FIRE SPRINKLER PLAN REVIEW

19TH ANNUAL BUILDING CODES EDUCATION CONFERENCE

1

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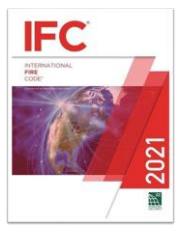
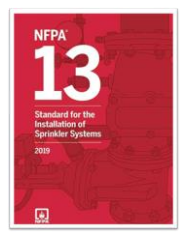
REFERENCES





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IN-CLASS MATERIALS

You:

IBC/IFC – 2021 edition
NFPA 13: 2019
Free viewer: www.nfpa.org/13
Calculator
- Phone, PC, or handheld

Your questions are important.
- Use this time to improve yourself.

NFSA participant materials:

Participant Guide
- Checklists
- Shop drawings
- Calculations

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LEARNING OBJECTIVES

By the end of this program, you will be able to:

1. Apply the requirements of plans examination according to NFPA 13, building and fire codes.
2. Discuss the importance of a systematic review process.
3. Identify the documents required for a complete plan review process.
4. Evaluate the hydraulic calculations presented with a set of working plans submitted for review and approval.

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MODULE 1 – INTRODUCTION AND OVERVIEW

Fire Sprinkler System Plan Review

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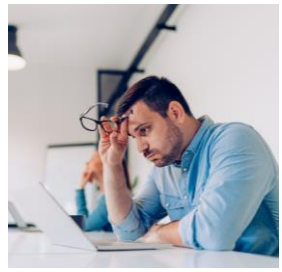
ASSUMPTIONS

Design code and judgements already made.

Sprinklered building

Start at shop drawings, cut sheets, calculations



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WHAT IS A FIRE SPRINKLER PLANS EXAMINER?

Fire sprinkler plans examination is a process where the municipality or the authority having jurisdiction is obligated to examine a proposed fire sprinkler system and compare its proposed installation to the laws and ordinances enforced.

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COMMON ACRONYMS FOR FIRE SPRINKLER PLANS EXAMINERS

GPM – gallons per minute
PSI – pounds per square inch
FDC – fire department connection
SDC – seismic design category
SR – standard response
QR – quick response
CMSA – Control Mode Specific Application
ESFR – Early Suppression Fast Response

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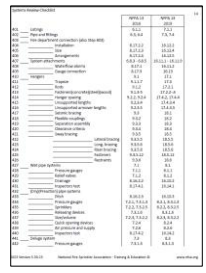
CHECKLISTS

Checklists are tools.
- Use this one, use someone else's, but USE ONE!

Checklists need to be complete…but flexible

Checklists need to catch the big items…but not be lengthy

Checklist cannot be all-inclusive.



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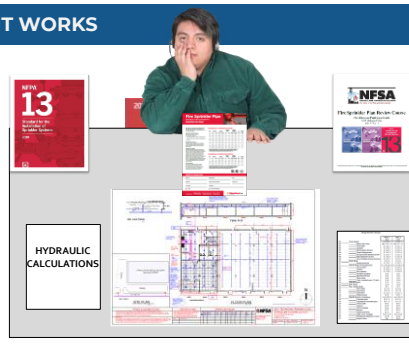
HOW IT WORKS



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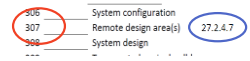
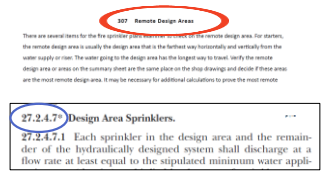
HOW TO BENEFIT FROM THIS PROGRAM

This program provides checklists with informative modules that coordinate with each checklist and step.

Each module or checklist may be done in order, or out-of-order, but all of the modules provide a thorough review of a sprinkler system.

The checklists cover many systems. Not all spaces or areas of the checklists will be filled in.





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MODULE 1 ASSESSMENT

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MODULE 2 – OVERVIEW OF CODES AND STANDARDS (ICC/NFPA 13/13R/13D)

Fire Sprinkler System Plan Review

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REVIEW REFERENCED STANDARDS

IBC

- CHAPTER 30 ELEVATORS AND CONVEYING SYSTEMS
- CHAPTER 31 SPECIAL CONSTRUCTION
- CHAPTER 32 ENCROACHMENTS INTO THE PUBLIC RIGHT-OF-WAY
- CHAPTER 33 SAFEGUARDS DURING CONSTRUCTION
- CHAPTER 34 RESERVED
- CHAPTER 35 REFERENCED STANDARDS

IFC

- TABLE OF CONTENTS
- PART I—ADMINISTRATIVE
- PART II—GENERAL SAFETY PROVISIONS
- PART III—BUILDING AND EQUIPMENT DESIGN FEATURES
- PART IV—SPECIAL OCCUPANCIES AND OPERATIONS
- PART V—HAZARDOUS MATERIALS
- PART VI—REFERENCED STANDARDS
- PART VII—APPENDICES

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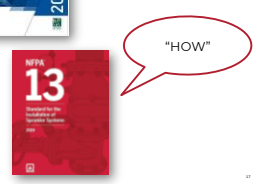
CODES AND STANDARDS

Model codes
- Legally adopted – "what" must be done
- Does include some important sprinkler installation requirements.

Standards
- Adopted by reference – "how" to do it



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NFPA 13 SCOPE

NFPA 13 is a sprinkler design and installation standard focused on both life safety and property protection for commercial and residential occupancies

Scope: Minimum requirements for the design and installation of automatic fire sprinkler systems and exposure protection sprinkler systems

Purpose: Reasonable degree of protection for life and property
- Covers design, installation and testing
- Based upon sound engineering principals, test data and experience

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NFPA 13R SCOPE

NFPA 13R is a residential sprinkler design standard focused on low-rise residential occupancies

Scope: Design and installation of sprinklers in residential occupancies up to 4-stories and 60 ft in height

Purpose: Aids in control and detection of residential fires and provides:
- Improved protection "against injury and life loss, and property protection"
- Prevent flashover in room of fire origin (where sprinklered)
- Improve chance for occupants to escape or be evacuated

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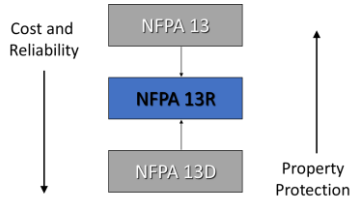
NFPA 13R - A STANDARD IN THE MIDDLE

NFPA 13R is a residential sprinkler design standard focused on low-rise residential occupancies



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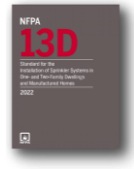
NFPA 13D SCOPE

NFPA 13D is a residential sprinkler design standard focused on one- and two- family dwellings and manufactured homes. The intent is to provide an affordable sprinkler system in homes while maintaining a high level of life safety.

Scope: Design and installation and **maintenance** of sprinklers in one- and two-family dwellings, manufactured homes and townhouses
Purpose: Aids in control and detection of residential fires and provides:
- Improved protection "against injury and life loss"
- Prevent flashover in room of fire origin (where sprinklered)
- Improve chance for occupants to escape or be evacuated



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INVESTIGATE IF EARTHQUAKE PROTECTION IS NEEDED

NFPA 13 says "how", not "where"

Building code generally says "where"

Based on Risk Category and possible forces

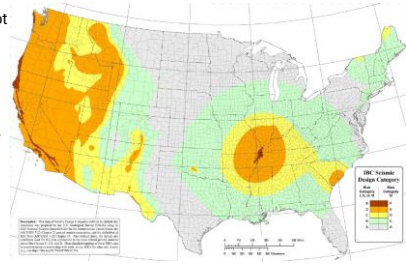

Image credit: 2024 IBC; code change S128-22

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EARTHQUAKE PROTECTION DETERMINATION

- Model building codes reference ASCE 7, Minimum Design Loads for Buildings and Other Structures
- ASCE 7 and Fire Sprinkler Systems
  - Seismic Design Category (SDC)
    - **A & B** are exempt
    - **C, D, E, and F** need protection
  - SDC is the same for the building and systems contained in the building.

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NFPA 13 – CHAPTERS 1-4

1. Administration
2. Referenced Publications
3. Definitions
4. General Requirements

NFSA

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NFPA 13 - CHAPTER 4

Identifying the hazard Classification of:

- Occupancy hazards
- Stored commodities
- Pallet types

NFSA

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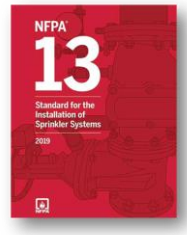
NFPA 13 - CHAPTERS 6-11

6. Installation Underground Piping
7. Requirements for System Components and Hardware
8. System Types and Requirements
9. Sprinkler Location Requirements
10. Installation Requirements for Standard Pendent, Upright and Sidewall Spray Sprinklers
11. Installation Requirements for Extended Coverage Upright, Pendent and Sidewall Spray Sprinklers



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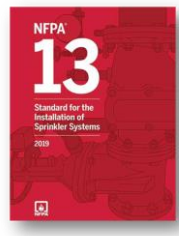
NFPA 13 - CHAPTERS 12-15

12. Installation Requirements for Residential Sprinklers
13. Installation Requirements for CMSA Sprinklers
14. Installation Requirements for Early Suppression Fast-Response Sprinklers
15. Installation Requirements for Special Sprinklers



NFSA

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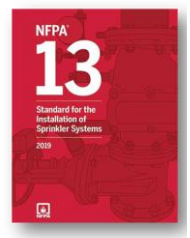
NFPA 13 - CHAPTERS 16-19

16. Installation of Piping, Valves, and Appurtenances
17. Installation Requirements for Hanging and Support of System Piping
18. Installation Requirements for Seismic Protection
19. Design Approaches



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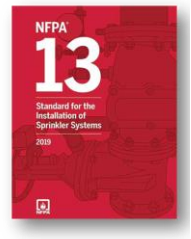
NFPA 13 - CHAPTERS 20-25

20. General Requirements for Storage
21. Protection of High Piled Storage using CMDA Sprinklers
22. Protection of High Piled Storage using CMSA Sprinklers
23. ESFR Requirements for Storage Applications
24. Alternative Sprinkler System Designs for Chapters 20-25
25. Protection of Rack Storage Using In-Rack Sprinklers



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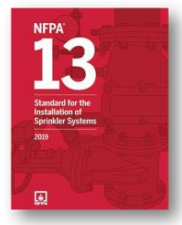
NFPA 13 - CHAPTERS 26-32

26. Special Designs of Storage Protection
27. Special Occupancy Requirements
28. Plans and Calculations
29. System Acceptance
30. Existing System Modifications
31. Marine Systems
32. System Inspection, Testing, and Maintenance



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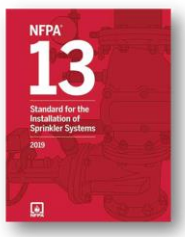
ORGANIZATION OF NFPA 13 SECTIONS WITHIN CHAPTERS



Within each chapter, information starts with the most general information and proceeds to the least general (most specific)

Most popular items are first followed by other items in descending order of popularity

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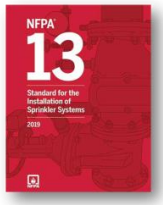
EXAMPLE: CHAPTER 8 OF NFPA 13



8.1 Wet Pipe Systems
8.2 Dry Pipe Systems
8.3 Preaction and Deluge Systems.
8.4 Combined…Systems…Piers
8.5 Multi-Cycle Systems
8.6 Antifreeze Systems
8.7 Systems with Non-Fire Connection
8.8 Exposure Protection….
8.9 Refrigerated Spaces
8.10 Cooking Equipment
8.11 Additives and Coatings

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TYPES OF SPRINKLER SYSTEMS

- Wet-pipe
- Dry-pipe
- Pre-action
- Deluge

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WET PIPE SYSTEM

- Most common
- Most reliable
- Least expensive
- Piping always filled with water
- Upon head activation, water is immediately discharged
  - Each sprinkler activates independently by heat
- Cannot be used in areas subject to freezing

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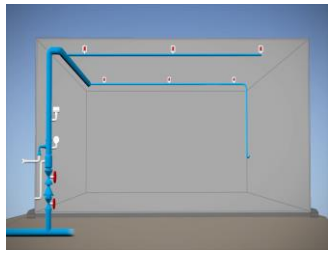

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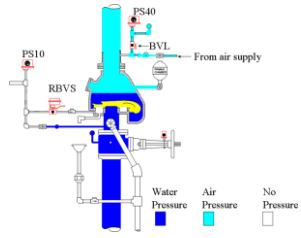
DRY PIPE SYSTEM

- Less common
- Piping always filled compressed gas above the dry-pipe valve
- Upon head activation, water is discharged after compressed gas
  - Each sprinkler activates independently
- Designed to be used in areas subject to freezing



