklers below the obstruction

Section 14.2.11.2

157

Isolated Obstruction Options

158

<p>2022 edition</p> <ol style="list-style-type: none"> 2. No additional sprinklers if <ul style="list-style-type: none"> ▪ Width \leq 1-1/2 in. ▪ Obstruction is at least 12 in. below the sprinkler 	<p>2019 edition</p> <ol style="list-style-type: none"> 2. No additional sprinklers if <ul style="list-style-type: none"> ▪ Width \leq 2 in. ▪ Obstruction is at least 24 in. below the sprinkler <p style="text-align: center;">OR</p> <ul style="list-style-type: none"> ▪ Obstruction is 1 ft away horizontally
--	---

Section 14.2.11.2

158

Isolated Obstruction Options

2022 edition

3. No additional sprinklers if

- Width \leq 6 in.
- Obstruction is at least 6 in. horizontally from sprinkler

2019 edition





Section 14.2.11.2

159


Isolated Obstruction Options


2022 edition

4. No additional sprinklers if

- Width \leq 24 in.
- Obstruction is at least 12 in. horizontally from sprinkler

2019 edition





Section 14.2.11.2

160


Isolated Obstruction Options


2022 edition

5. No additional sprinklers if

- Location complies with beam rule

2019 edition





Section 14.2.11.2

161


Isolated Obstruction Options


2022 edition

2019 edition

6. No additional sprinklers if

- Installed in accordance with listing





Section 14.2.11.2

162

Isolated Obstruction Options

2022 edition

2019 edition

7. No additional sprinklers if

- Protecting LH/OH
- SSU/SSP obstruction rules met





Section 14.2.11.2


163


Isolated Obstruction Options

2022 edition

2019 edition

8. Extend ESFR obstruction rules 6 ft into adjacent LH/OH occupancy protected with ESFR sprinklers





Section 14.2.11.2

164

165

Continuous Obstructions Below Sprinklers

165

Continuous Obstruction Options

166

1. Install sprinklers
 - a. Comply with the beam rule
 - b. Install sprinklers below

Section 14.2.11.3.1

166

Continuous Obstruction Options

167

2022 edition	2019 edition
<ol style="list-style-type: none"> 2. No additional sprinklers if <ul style="list-style-type: none"> ▪ Width $\leq 1\text{-}1/2$ in. ▪ Obstruction is at least 12 in. below the sprinkler 	<ol style="list-style-type: none"> 2. No additional sprinklers if <ul style="list-style-type: none"> ▪ Width ≤ 2 in. ▪ Obstruction is at least 24 in. below the sprinkler ▪ Obstruction is at least 1 ft away horizontally

Section 14.2.11.3.1

167

Continuous Obstruction Options

168

2022 edition


3. Install sprinklers

- Width ≤ 6 in.
- Obstruction is at least 6 in. horizontally from sprinkler

2019 edition

3. Install sprinklers

- Width ≤ 12 in.
- Obstruction is at least 12 in. horizontally from sprinkler



Section 14.2.11.3.1

168

Continuous Obstruction Options

169

2022 edition


4. Install sprinklers

- Width ≤ 24 in.
- Obstruction is at least 12 in. horizontally from sprinkler

2019 edition

4. Install sprinklers

- Width ≤ 24 in.
- Obstruction is at least 24 in. horizontally from sprinkler



Section 14.2.11.3.1

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Continuous Obstruction Options

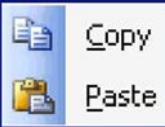
170


2022 edition

5. Beam rule not applicable if

- Row of sprinklers installed below the obstruction

2019 edition





Section 14.2.11.3.1

170

56

Continuous Obstruction Options

2022 edition

6. No additional sprinklers if

- Protecting LH/OH
- SSU/SSP obstruction rules met

2019 edition

NEW

171

Section 14.2.11.3.1

171

Bottom Chords of Bar Joists or Open Trusses

2022 edition

- Bottom chord ≤ 4 in.
 - Sprinkler over chord
 - No additional protection
- Bottom chord ≤ 6 in.
 - Locate sprinkler at least 6 in. away horizontally from edge
- Bottom chord ≤ 24 in.
 - Locate sprinkler at least 12 in. away horizontally from edge

2019 edition

- Bottom chord ≤ 4 in.
 - Sprinkler over chord
 - No additional protection
- Bottom chord ≤ 12 in.
 - Locate sprinkler at least 12 in. away horizontally from edge


172

Section 14.2.11.3.2

172

Branch Lines

- Upright sprinklers
 - Attached to pipe 4 in. or less
 - Offset 12 in. horizontally
 - Sprigged 12 in. vertically



173

Section 14.2.11.3.3



173

57

174

Multiple Obstructions

- Obstructions must be separated by 3x rule
- Otherwise considered a grouped obstruction



Section 14.2.11.3.4

174

175

Open Grating

- Intermediate level/rack storage type

OR

- Shielded from discharge of overhead sprinklers






Photo Credit: RASCO (Model N25)





Section 14.2.11.3.5

175

176

Overhead Doors and Special Obstruction

- Standard spray QR sprinklers permitted
- Special obstruction allowance
 - Install according to the listing




Section 14.2.11.3.6 & 14.2.11.3.7


176

177

Conveyors

- Standard spray QR sprinklers permitted
 - No high-piled storage below
- ESFR required where high-piled storage is present





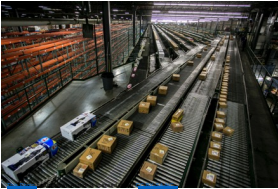
Section 14.2.11.4


177

178

Conveyors

- Additional sprinklers not required if
 - 70% open
 - Up to 4 ft wide and no high-piled storage
 - Openings between rollers exceeds width of roller
 - Roller conveyors with no high-piled storage



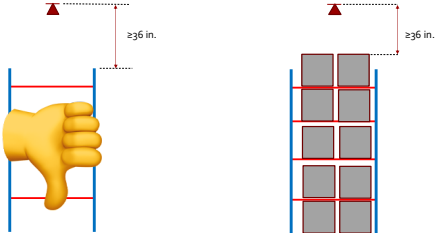



Section 14.2.11.4

178

179

Clearance to Storage





Section 14.2.12

179

Any Questions?





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For additional questions regarding the content in today's presentation, please contact:

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