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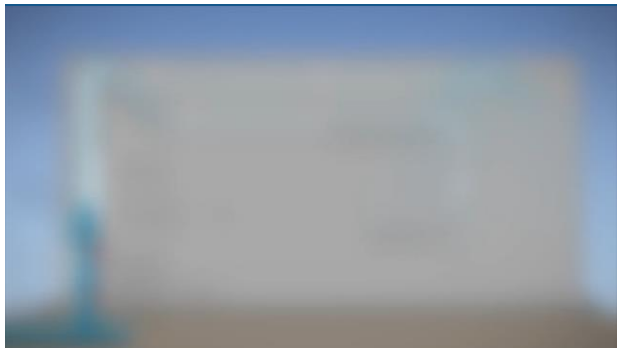

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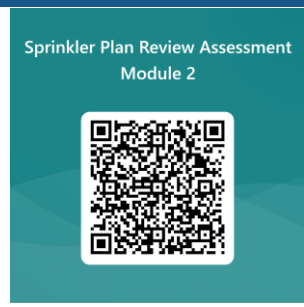
MODULE 2 ASSESSMENT



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MODULE 3 – OCCUPANCY HAZARD & COMMODITY CLASSIFICATION CONSIDERATIONS

Fire Sprinkler System Plan Review

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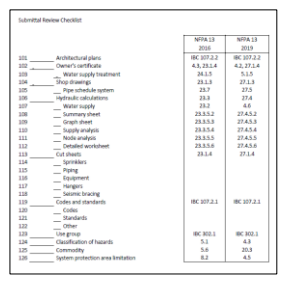
CHECKLIST

This modules covers several steps in the following checklists:

- Submittal checklist


Submittal Review Checklist

		NFPA 13 2016	NFPA 13 2019
101	Architectural plans	IBC 107.2.2	IBC 107.2.2
102	Owner's certificate	4.1, 23.1.4	4.2, 27.1.4
103	Water supply treatment	24.1.5	5.1.5
104	Shop drawings	23.1.3	27.1.3
105	Pipe schedule system	23.7	27.5
106	Hydraulic calculations	23.3	27.4
107	Water supply	23.2	4.6
108	Summary sheet	23.3.5.2	27.4.5.2
109	Graph sheet	23.3.5.3	27.4.5.3
110	Supply analysis	23.3.5.4	27.4.5.4
111	Node analysis	23.3.5.5	27.4.5.5
112	Detailed worksheet	23.3.5.6	27.4.5.6
113	Cut sheets	23.1.4	27.1.4
114	Sprinklers		
115	Piping		
116	Equipment		
117	Hangers		
118	Seismic bracing		
119	Codes and standards	IBC 107.2.1	IBC 107.2.1
120	Codes		
121	Standards		
122	Other		
123	Use group	IBC 302.1	IBC 302.1
124	Classification of hazards	5.1	4.3
125	Commodity	5.6	20.3
126	System protection area limitation	8.2	4.5

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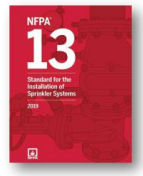
OCCUPANCY HAZARD AND COMMODITY CLASSIFICATION

IBC

Occupancy classification is the formal designation of the primary purpose of the building, structure, or portion thereof

NFPA 13

Occupancy classification for this standard shall relate to sprinkler design, installation, and water supply requirements only



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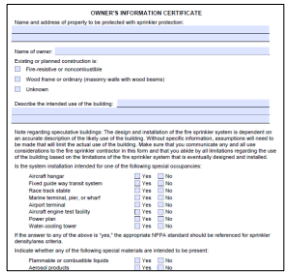
OWNER'S CERTIFICATE


OWNER'S INFORMATION CERTIFICATE

Name and address of property to be protected with sprinkler protection:

Name of owner:

Existing or planned construction is:

- Fire-resistive or noncombustible
- Wood frame or ordinary (masonry walls with wood beams)
- Unknown

Describe the intended use of the building:

Note regarding speculative buildings: The design and installation of the fire sprinkler system is dependent on an accurate description of the likely use of the building. Without specific information, assumptions will need to be made that will limit the actual use of the building. Make sure that you communicate any and all use considerations to the fire sprinkler contractor in this form and that you abide by all limitations regarding the use of the building based on the limitations of the fire sprinkler system that is eventually designed and installed.

Is the system installation intended for one of the following special occupancies:

Aircraft hangar	Yes	No
Fixed guide way transit system	Yes	No
Race track stable	Yes	No
Marine terminal, pier, or wharf	Yes	No
Airport terminal	Yes	No
Aircraft engine test facility	Yes	No
Power plan	Yes	No
Water-cooling tower	Yes	No

If the answer to any of the above is "yes," the appropriate NFPA standard should be referenced for sprinkler density/area criteria.

Indicate whether any of the following special materials are intended to be present.

Flammable or combustible liquids	Yes	No
Aerosol products	Yes	No

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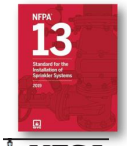
HIGH PILED STORAGE: WHAT IS IT?

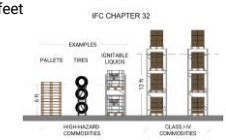
IFC

- Class I-IV Commodities: Storage height > 12 feet
- High hazard commodities: >6 feet



NFPA 13

- Class I-IV commodities: Storage height > 12 feet
- Group A plastics: Storage height >5 feet



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HIGH PILED STORAGE: WHAT IS IT?

- High Piled Storage: Storage of combustible materials closely packed piles of combustible materials on pallets, in racks, or on shelves where the top of the storage is greater than 12 feet in height.
- Where required by the FCO, high piled storage also includes high-hazard commodities…where the top of storage is greater than 6 feet in height

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HIGH PILED STORAGE: FIRE PROTECTION

- See Chapter 32
- Fire protection: See Table 3206.2

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NFPA 13: LOW-PILED STORAGE

- Solid-piled, palletized, rack storage, bin box, and shelf storage up to 12 ft in height (Section 3.9.1.17)

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NFPA 13: MISCELLANEOUS STORAGE

- Storage that does not:
  - Exceed 12 ft. in height
- Incidental to another occupancy use group
- Does not constitute more than 10% of the building area or 4,000 sq. ft. of the sprinklered area, whichever is greater
- Does not exceed 1,000 sq. ft. in one pile or area, and is separated from other storage areas by at least 25 ft.

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CODES VS. STANDARDS

- ✓ Storage Layout Floor Plan (2018 IFC) & Maintenance (2021 IFC)
- ✓ General Fire Protection & Life Safety Requirements
- ✓ Fire Department Access roads
- ✓ Fire Department Access Doors

- ✓ What is the Commodity Classification?
- ✓ How is it stored?
- ✓ What is the height of the storage?
- ✓ Building height?
- ✓ What type of sprinkler is being used?
- ✓ Special Commodity?

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STORAGE

- **Group S-1** Examples (Moderate Hazard)
  - Combustible
    - Furniture
    - Lumber
    - Bulk Storage of Tires
- **Group S-2** Examples (Low Hazard)
  - Non-combustible
    - Food Products
    - Metal Cabinets
    - Washers & Dryers

NON-STORAGE ("Occupancies")

- LH
- OH 1 & 2
- EH 1 & 2

STORAGE ("Commodities")

- Class I
- Class II
- Class III
- Class IV
- Group C Plastics (Class III)
- Group B Plastics (Class IV)
- Group A Plastics

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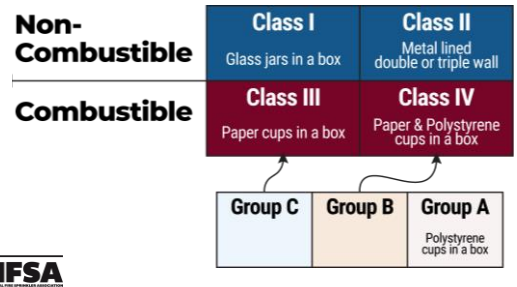
COMMODITY CLASSIFICATION



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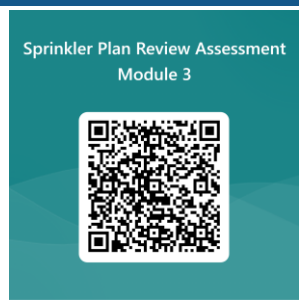
MODULE 3 ASSESSMENT



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MODULE 4 – PIPING, EQUIPMENT, AND CUT SHEET REVIEW

Fire Sprinkler System Plan Review

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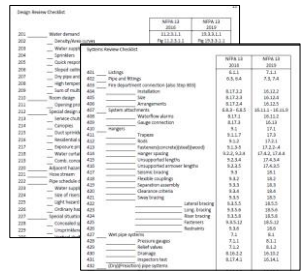
CHECKLIST

This modules covers several steps in the following checklists:

- Systems review checklist
- Design review checklist



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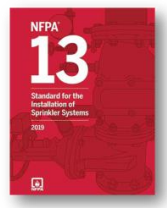
LISTING

- All components and equipment shall be listed.
- The submitted cut sheet should verify listing.
- Exceptions:
  - Valve components
  - Pipe and fittings when manufactured to Table 6.3.1.1 and 6.4.1
  - All threaded rod
  - Drain piping and drain valves
  - Signage

67

UNDERGROUND PIPE: NFPA 13

- Review Table 6.1.1.1 in NFPA 13, 2019 edition
  - Ductile Iron
  - Concrete
  - Plastic
  - Brass
  - Copper
  - Stainless steel



68

ABOVEGROUND PIPE: NFPA 13

- Review NFPA 13 Section 7.3.1 and Table 7.3.1.1



71

TYPES OF PIPE MATERIALS

- Steel Pipe
  - Black
  - Galvanized
  - Stainless
- Copper Tube
- Nonmetallic Pipe
  - CPVC
  - Polypropylene
  - PEX (NFPA 13D only)

72

VALVES: CONTROL VALVES

- Control
  - Turn systems on and off
- Directional
  - Allow water to flow in one direction
    - Check valves
    - Double check valves assemblies
    - Reduced pressure (zone) backflow prevention assembly (RP or RPZ)


82

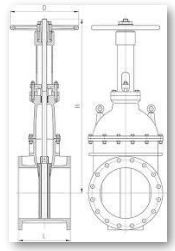
VALVES: CONTROL VALVES

- At least one for each water supply
- Must be listed
- Must be indicating
  - Outside Screw and Yoke (OS&Y) (a type of gate valve)
  - Post Indicator Valve (PIV) (also a type of gate valve)
  - Wall Post Indicator Valve (WPIV) (also a gate valve)
  - Butterfly Valves
- Shall NOT close in less than 5 seconds

NFSA

83

OS & Y VALVE



NFSA

84

POST INDICATOR VALVE (PIV)

NFSA

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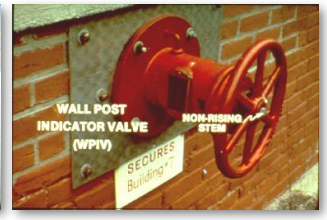
WALL POST INDICATOR VALVE (WPIV)



86

BUTTERFLY VALVE

Indicator rotates with inner portion of valve to show whether the valve is open or closed.

Portion of the valve that stops the flow of water is always in the waterway. When rotated, it allows flow, but still causes friction loss and turbulence.

87

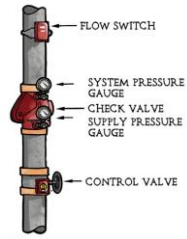
CONTROL VALVES

- Quantity of valves required:
- ONE per system
- ONE per floor if system is attached to hose valves for fire department use
- Control valves installed overhead must have indicator visible from floor level
- NOTE: Permanently marked weatherproof identification signs are required for ALL control valves on sprinkler systems.

88

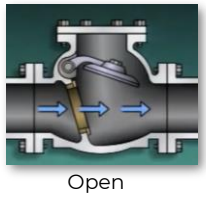
DIRECTIONAL VALVES

- Required on all systems
- Must be listed
- Must be installed horizontal or vertical according to their listing
- Alarm check valves are acceptable as directional valves
- Control valves shall be installed on each side of the directional valve when the system is served by multiple water supplies

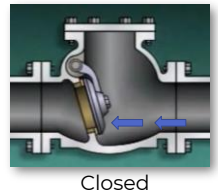


89

SWING CHECK VALVE



Open



Closed

90

INTERNALLY LOADED CHECK VALVE CUT-AWAY

91

BACKFLOW PREVENTERS

- Installed to keep the water in the sprinkler system from going back into the public water system
- Types:
  - Double Check Valve
  - Reduced Pressure Zone (RPZ)
  - Air Gap

92

BACKFLOW PREVENTION ASSEMBLY

93

MODULE 4 ASSESSMENT

95

MODULE 6 – BASIC OVERVIEW & INSTALLATION REQUIREMENTS OF SPRINKLERS

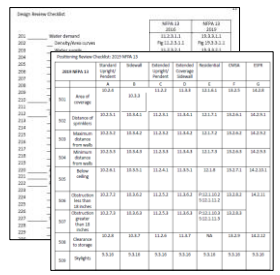
Fire Sprinkler System Plan Review

141

CHECKLIST

This modules covers several steps in the following checklists:

- Positioning checklist
- Design review checklist



142

BASIC REQUIREMENTS

Temperature Classification	Temperature Rating	Max Ceiling Temperature	Glass Bulb Color	Frame Color (Soldered Link)
Ordinary	135 – 170	100	Orange or Red	Uncolored or Black
Intermediate	175 – 225	150	Yellow or Green	White
High	250 – 300	225	Blue	Blue
Extra High	325 – 375	300	Purple	Red
Very Extra High	400 – 475	375	Black	Green
Ultra High	500 – 575	475	Black	Orange
Ultra High	650	625	Black	Orange

143

SPRINKLER SELECTION

- Response Characteristics
- Deflector Style
- Applications
- Orifice Size
- Temperature Rating

148

RESPONSE CHARACTERISTICS

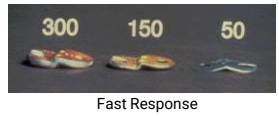
- Standard Response
- Fast Response
  - Quick Response
  - Quick Response Extended Coverage
  - ESFR
  - Residential

149

RESPONSE CHARACTERISTICS

Standard Response of the Past

Standard Response of the Present



Fast Response

150

RESPONSE LIMITATIONS

- Light Hazard must use quick response or residential sprinklers
- Existing systems (or modifications to existing systems) may use standard response
- Quick response is not permitted for Extra Hazard

151

DEFLECTOR STYLE

Sprinklers can be made to distribute water to different places with different droplet sizes.

152

APPLICATION OF STANDARD UPRIGHT AND PENDENT SPRAY SPRINKLERS

- Upright and pendent spray sprinklers are permitted in all:
  - Hazard classification
    - LH, OH, EH
  - Types of construction
    - Non-combustible
    - Limited combustible
    - Combustible
    - Obstructed
    - Unobstructed

153

APPLICATION OF SIDEWALL SPRINKLERS

- Light hazard
  - Smooth, horizontal or sloped, flat ceilings
- Ordinary hazard
  - Smooth, flat ceilings when listed.
- Overhead doors
- Not permitted to be installed back-to-back unless separated by a lintel or soffit.

154

UH OH!

- Sidewall sprinklers cannot be installed back-to-back without a lintel or soffit.
  - Section 10.3.4.1.4

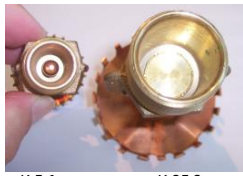
155

APPLICATION OF SPECIAL SPRINKLERS

- When evaluated and listed
- Window sprinklers
- Combustible concealed
- Attic sprinklers
- Institutional
- Conventional

156

ORIFICE SIZE



K-5.6 K-25.2

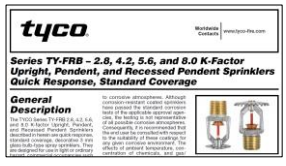
- Sprinklers are made in at least 13 different orifice sizes
  - See Table 7.2.2.1 in NFPA 13
- The larger the orifice, the easier it is for water to discharge from the sprinkler
- Orifice sizes are described by using the term "k-factor"

157

SPRINKLER LEGEND AND CUT SHEETS

SPRINKLER ~~HEAD~~ LEGEND

SYM	CNT	POSITION	FINISH	TEMP	K	NPT	SIN	MFG.	MODEL#	ESCUTCHEON
○	48	UPR	BRASS	155	5.60	1/2"	TY3131	TYCO	TY-FRB	N/A
▼	3	HSW	CHROME	200	5.60	1"	TY3335	TYCO	DS-1	STANDARD
										TOTAL: 51



tyco

Series TY-FRB – 2.8, 4.2, 5.6, and 8.0 K-Factor Upright, Pendent, and Recessed Pendent Sprinklers Quick Response, Standard Coverage

General Description

tyco

Series DS-1 Dry-Type Sprinklers 5.6K Pendent, Upright, and Horizontal Sidewall Quick Response, Standard Coverage

General Description

160

AREA OF COVERAGE

- Type of sprinkler selected
- Ceiling construction
- Minimum allowable distance between sprinklers
- Placement of walls and room dividers
- Maximum allowable distances between sprinklers
- Hazard classification of the occupancy
- Obstructions to heat flow and discharge
- Heat zones near heat sources

161

CEILING CONSTRUCTION: NFPA 13

Materials	Non-combustible Limited Combustible Combustible
Potential Obstructions	Obstructed Unobstructed

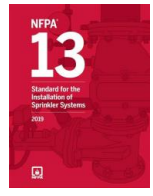
NFSA

162

HOW DOES CEILING CONSTRUCTION MATTER TO FIRE SPRINKLER INSTALLATION?

Review Section 3.3.43.1 and A.3.3…– obstructed construction

Review Section 3.3.43.2 and A.3.3– unobstructed construction



NFSA

163

OBSTRUCTED CONSTRUCTION

Official NFPA Definition

- Panel construction and other construction where beams, trusses, or other members impede heat flow or water distribution in a manner that materially affects the ability of sprinklers to control or suppress a fire. (3.7.1)

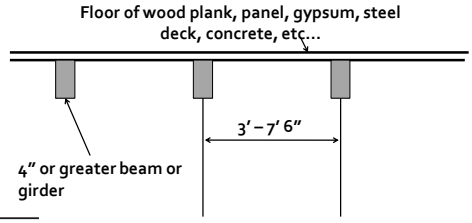
NFSA definition

- Any construction that does not meet the definition of unobstructed construction

NFSA

168

BEAM AND GIRDER CONSTRUCTION



169

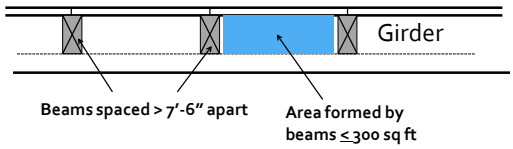
CONCRETE TEE CONSTRUCTION

170

COMPOSITE WOOD JOIST CONSTRUCTION

171

PANEL CONSTRUCTION



172

WOOD JOIST CONSTRUCTION

173

STEEL PURLIN CONSTRUCTION

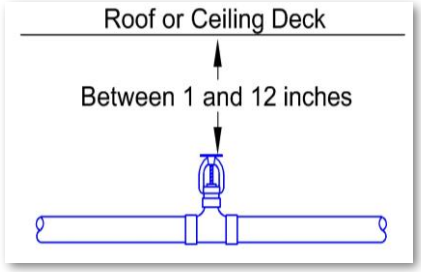
174

DEFLECTOR BELOW CEILING

- Each sprinkler will have specific rules on how far the sprinkler may be down from the ceiling.

175

UNOBSTRUCTED CONSTRUCTION – DEFLECTOR BELOW CEILING



176

It's OK!

- Deflector Distance?
  - Unobstructed Construction
    - 1-12"?

177

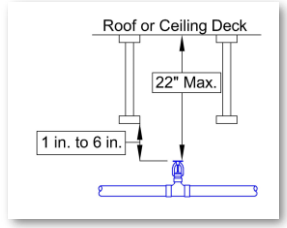
UH OH!

- Deflector Distance?
  - Unobstructed Construction
    - 1-12”?

178

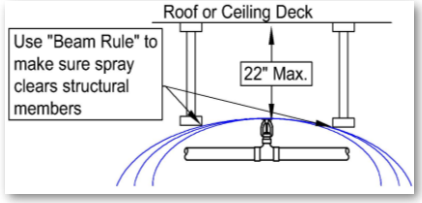
DEFLECTOR DISTANCES BELOW CEILINGS

Obstructed Construction
- 1-6 inches below structural members
- Not more than 22 inches below ceiling



179

EXCEPTION TO OBSTRUCTED CONSTRUCTION RULE

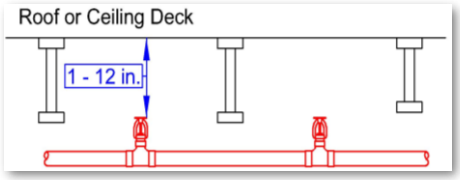


Sprinklers are allowed to be installed with deflectors at or above members where the distances meet Section 10.2.7.1.2 (Beam Rule)

180

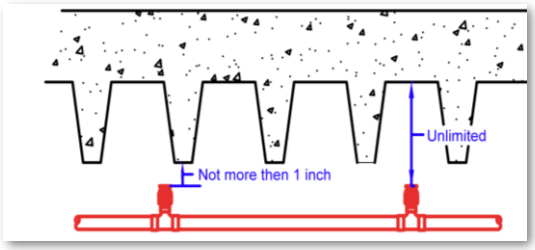
EXCEPTION TO OBSTRUCTED CONSTRUCTION RULE

- Sprinklers can be installed in each bay of obstructed construction with deflectors 1-12 inches below the ceiling



181

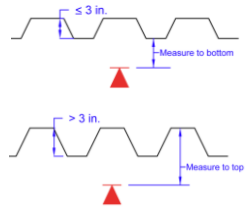
CONCRETE TEES - 3 FT AND 7.5 FT ON CENTER



182

DISTANCE BELOW SPECIAL CEILINGS

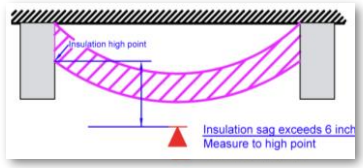
Corrugated metal roof decks up to 3 inches measured from the bottom of deck. Deeper decks measure from the top of deck.



183

DISTANCE BELOW SPECIAL CEILINGS

Measure to attached insulation. If insulation sags measure to mid point. If it sags more than 6 inches measure to high point of the insulation.



New for 2019 Insulation used to measure deflector distance – must withstand 3 lb/ft2 uplift (9.5.4.1.3.1)

184

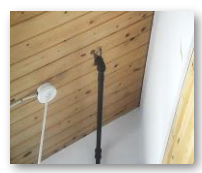
STANDARD SPRAY SPRINKLERS DEFLECTOR POSITION

- Deflectors are required to be installed parallel to ceilings, roofs and incline of stairs

185

STANDARD SPRAY SPRINKLERS DEFLECTOR POSITION

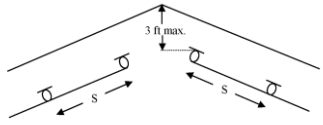
- Where sprinklers are installed at the peak of a pitched roof, the deflectors shall be horizontal
- Sprinklers under pitched roofs with slopes less than 2 in 12 are permitted to be installed with their deflectors horizontal



186

STANDARD SPRAY SPRINKLERS UNDER PITCHED SURFACES

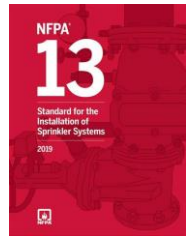
- The sprinkler closest to the peak must be within 3 ft vertically of the peak



187

CEILING CONSTRUCTION = AREA PER SPRINKLER AND SPACING

Review Table 10.2.4.2.1(a)



188

DETERMINATION OF "AREA OF COVERAGE"

Based upon the "S x L rule"

AS = S x L

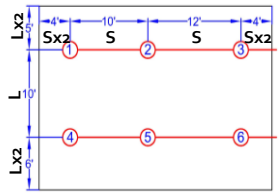
AS = Area of Coverage

S = Distance along branch line or twice distance to wall.

L = Distance between branch line or twice distance to wall.

190

DETERMINE AREA OF COVERAGE FOR EACH SPRINKLER



Spr.	S	L	A_S
1			
2	12	10	120
3			
4			
5			
6			

RESIDENTIAL SPRINKLERS AREA OF COVERAGE

- For residential sprinklers…
  - Do not use SxL
  - Coverage criteria will be covered in the listing/manufacturer's data sheet

Victaulic V2742, 4.9 K-Factor Concealed Pendent Sprinkler
For Ceiling types refer to NFPA 13, 13R or 13D 2013 Editio

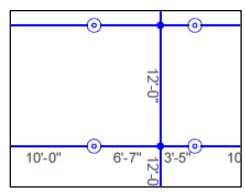
Max. Coverage Area[a]	Ordinary Temp Rating 155°F/68°C		Intermediate Temp Rating 175°F/79°C		D
Ft. x Ft. m x m	Flow[b] GPM L/min	Pressure[b] PSI bar	Flow[b] GPM L/min	Pressure[b] PSI bar	
12 X 12 3.7 X 3.7	13 49.2	7.0 0.48	N/A	N/A	
14 X 14 4.3 X 4.3	13 49.2	7.0 0.48	N/A	N/A	
16 X 16 4.9 X 4.9	13 49.2	7.0 0.48	N/A	N/A	
18 X 18 5.5 X 5.5	17 64.3	12 0.83	N/A	N/A	
20 X 20 6.1 X 6.1	20 75.7	16.7 1.15	N/A	N/A	

Notes:

DISTANCE OF SPRINKLERS

- SS U/P light hazard: 15 feet
- SS U/P ordinary hazard: 15 feet
- SS U/P extra hazard: 12 feet

- SS Sidewall light hazard: 14 feet
- SS Sidewall ordinary hazard: 10 feet



MAXIMUM DISTANCE FROM WALLS

Sprinklers cannot be more than one-half the maximum distance between sprinklers.

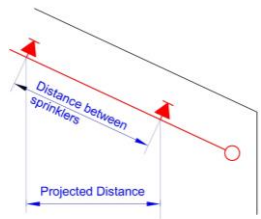
Large items against the wall, such as large portraits, furniture, trophy cases, portable closets, the sprinkler is measured to the wall.

When sprinklers are adjacent to windows, and no additional floor space is created, the distance is measured to the wall line.

195

UNDER PITCHED SURFACES

- Distances between sprinklers are measured along the slope
- For determining the amount of water necessary to meet the density/area requirements (hydraulic calculations), the projected area on the floor shall be used.



196

UNDER PITCHED SURFACES

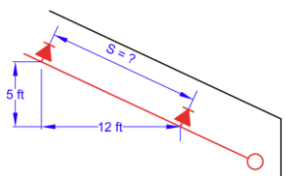
What is the "S" dimension?

$a^2 + b^2 = c^2$ (Pythagorean Theorem)

$12^2 + 5^2 = c^2$

$\sqrt{169} = \sqrt{c^2}$

C = 13 ft



197

MAXIMUM DISTANCES FROM WALLS FOR STANDARD SPRAY SPRINKLERS

- ½ of the allowable distance between sprinklers
  - Small room rule exception (will be covered later in the class)
- Measured perpendicular to the wall

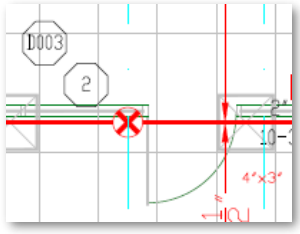
What is the Maximum Distance from the Wall for Ordinary Hazard?

7 ½ ft (half of maximum allowable distance – 15 ft)

198

MINIMUM DISTANCE FROM WALL

- The distance of sprinklers to walls shall not be less than 4 inches, unless specifically listed to be closer than 4 inches.



199

SUMMARY OF SPRINKLER SELECTION

- 13 different orifice sizes
- 2 different response characteristics
- 7 different temperature ratings
- 8 different deflector styles
- 1456 different kinds of sprinklers!

200

MODULE 6 ASSESSMENT

201

MODULE 7 – OVERVIEW & INSTALLATION REQUIREMENTS OF SPRINKLERS

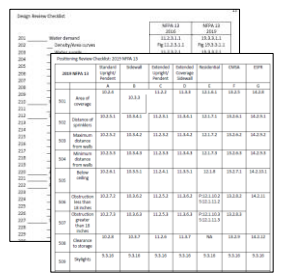
Fire Sprinkler System Plan Review

202

CHECKLIST

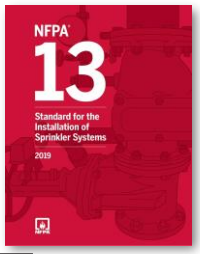
This modules covers several steps in the following checklists:

- Positioning checklist
- Design review checklist



203

SPECIAL SITUATIONS & EXEMPTIONS

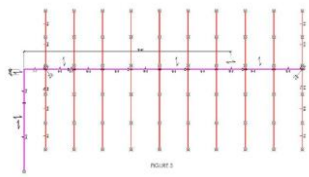


- Section 9.1.1 has an extensive list of the basic rules of spacing, location and position rules.
- Throughout the building
- Maximum protection area
- Shadows are permitted
- Sprinklers can be exempt
- Deviations from rules
- Break the rules
- No sprinklers in furniture
- No sprinklers in equipment

204

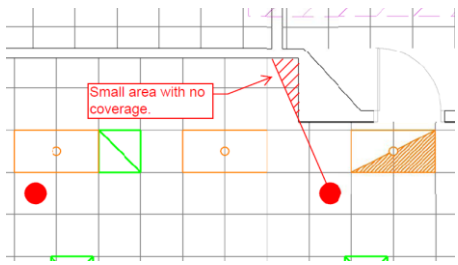
MAXIMUM SYSTEM SIZE

- Need a separate system (control valve, drain, and alarm) when you exceed:
  - 52,000 sq ft per floor for light and ordinary hazard systems
  - 40,000 sq ft per floor for extra hazard and storage systems
  - Area of mezzanines does not count



206

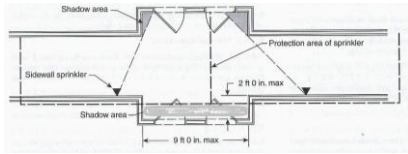
SHADOW



207

NFPA 13R & NFPA 13D SHADOWS

- A single sprinkler can have up to 15 sq. ft. of dry area.
- Sprinklers are permitted to be omitted from corridors to 2' in depth and 9' in length (13R only)



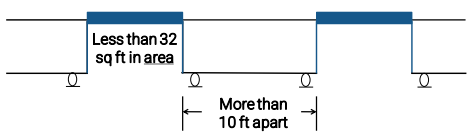
208

MULTISTORY CONTROL VALVES

- Multistory buildings exceeding 2 stories shall be provided with a floor control valve, check valve, main drain valve, and flow switch for isolation, control, and annunciation of waterflow for each individual floor level

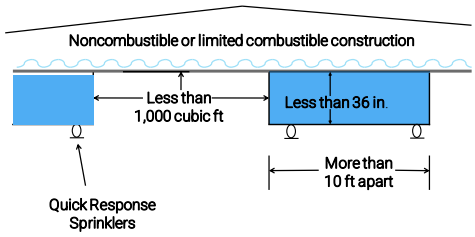
209

SKYLIGHTS



210

CEILING POCKET

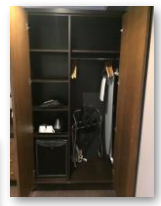


211

211

BATHROOMS AND CLOSETS

- NFPA 13 dwelling unit bathrooms in dwelling units 55 sf and under are exempt.
- IBC exempts bathrooms more than 55 sf from sprinkler protection for all Group R, provided walls and ceilings are noncombustible or limited combustible with a 15-minute thermal barrier



212

212

CONCEALED SPACES

Concealed spaces of exposed combustible construction shall be protected by sprinklers.

Except in concealed spaces where sprinklers are not required to be installed by 9.2.1 through 9.2.1.19 and 9.3.18.

Credit: www.eng-tips.com

213

213

CONCEALED SPACES

- No Formal Definition
  - However:
  - Enclosed on All Sides
  - Limited or No Access
  - Not Intended for Occupancy
  - Not Intended for Storage
- Where sprinklers are installed, use light hazard density.

214

UNSPRINKLERED CONCEALED SPACES

- Why are sprinklers permitted to be omitted from certain concealed spaces?
  - Access
  - Fuel Load
  - Physically Impractical

215

WHY ARE CONCEALED SPACES IMPORTANT?

Courtesy of Drake Exhibits

216

UNSPRINKLERED CONCEALED SPACES: MINIMAL COMBUSTIBLE LOADING

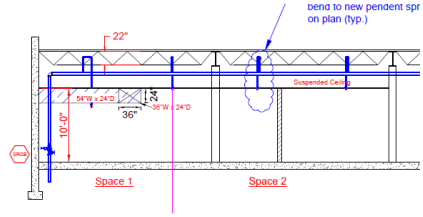
217

UNSPRINKLERED CONCEALED SPACES: SMALL OPENINGS

- The space shall be considered concealed space even with small openings such as those used as return air for a plenum.

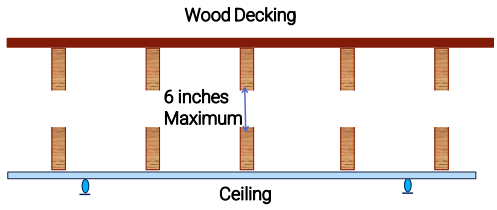
218

ARE SPRINKLERS REQUIRED ABOVE A SUSPENDED CEILING?



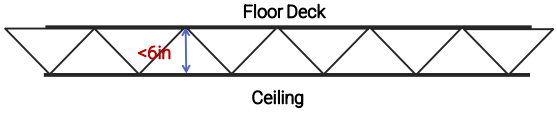
219

JOIST SPACES



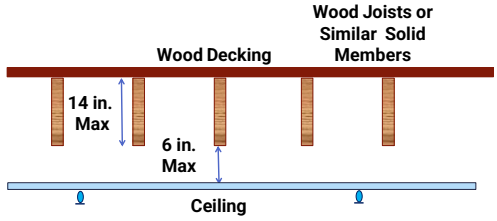
220

SMALL BAR JOISTS



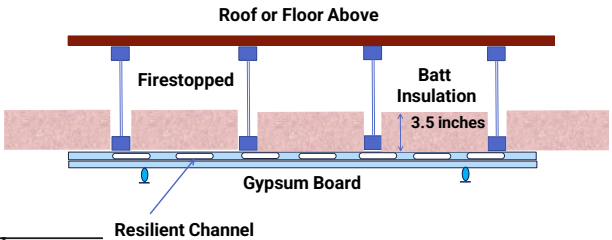
221

DROP CEILINGS BELOW JOISTS



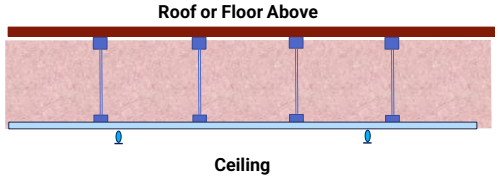
222

I-JOISTS WITH CEILINGS



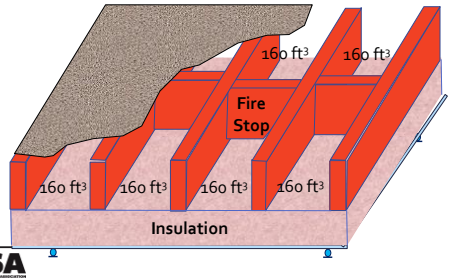
223

FILLED SPACES



224

JOISTS WITH DROP CEILINGS AND INSULATION



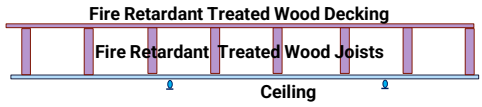
225

SMALL ROOMS

- Concealed spaces over isolated small rooms not exceeding 55 ft2 in area

226

FIRE RETARDANT TREATED WOOD



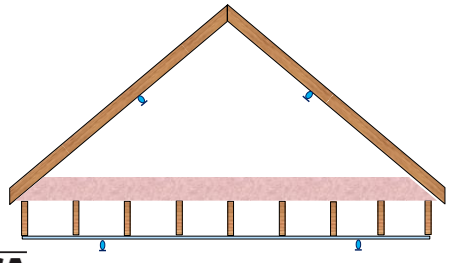
227

PAPER-FACED INSULATION

- Noncombustible concealed spaces having exposed combustible insulation where the heat content of the facing and substrate of the insulation material does not exceed 1000 Btu/ft2 shall not require sprinkler protection.

228

CONCEALED JOIST SPACES

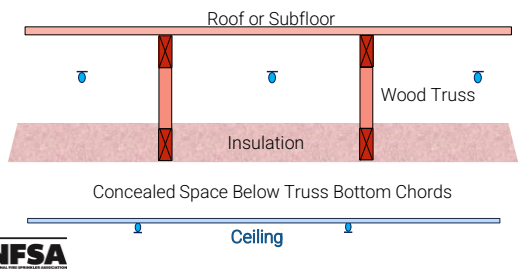


229

PIPE CHASE

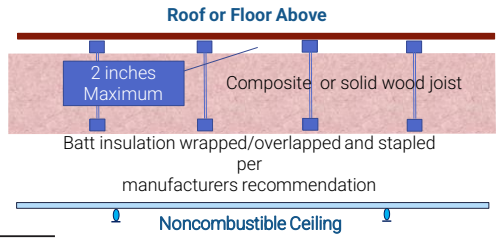
230

LIMITED COMBUSTIBLE SPACE



231

FILLED I JOIST WITH DROP CEILING



232

VERTICAL OPENINGS

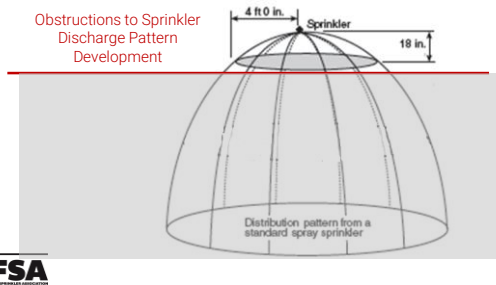
233

ELEVATOR SHAFTS

- NFPA 13 has updated text for new elevator technology.
- Elevator divisions usually overrule NFPA 13.
- Sprinkler within two feet of bottom of shaft.

234

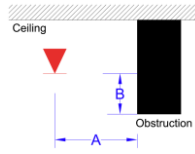
OBSTRUCTIONS WITHIN 18 INCHES



235

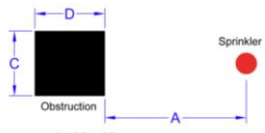
BEAM RULE

If "A" (inches)	Maximum Allowable "B" (inches)
< 12	0
12 – 17.9	2.5
18 – 23.9	3.5
24 – 29.9	5.5
30 – 35.9	7.5
36 – 41.9	9.5
42 – 47.9	12
48 – 53.9	14
54 – 59.9	16.5
Table continues	



236

THREE TIMES RULE



A ≥ 3C or 3D
A ≤ 24 in.

If C or D (whichever is greater)	Then A must be at least
1 inch	3 inches
2 inches	6 inches
4 inches	12 inches
8 inches	24 inches
12 inches	24 inches

239

THE PARTITION RULE

- **2019 edition**
  - Light Hazard Only
  - Privacy curtains, room dividers, freestanding partitions
- **2022 edition**
  - Ordinary hazard occupancies added
  - See Section 10.2.7.3.2.3

243

THE PARTITION RULE

Privacy Curtains shall not be considered obstructions where:

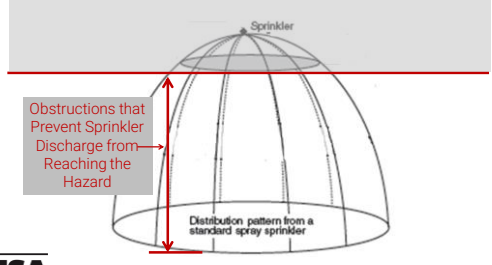
Curtains supported by fabric mesh on ceiling track

Openings in mesh are 70% open or greater

Mesh extends at least 22 inches down from ceiling.

244

OBSTRUCTIONS OVER 18 INCHES

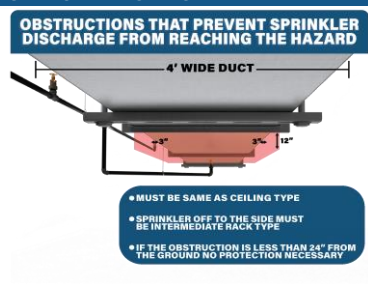


246

OBSTRUCTIONS OVER 18 INCHES

247

OBSTRUCTIONS THAT PREVENT SPRINKLER DISCHARGE FROM REACHING THE HAZARD



248

ENCLOSED STAIRWAYS

- Combustible
  - Top of stairway
  - Under each floor landing
  - Under lowest intermediate landing
- Noncombustible
  - Top of stairway
  - Under lowest intermediate landing

249

400 CUBIC FT CLOSETS/COMPARTMENTS

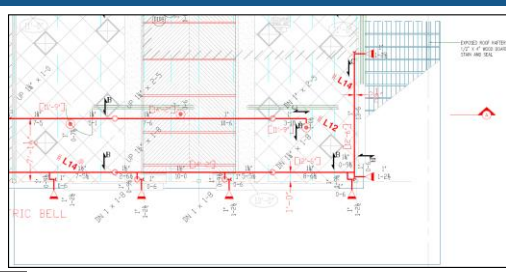
- Closets and compartments, including areas housing mechanical equipment 400 ft³ or less:
  - A single sprinkler at the highest ceiling level is sufficient
  - Obstructions and minimum distance(s) to walls do not need to be considered.

250

EXTERIOR PROJECTIONS

251

EXTERIOR PROJECTIONS



252

SOFFITS, EAVES, OVERHANGS

253

EXTERIOR PROJECTIONS

254

SPACES UNDER GROUND FLOORS, EXTERIOR DOCKS, AND PLATFORMS

- Spaces Under ground Floors, Exterior Docks, and Platforms
  - The space is not accessible
  - Protected against wind-borne debris accumulation
  - No fuel-fired equipment
  - Floor above is of tight construction
  - No combustible/flammable liquids handled above

255

256

CLEARANCE TO STORAGE

Pendent and upright spray sprinklers clearance to storage is a minimum of 18 inches.

Storage on a shelf against a wall, the 18-inch minimum does not apply.

257

MODULE 7 ASSESSMENTS

258

MODULE 8 – SYSTEMS REVIEW – INSTALLATION REQUIREMENTS FOR PIPING & COMPONENTS

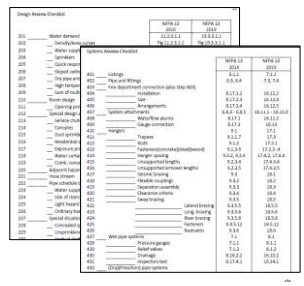
Fire Sprinkler System Plan Review

259

CHECKLIST

This modules covers several steps in the following checklists:

- Systems review checklist
- Design review checklist



260

AIR VENTS (NEW SINCE NFPA 13 – 2016 EDITION)

- A single air vent on wet pipe systems utilizing metallic pipe (8.1.5 & 16.7)
- The air vent shall be installed near a high point in the system and shall consist of:
  - Manual valve at least ½ inch in size
  - Automatic valve
  - Other approved means

261

RELIEF VALVES (8.1.2)

Setting:
- operate at 175 psi (12 bar) or 10 psi (0.7 bar) in excess of the maximum system pressure, whichever is greater.

Location:
- Downstream of check valves

Size:
- ½ inch min.

262

DRAINAGE - MAIN DRAIN CONNECTION

- Required on all systems
- Primary drain located on the system riser
- All piping arranged where practicable to drain to the main drain valve.
- Used as a flow test connection

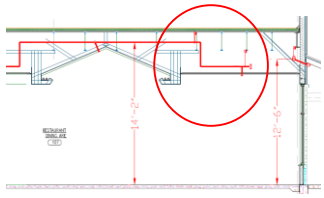
263

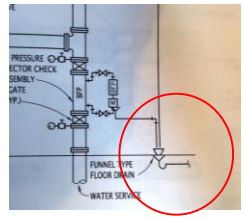
DRAINAGE

Wet and preaction systems not subject to freezing:
- 50 gals. and over, pipe to accessible location
  - 1 inch valve
- 5 to 50 gals: 3/4-inch valve with cap or plug
- Less than 5 gals:
  - 1/2-inch cap or plug
  - Removal of a pendent sprinkler
  - Flexible couplings

264

DRAINAGE



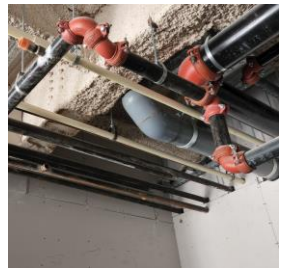


265

TRAPPED PIPING

Auxiliary drains shall be provided where a change in piping direction prevents drainage of system piping through the main drain valve.

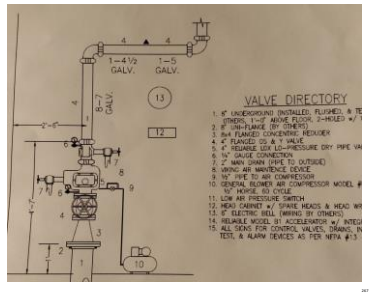
Trapped piping that will be covered should be piped and ready at rough inspection.



266

DRY AND PREACTION SYSTEMS

- Only use dry-pipe systems where wet systems cannot be used (Less than 40° F)
- More costly to maintain
- More costly to install and operate
- Located in freezers, canopies, etc.



267

PITCH OF PIPING

Helps water to drain out of dry & preaction pipe systems after use
Pitched back toward the riser
Branch lines: ½ inch per 10 ft
System mains: ¼ inch per 10 ft
Refrigerated mains: ½ inch per 10 ft
Affects distance of sprinklers from ceiling
Affects hanger length

268

SPRINKLERS

Upright sprinklers
Listed dry-pendent sprinklers
Pendent sprinklers on return bends with both located in heated areas
Sidewall sprinklers – pitched to drain

Dry pendent image courtesy of Viking

269

VOLUME OF SYSTEM

- Shop drawings shall indicate the size of the dry pipe or preaction system.
- Deliver water to test connection within 60 seconds.
  - Except: less than 500 gallons and over 500 to 750 gallons with a QOD.

OPEN PARKING LEVEL
DRY SYSTEM CAPACITY = 371 GALLONS

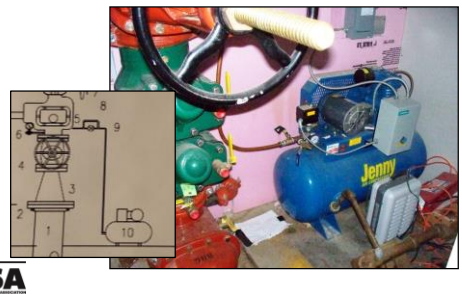
270

QUICK OPENING DEVICES

- Installed to meet discharge times.
- Listed
- Accelerators
  - Electric
  - Mechanical
- Exhausters

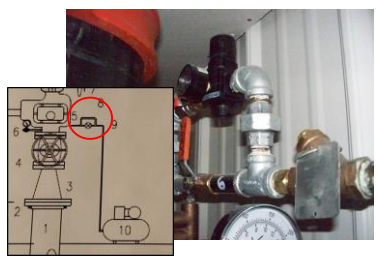
271

AIR PRESSURE AND SUPPLY



272

AIR PRESSURE (AIR MAINTENANCE DEVICE)



273

WATERFLOW ALARMS

- Exterior alarm per Step 827 (IBC)
- IBC requires audible device on exterior of building. (903.4.2)
- Approved identification signs, should be provided for outside alarm devices.

274

WATERFLOW ALARMS

- IBC requires control valves for sprinkler systems to be supervised by a listed fire alarm control unit
- Waterflow must activate within 100 seconds
  - 90 seconds for water flow alarm to activate +
  - 10 seconds to activate occupant notification (if provided)

275

CONTROL VALVE SUPERVISION

NFPA 13 Acceptable methods of supervision:

Central station, proprietary or remote signaling service	Local signaling service to a constantly attended station	Locking valves open	Seal in open position (if fenced, under control of the owner and inspected weekly)

Building codes require electrically supervised control valves

276

SUPERVISED BUTTERFLY VALVE

Supervisory initiating device
AKA: Tamper switch

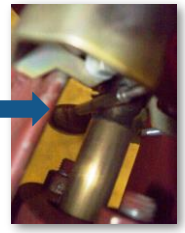
Supervised valve

277

SUPERVISORY SWITCH CLOSE-UP

Supervisory initiating device
AKA: Tamper switch

Supervised valve



278

LOCKED OPEN OS & Y

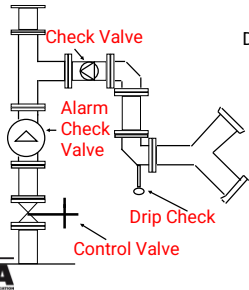
279

FDC - INSTALLATION

- Fire department connections are required on all NFPA 13 installations, except:
- The building is remote from FD access.
- The building is 2,000 sq.ft. or less.
- The building has a deluge sprinkler system that exceeds the capacity of the fire department.

280

WET (SINGLE) SYSTEM



Install the Fire Department Connection on the System Side of the Control, Check, or Alarm Valves

Fire Department Connection

281

UH OH!

- What's wrong?
  - FDC to be located between system control valve and dry-pipe valve on single dry system – NFPA 13 8.17.2.4.2. Here there is a shut-off valve above the FDC

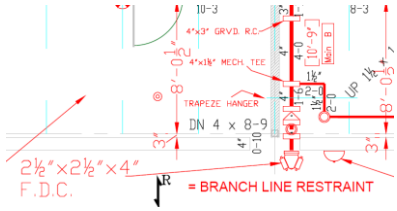
282

FDC - SIZE

- 4 inches for engine connections
- 6 inches for boat connections
- Hydraulically calculated systems:
  - Can be less than 4 inches
    - No less than riser size
    - For a single system riser.

283

FDC - ARRANGEMENT



284

LOCKING CAPS

- The fire code official may require locking caps on fire department connections
- Responding fire department must have the appropriate key readily available

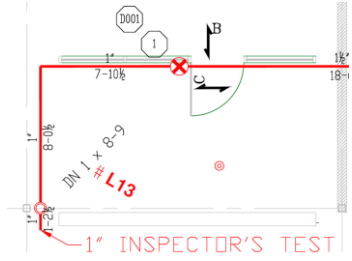
285

INSPECTOR'S TEST CONNECTIONS (16.14.1)

- Purpose:
  - Alarm test connection
- Location:
  - Anywhere - Downstream of flow alarm
  - Termination Point:
    - Outside or to a drain sized to accept full flow under system pressure

286

INSPECTOR'S TEST CONNECTION



287

COMPRESSOR AND DRY SYSTEMS

- Air compressors for dry sprinkler systems are not required to be listed
- Compressors are not permitted to be wired to a light switch or use a plug into a wall outlet (hard-wired)
- Air maintenance device is required, unless the dry system has a capacity less than 5.5 ft³ at 10 psi
  - Air maintenance device (when required) must be listed
  - An air maintenance device is required for each dry system

288

NITROGEN AND DRY SYSTEMS

- Nitrogen
  - Supply must be reliable
  - When nitrogen is used for increased C factor, a listed nitrogen generator must be used.
  - ITM per NFPA 25
    - Monthly inspection
    - Annual testing
    - Maintained per manufacturer's instructions

289

NITROGEN AND DRY SYSTEMS

290

MODULE 9 ASSESSMENT

Module 8 Assessment

291

MODULE 9 – DESIGN APPROACHES

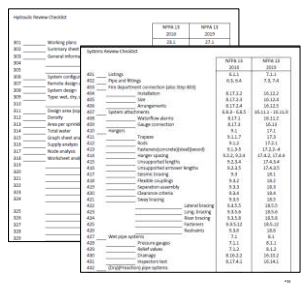
Fire Sprinkler System Plan Review

292

CHECKLIST

This modules covers several steps in the following checklists:

- Systems review checklist
- Hydraulic review checklist



293

AUTOMATIC WATER SUPPLIES

- Municipal or Private water supply
- Water storage reservoir and fire pump
- Pressure tank
- Gravity tank

294

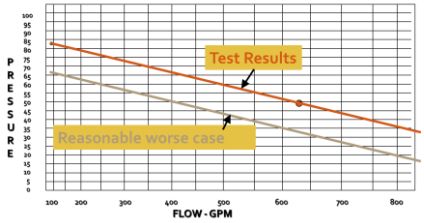
NFPA 13 (2019) – 5.2.2.2

Requirement: The volume and pressure of a public water supply shall be determined from waterflow test data or other approved method.

Annex: An adjustment to the waterflow test data to account for daily and seasonal fluctuations, possible interruption by flood or ice conditions, large simultaneous industrial use, future demand on the water supply system, or any other condition that could affect the water supply should be made as appropriate.

299

FLOW TEST SUMMARY SHEET



300

WATER DEMAND

- The water supply for sprinklers shall be determined only from one of the following methods:

- Density/area curves
- The room design method
- Special design areas

- What method is used? Follow the checklist accordingly.

302

DESIGN OPTIONS

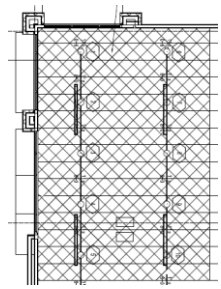
Area/Density

- Single point (new)
- Curves (existing)

Room design method

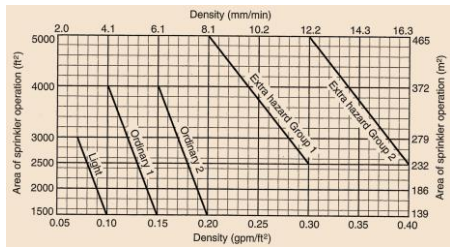
Special design approaches

- Residential
- Corridors
- Exposure



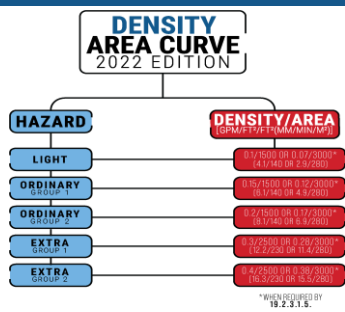
303

DENSITY/AREA CURVES



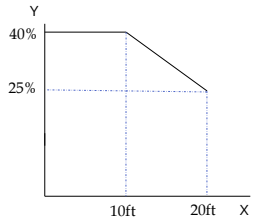
304

DENSITY/AREA CURVES – 2022 EDITION



305

QUICK RESPONSE DECREASE



Ceiling Height ≤10 ft
Reduction is 40%

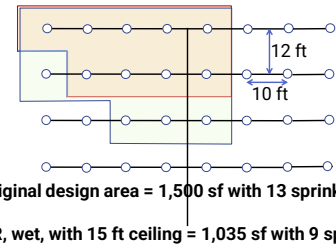
Between 10 and 20 ft
Y = (-3x/2)+55

Ceiling Height is 20 ft
Reduction is 25%

Over 20 ft Ceiling Height
No reduction allowed

306

QUICK RESPONSE DESIGN AREA EXAMPLE



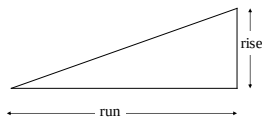
Original design area = 1,500 sf with 13 sprinklers

QR, wet, with 15 ft ceiling = 1,035 sf with 9 sprinklers

309

SLOPED CEILING INCREASE

- Sloped Ceilings
  - Area of operation is increased by 30% if pitch exceeds 2 in 12 (rise in run).
  - This is an angle of 9.46°



310

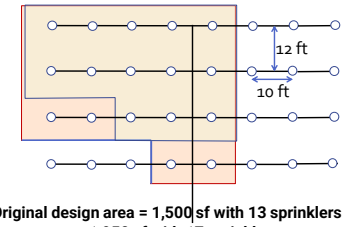
DRY PIPE AND DOUBLE INTERLOCK PREACTION SYSTEM INCREASE

For dry pipe and double interlock preaction sprinkler systems, increase by 30%.

The adjustment to the design area is made without changing the density.

311

DRY PIPE INCREASE EXAMPLE

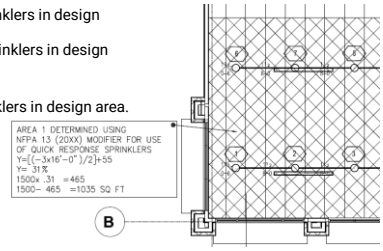


Original design area = 1,500 sf with 13 sprinklers
Dry system = 1,950 sf with 17 sprinklers

312

DENSITY/AREA SPRINKLERS

- Design areas can and are often modified:
  - Increases = more sprinklers in design area
  - Decreases = fewer sprinklers in design area
- Minimum five (5) sprinklers in design area.



313

HIGH TEMPERATURE DECREASE

The density/area curves for extra hazard are based on the use of ordinary temperature sprinklers.

When high temperature sprinklers are used, the design area is decreased by 25%, but never below the minimum threshold of 2,000 square feet.

314

SUM OF MULTIPLE INCREASES AND DECREASES

Compound adjustments based on original area of operation selected from density/area figure.

- Example 1: Dry-pipe system with ceiling slope of 4 in 12
  - 30% increase for dry system
  - 30% increase for slope
  - 1,500 sf x 1.3 x 1.3 = 2,535 sf design area

315

MULTIPLE ADJUSTMENTS EXAMPLE

Example 2:

QR sprinklers with wet pipe system and ceiling slope of 3 in 12, maximum ceiling height of 20 ft.

- 25% decrease for QR sprinklers
- 30% increase for slope
- 1,500 sf x 0.75 x 1.3 = 1,463 sf

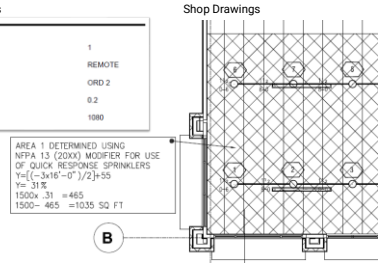
316

DESIGN AREA

Calculations

Design	
Remote Area Name	1
Remote Area Location	REMOTE
Occupancy Classification	ORD 2
Density (gpm/ft²)	0.2
Area of Application (ft²)	1080

Shop Drawings



317

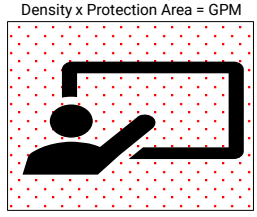
DESIGN AREA EXAMPLE

A building with a 15 ft ceiling
Wet pipe sprinkler system
Standard response sprinklers
120 sq ft spacing (12 ft between branch lines and 10 ft between sprinklers along the branch line)
Ordinary hazard group 2
0.2 gpm per sq ft over 1500 sq ft (No adjustments apply)

318

HOW MUCH WATER WILL FLOW?

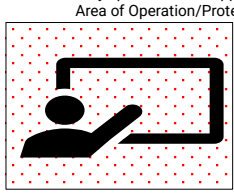
From an individual sprinkler?
Density x Protection Area = GPM



319

HOW MANY SPRINKLERS?

How many sprinklers are supposed to be in the design area?
Area of Operation/Protection Area = # Sprinklers



ALWAYS ROUND UP TO NEXT WHOLE SPRINKLER

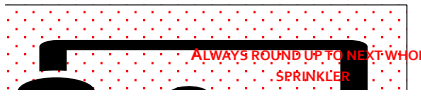
320

HOW MANY SPRINKLERS ON A BRANCH LINE?

How many sprinklers will be on a branch line? 27.2.4.2.1

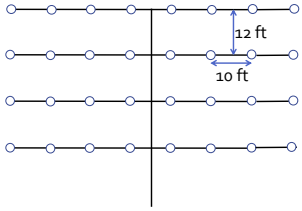
$$\frac{1.2\sqrt{1500}}{10} = 4.6$$ Area of Operation "S" Dimension

- 4 sprinklers per branch line
- 5 sprinklers per branch line



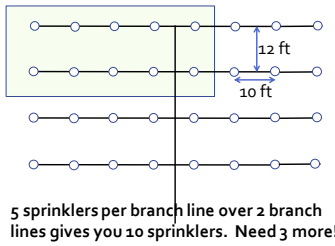
321

DESIGN AREA EXAMPLE



322

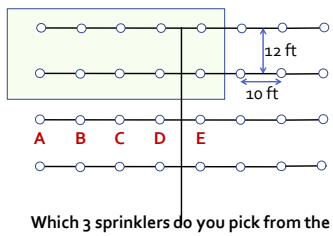
DESIGN AREA EXAMPLE



5 sprinklers per branch line over 2 branch lines gives you 10 sprinklers. Need 3 more!

323

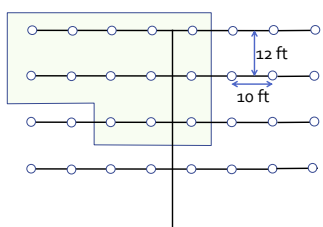
DESIGN AREA EXAMPLE



Which 3 sprinklers do you pick from the next branch line: ABC or CDE?

324

DESIGN AREA EXAMPLE



Design area = 120 x 13 = 1560 sq ft

325

HOSE STREAM ALLOWANCE

Occupancy	Inside Hose in GPM	Inside and Outside – Total Hose, in GPM	Duration
Light	0, 50, or 100	100	30 minutes
Ordinary	0, 50, or 100	250	60 minutes
Extra	0, 50, or 100	500	90 minutes

```
HOSE-STREAM DEMAND: 250 gpm
TOTAL WATER REQUIRED (INCLUDING HOSE):638.1 gpm
```

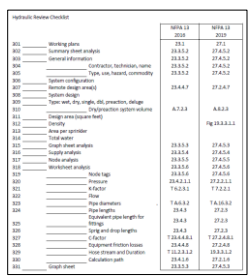
326

MODULE 10 – HYDRAULIC CALCULATION REVIEW

Fire Sprinkler System Plan Review

327

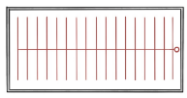
HYDRAULIC REVIEW CHECKLIST



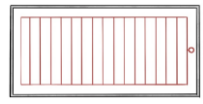
328

SYSTEM CONFIGURATION

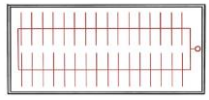
Tree Systems



Gridded Systems

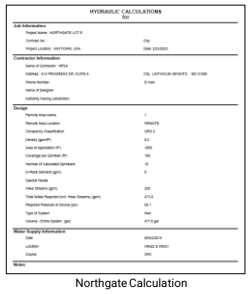


Looped Systems



330

SUMMARY SHEET



HYDRAULIC CALCULATIONS
for

Job Information

Contractor Information

Design

Water Supply Information

Notes

Northgate Calculation

331

GENERAL INFORMATION

Job Information

Project Name : NORTHGATE LOT E

Contract No. :

City:

Project Location: ANYTOWN, USA

Date: 2/23/2023

Northgate Calculation

Contractor Information

Name of Contractor: John Swanson

Address: 514 PROGRESS DR, SUITE A Phone Number:

City: LINTHICUM HEIGHTS, MD 21090

E-mail:

Name of Designer: Its John Again...

Authority Having Jurisdiction: Jeff Hugo

Northgate Calculation

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GENERAL INFORMATION

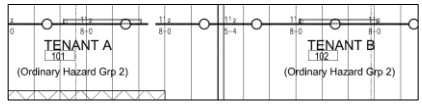
Northgate Shop Drawing

333

TYPE OF CONSTRUCTION, USE, HAZARD, COMMODITY

Design	
Remote Area Name	1
Remote Area Location	REMOTE
Occupancy Classification	ORD 2

Northgate Calculation



Northgate Shop Drawing

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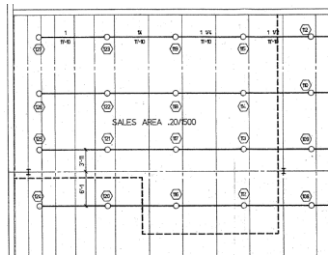
REMOTE DESIGN AREAS

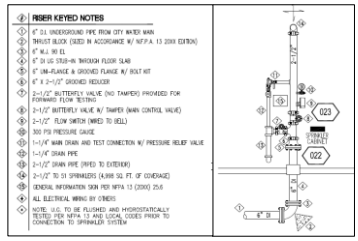


335

TYPE OF SYSTEM

Type of System | Wet

Northgate Calculation



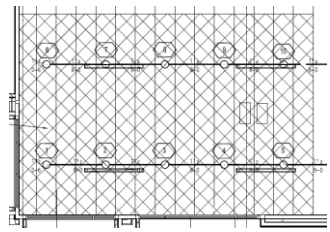
Northgate Shop Drawing

336

DESIGN AREA

Area of Application (ft²)	1080
Coverage per Sprinkler (ft²)	108
Number of Calculated Sprinklers	10

Northgate Calculation



Northgate Shop Drawing

338

DENSITY

Design	
Remote Area Name	1
Remote Area Location	REMOTE
Occupancy Classification	ORD 2
Density (gpm/ft²)	0.2
Area of Application (ft²)	1080

Northgate Calculation

Northgate Shop Drawing

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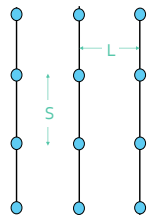
AREA OF SPRINKLER

Based upon the "S x L rule"

AS = S x L

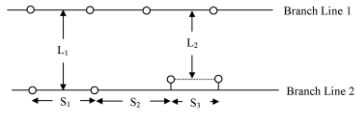
AS = Area of Coverage
S = Distance along branch line or twice distance to wall.
L = Distance between branch line or twice distance to wall.



340

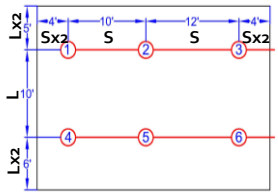
S X L RULE

"S" and "L" Dimensions are measured to the sprinklers, not the branch lines



341

AREA OF SPRINKLER



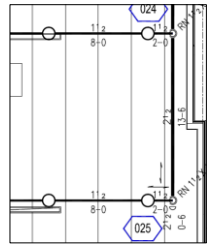
Spr.	S	L	A_S
1			
2	12	10	120
3			
4			
5			
6			

342

AREA OF SPRINKLER

Area of Application (ft²)	1500
Coverage per Sprinkler (ft²)	130
Number of Calculated Sprinklers	10

Northgate Calculation



Northgate Shop Drawing

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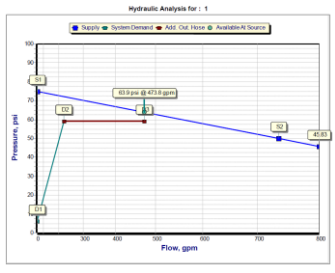
GRAPH SHEET ANALYSIS



Northgate Calculation

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SUPPLY ANALYSIS

Supply Analysis

Node at Source	Static Pressure (psi)	Residual Pressure (psi)	Flow (gpm)	Available Pressure (psi)	Total Demand (gpm)	Required Pressure (psi)
SRC	75	50	736	72.2	473.8	59.1

Northgate Calculation

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NODE ANALYSIS

Node Data

Node# Elev.	Type Hgroup	K-Fact. Open/Closed	Discharge Overdischarge	Coverage Density	Tot. Pres. Elev. Pres.	Req. Pres. Req. Discharge
ft		gpm/psi½	gpm gpm	ft² gpm/ft²	psi psi	psi gpm
1 13.67	Overhead Sprinkler HEAD	5.6 Open	21.6 0	108 0.2	14.9 -5.9	14.9 21.6
6 13.92	Overhead Sprinkler HEAD	5.6 Open	21.7 0.1	108 0.201	15 -6	14.9 21.6
2 13.67	Overhead Sprinkler HEAD	5.6 Open	21.7 0.1	108 0.201	15 -5.9	14.9 21.6
7 13.92	Overhead Sprinkler HEAD	5.6 Open	21.8 0.2	108 0.202	15.1 -6	14.9 21.6
3 13.67	Overhead Sprinkler HEAD	5.6 Open	22 0.4	108 0.204	15.4 -5.9	14.9 21.6
8 13.92	Overhead Sprinkler HEAD	5.6 Open	22.1 0.5	108 0.204	15.6 -6	14.9 21.6
4 13.67	Overhead Sprinkler HEAD	5.6 Open	22.7 1.1	108 0.21	16.4 -5.9	14.9 21.6
9 13.92	Overhead Sprinkler HEAD	5.6 Open	22.7 1.1	108 0.211	16.5 -6	14.9 21.6
5 13.67	Overhead Sprinkler HEAD	5.6 Open	23.8 2.2	108 0.22	18 -5.9	14.9 21.6
10 13.92	Overhead Sprinkler HEAD	5.6 Open	23.8 2.2	108 0.221	18.1 -6	14.9 21.6
025 11.67	Node NODE				40.8 -3.1	

Northgate Calculation

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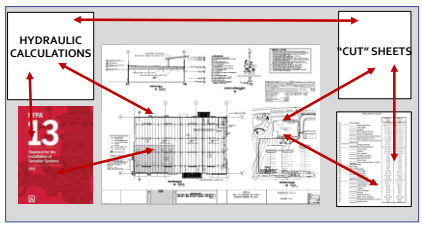
WORKSHEET REVIEW



VERIFY CALCS TO SHOP DRAWINGS TO CUT SHEETS TO STANDARD TO CHECKLIST

347

CALCULATION PATH

- From most remote sprinkler to the water source.

318	_____	Worksheet analysis
319	_____	Node tags
320	_____	Pressure
321	_____	K-factor
322	_____	Flow
323	_____	Pipe diameters
324	_____	Pipe lengths
325	_____	Equivalent pipe length for fittings
326	_____	Sprig and drop lengths
327	_____	C-factor
328	_____	Equipment friction losses
329	_____	Hose stream and Duration
330	_____	Calculation path

NFSA hydraulic review checklist

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WORKSHEET REVIEW

Node 1 Node 2	Elev 1 Elev 2	K-Factor 1 K-Factor 2	Flow added (q) Total flow (Q)	Nominal ID Actual ID	Fittings quantity x (name) = length	L F T	C Factor Pf per ft	total (Pt) elev (Pe) frict (Pf)	NOTES
	(ft)	(gpm/psi½)	(gpm)	(in)	(ft)	(ft)	(psi)	(psi)	
Path No: 1									
1	13.67	5.6	21.6	1.5		8	120	14.9	
2	13.67	5.6	21.6	1.68		0	0.0151	0	
						8		0.1	
2	13.67	5.6	21.7	1.5		8	120	15	
3	13.67	5.6	43.3	1.68		0	0.0547	0	
						8		0.4	
3	13.67	5.6	22	1.5		8	120	15.4	
4	13.67	5.6	65.3	1.68		0	0.117	0	
						8		0.9	
4	13.67	5.6	22.7	1.5		8	120	16.4	

#1
#2
#3

NFSA

Northgate Calculation

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WORKSHEET REVIEW

Node 1 Node 2	Elev 1 Elev 2	K-Factor 1 K-Factor 2	Flow added (q) Total flow (Q)	Nominal ID Actual ID	Fittings quantity x (name) = length	L F T	C Factor Pf per ft	total (Pt) elev (Pe) frict (Pf)	NOTES
	(ft)	(gpm/psi½)	(gpm)	(in)	(ft)	(ft)	(psi)	(psi)	
Path No: 1									
1	13.67	5.6	21.6	1.5		8	120	14.9	
2	13.67	5.6	21.6	1.68		0	0.0151	0	
						8		0.1	
2	13.67	5.6	21.7	1.5		8	120	15	
3	13.67	5.6	43.3	1.68		0	0.0547	0	
						8		0.4	
3	13.67	5.6	22	1.5		8	120	15.4	
4	13.67	5.6	65.3	1.68		0	0.117	0	
						8		0.9	
4	13.67	5.6	22.7	1.5		8	120	16.4	

NFSA

351

Node 1 Node 2	Elev 1 Elev 2	K-Factor 1 K-Factor 2	Flow added (q) Total flow (Q)	Nominal ID Actual ID	Fittings quantity x (name) = length	L F T	C Factor Pf per ft	total (Pt) elev (Pe) frict (Pf)	NOTES
	(ft)	(gpm/psi½)	(gpm)	(in)	(ft)	(ft)	(psi)	(psi)	
1	13.67	5.6	21.6	1.5		8	120	14.9	
2	13.67	5.6	21.6	1.68		0	0.0151	0	
						8		0.1	
2	13.67	5.6	21.7	1.5		8	120	15	
3	13.67	5.6	43.3	1.68		0	0.0547	0	
						8		0.4	
3	13.67	5.6	22	1.5		8	120	15.4	
4	13.67	5.6	65.3	1.68		0	0.117	0	
						8		0.9	
4	13.67	5.6	22.7	1.5		8	120	16.4	

NFSA

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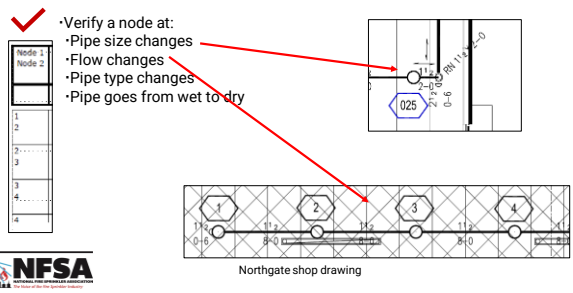
NODE TAGS



Northgate shop drawing

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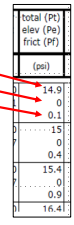
PRESSURE - PSI

·Pressure (expressed in psi)
·Pt = Total Pressure
·Pe = Elevation Pressure
·Pf = Friction Loss Pressure

S1=14.9 psi
S2=15 psi
S3=15.4 psi



Northgate shop drawing

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FINDING PRESSURE OR "P"

Why 14.9 psi?

$$\mathbf{P} = \left(\frac{Q}{K}\right)^2$$

Q = Flow = 21.6 gpm
K = K-factor = 5.6

What would be the P if a K-8.0 is used?

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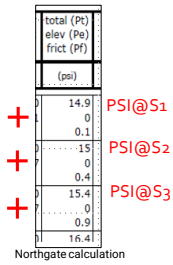
PRESSURE - PSI

✓

1)Pressures add up 2) Elevation losses (gains)



Northgate calculation

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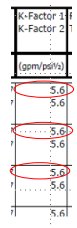
K-FACTOR

✓

1) K-factors on calcs and shop drawing match cut sheets.
2) Some branch lines are K-factors



Northgate calculation

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FINDING K-FACTOR OR "K"

Why K-5.6?

$K = \frac{Q}{\sqrt{p}}$

Q = Flow = 21.6 gpm
P = Pressure = 14.9 psi

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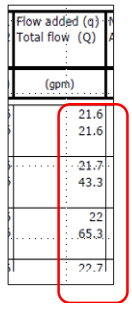
FLOW – Q AND GPM



359

FINDING FLOW OR "Q"

Why 21.6 gpm?

$$Q = K\sqrt{P}$$

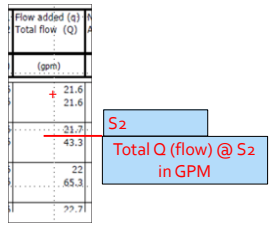
K = K-factor = 5.6
P = Pressure = 14.9 psi

What is the flow using a K-8.0 sprinkler?

360

FLOW – Q AND GPM

1) Flows add up 2) Missing nodes that flow



$K\sqrt{P} = Q$

$5.6\sqrt{15} = 21.7$

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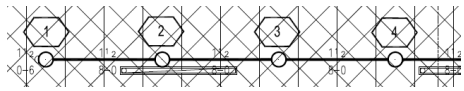
FLOW – Q AND GPM



Northgate shop drawing

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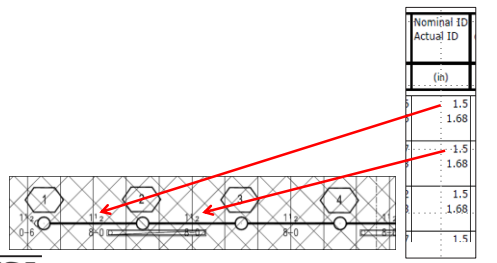
PIPE DIAMETERS



Northgate shop drawing

Northgate calculations

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TABLE A.16.3.2

Nominal Pipe Size		Outside Diameter		Schedule 5				Schedule 10*				Schedule 30				Schedule 40			
				Inside Diameter		Wall Thickness		Inside Diameter		Wall Thickness		Inside Diameter		Wall Thickness		Inside Diameter		Wall Thickness	
in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
⅛	6	0.405	10.3	—	—	—	—	0.307	7.8	0.049	1.2	—	—	—	—	0.269	6.8	0.068	1.73
¼	8	0.540	13.7	—	—	—	—	0.410	10.4	0.065	1.6	—	—	—	—	0.364	9.2	0.088	2.24
⅜	10	0.675	17.1	—	—	—	—	0.545	13.8	0.065	1.6	—	—	—	—	0.493	12.5	0.091	2.31
½	15	0.840	21.3	—	—	—	—	0.674	17.1	0.083	2.1	—	—	—	—	0.622	15.8	0.109	2.77
¾	20	1.050	26.7	—	—	—	—	0.884	22.4	0.083	2.1	—	—	—	—	0.824	21.0	0.113	2.87
1	25	1.315	33.4	1.185	30.1	0.065	1.7	1.097	27.9	0.109	2.8	—	—	—	—	1.049	26.6	0.133	3.37
1¼	32	1.660	42.2	1.530	38.9	0.065	1.7	1.442	36.6	0.109	2.8	—	—	—	—	1.380	35.1	0.140	3.56
1½	40	1.900	48.3	1.770	45.0	0.065	1.7	1.682	42.7	0.109	2.8	—	—	—	—	1.610	40.9	0.145	3.68
2	50	2.375	60.3	2.245	57.0	0.065	1.7	2.157	54.8	0.109	2.8	—	—	—	—	2.067	52.5	0.154	3.91
2½	65	2.875	73.0	2.709	68.8	0.083	2.1	2.635	66.9	0.120	3.0	—	—	—	—	2.469	62.7	0.203	5.16
3	80	3.500	88.9	3.334	84.7	0.083	2.1	3.260	82.8	0.120	3.0	—	—	—	—	3.068	77.9	0.216	5.49
3½	90	4.000	101.6	3.834	97.4	0.083	2.1	3.760	95.5	0.120	3.0	—	—	—	—	3.548	90.1	0.226	5.74
4	100	4.500	114.3	4.334	110.1	0.083	2.1	4.260	108.2	0.120	3.0	—	—	—	—	4.026	102.3	0.237	6.02

1) Calcs match shop drawings
2) Correct I.D.

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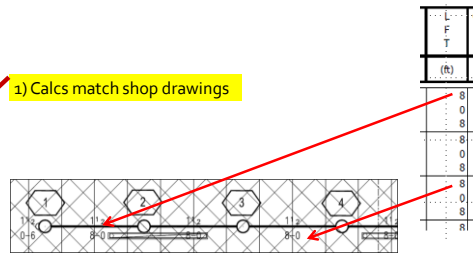
PIPE LENGTH COORDINATION

1) Calcs match shop drawings



Northgate shop drawing

Northgate calculations

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EQUIVALENT PIPE LENGTH – TABLE 27.2.3.1.1

Equivalent pipe length is the friction loss of a fitting expressed in pipe length.

Fittings and Valves Expressed in Equivalent Feet (Meters) of Pipe

Fittings and Valves	½ in. (15 mm)	¾ in. (20 mm)	1 in. (25 mm)	1¼ in. (32 mm)	1½ in. (40 mm)	2 in. (50 mm)	2½ in. (65 mm)	3 in. (80 mm)	3½ in. (90 mm)	4 in. (100 mm)	5 in. (125 mm)	6 in. (150 mm)	8 in. (200 mm)	10 in. (250 mm)	12 in. (300 mm)
45°elbow	—	1 (0.3)	1 (0.3)	1 (0.3)	2 (0.6)	2 (0.6)	3 (0.9)	3 (0.9)	3 (0.9)	4 (1.2)	5 (1.5)	7 (2.1)	9 (2.7)	11 (3.3)	13 (4)
90°standard elbow	1 (0.3)	2 (0.6)	2 (0.6)	3 (0.9)	4 (1.2)	5 (1.5)	6 (1.8)	7 (2.1)	8 (2.4)	10 (3)	12 (3.7)	14 (4.3)	18 (5.5)	22 (6.7)	27 (8.2)
90°long-turn elbow	0.5 (0.2)	1 (0.3)	2 (0.6)	2 (0.6)	2 (0.6)	3 (0.9)	4 (1.2)	5 (1.5)	5 (1.5)	6 (1.8)	8 (2.4)	9 (2.7)	13 (4)	16 (4.9)	18 (5.5)
Tee or cross (flow turned 90°)	3 (0.9)	4 (1.2)	5 (1.5)	6 (1.8)	8 (2.4)	10 (3)	12 (3.7)	15 (4.6)	17 (5.2)	20 (6.1)	25 (7.6)	30 (9.1)	35 (10.7)	50 (15.2)	60 (18.3)
Butterfly valve	—	—	—	—	—	6 (1.8)	7 (2.1)	10 (3)	—	12 (3.7)	9 (2.7)	10 (3)	12 (3.7)	19 (5.8)	21 (6.4)
Gate valve	—	—	—	—	—	1 (0.3)	1 (0.3)	1 (0.3)	1 (0.3)	2 (0.6)	2 (0.6)	3 (0.9)	4 (1.2)	5 (1.5)	6 (1.8)
Vane type flow switch			6 (1.8)	9 (2.7)	10 (3)	14 (4.3)	17 (5.2)	22 (6.7)	—	30 (9.1)	—	16 (4.9)	22 (6.7)	29 (8.8)	36 (11)
Swing check*	—	—	5 (1.5)	7 (2.1)	9 (2.7)	11 (3.3)	14 (4.3)	16 (4.9)	19 (5.8)	22 (6.7)	27 (8.2)	32 (10)	45 (14)	55 (17)	65 (20)

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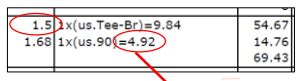
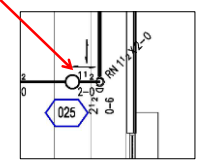
EQUIVALENT PIPE LENGTH



Northgate calculations

1) Calcs match shop drawings
2) Missing fittings



Northgate shop drawing

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EQUIVALENT PIPE LENGTH

Flexible hose friction loss data

FlexHead Model #	Internal I.D.	Outlet Orifice Size	Hose Assembly Length	Maximum Number of 90-degree Bends			Maximum Equivalent Length of Schedule 40, Nominal 1in. Diameter Pipe, ft	
				3" – UL	8" – FM			
	in	in (cm)	ft (cm)		175psi	300psi	FM	UL
2024, 2024H	1	1/2 (1.27)	2 (60.96)	3	1	2	18.4	11
2036, 2036H	1	1/2 (1.27)	3 (91.44)	3	2	3	26.6	16
2048, 2048H	1	1/2 (1.27)	4 (121.92)	4	3	4	30.3	24
2060, 2060H	1	1/2 (1.27)	5 (152.4)	4	4	4	35.8	29
2072, 2072H	1	1/2 (1.27)	6 (182.88)	4	4	4	45.6	35

Image courtesy of ASC Engineered Solutions

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UH OH!

- Bends are too tight

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SPRIG AND DROP LENGTH

- Positive (adding to calcs) for sprig
- Negative (- sign in calcs) for drops

S	13.67	5.6	23.8	1.5	1x(us.Tee-Br)=9.84	54.67	120	1.8
025	11.67		111.7	1.68	1x(us.90)=4.92	14.76	0.3164	0.9
						69.43		22

- Why is it 0.9 psi? Each foot of pressure =0.433 psi
- 2.0 ft x 0.433 = 0.9 psi

✓ 1) Look that sprigs are add (or subtracted)

Northgate calculations

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C-FACTOR

✓ Look for C-factor changes in aboveground and underground

C Factor Pf per ft
120
0.128
140
0.0013

Northgate calculations

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C-FACTOR – TABLE 28.2.4.8.1 HAZEN-WILLIAMS C VALUE

Pipe or Tube	*C* Value*
Unlined cast or ductile iron	100
Black steel (dry systems including preaction)	100
Black steel (wet systems including deluge)	120
Galvanized steel (dry systems including preaction)	100
Galvanized steel (wet systems including deluge)	120
Plastic (listed) all	150
Cement-lined cast- or ductile iron	140
Copper tube, brass or stainless steel	150
Asbestos cement	140
Concrete	140

*The authority having jurisdiction is permitted to allow other *C* values.

Image courtesy of NFPA

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WHAT IS "FRICTION LOSS"?

The friction loss of pipe is totaled in Pf

Friction loss consists of:
- Flow "Q"
- C-factor "C"
- Inside pipe diameter "D"

Hazen-William formula
- 4.52 x Q1.85/C1.85/D4.87 = psi/ft of pipe
- psi/ft of pipe x total length = Pf

	Flow added (q) Total flow (Q)	Nominal ID Actual ID	C Factor Pf per ft	total (Pt) elev (Pe) frict (Pf)
	(gpm)	(in)	(psi)	(psi)
6	21.6	1.5	120	14.9
6	21.6	1.68	0.0151	0
				0.1
6	21.7	1.5	120	15
6	43.3	1.68	0.0547	0
				0.4
6	65.3	1.5	120	15.4
6	65.3	1.68	0.117	0
				0.9
6	22.7	1.5	120	16.4

Northgate calculations

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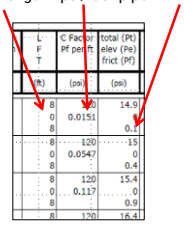
HAZEN WILLIAM = FRICTION LOSS

4.52 x Q1.85/C1.85/D4.87 = psi/ft of pipe
total length x psi/ft of pipe = Pf



L F T (ft)	C Factor Pf per ft (psi)	total (Pf) elev (Ps) frict (Pf) (psi)
8		14.9
0	0.0151	0
8		0.1
8	120	15
0	0.0547	0
8		0.4
8	120	15.4
0	0.117	0
8		0.9
8	120	16.4

Northgate calculations

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HOSE STREAM AND DURATION

Summary Sheet

Hose Streams (gpm)	250

Flow Analysis

Design Areas

Design Area Name	Calc. Mode (Model)	Occupancy	Area of Application	Total Water	Pressure @ Source	Min. Density	Min. Pressure	Min. Flow	Calculated Heads	Hose Streams
			(ft²)	(gpm)	(psi)	(gpm/ft²)	(psi)	(gpm)	#	(gpm)
1	Demand (HW)	ORD 2	1080	473.8	Required 59.1	0.2	14.9	21.6	10	250

Northgate calculations

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CALCULATION PATH

From most remote sprinkler to the water source.

318 _____ Worksheet analysis
319 _____ Node tags
320 _____ Pressure
321 _____ K-factor
322 _____ Flow
323 _____ Pipe diameters
324 _____ Pipe lengths
_____ Equivalent pipe length for
325 _____ fittings
326 _____ Sprig and drop lengths
327 _____ C-factor
328 _____ Equipment friction losses
329 _____ Hose stream and Duration
330 _____ Calculation path

NFSA hydraulic review checklist

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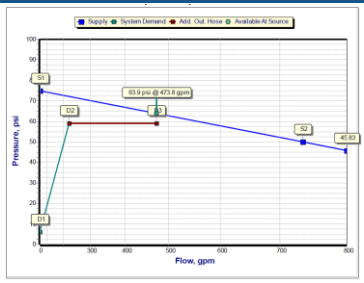
GRAPH SHEET



Northgate calculations

SUMMARY

- Apply the requirements of plans examination according to NFPA 13, building and fire codes.
- Discussed the importance of a systematic review process.
- Identified the documents required for a complete plan review process.
- Evaluated the hydraulic calculations presented with a set of working plans submitted for review and approval.

QUESTIONS?

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