



# ROUGH & FINAL INSPECTION OF FIRE SPRINKLER SYSTEMS



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## NFSA PRESENTER BIO: JOHN SWANSON

- Certified Fire Protection Specialist (NFPA)
- Codes & Standards Specialist-NFSA
- Former Deputy State Fire Marshal (MN)
- NFPA 72 Technical Committee
- Previous member – IBC Fire Safety Committee/IFC Interpretation Committee
- Instructor/SME for International Code Council and NFPA 72
- Appointed by MN Gov. Mark Dayton to MN Board of Architecture & Engineering (2013-2017)



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**NFSA** INTRODUCTIONS

- Please introduce yourself:
- Current position?
- Years of experience in your industry?



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**MODULE 1  
THE INSPECTOR, CODES AND STANDARDS**

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**NFSA** QUALIFICATIONS

**What qualifications are Needed in order to inspect?**

- National certifications
  - ICC
  - NFPA
- State or local certifications?



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**NFSA REGULATORY INSPECTIONS**



**IBC-2021**  
Sections 110 - Inspections, 901 Acceptance  
**IFC-2021**  
Sections 106 – Inspections, 901 Acceptance  
**NFPA-13, 2019**  
Chapter 28, System Acceptance

- Rough and/or final inspections
- Close-out documents
- Integrated testing
- C of O vs Temp C of O

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**NFSA ADMINISTRATIVE**

- Laws
- Regulations (Codes)
- Amendments
  - Local Amendments
  - By-laws – Ordinances
- NFPA Standards – Editions
- Permits – Terms and Conditions
- Appeals (Variances and/or Waivers)
- Modifications – Alternatives (AHJ-Local)
- Interpretations



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**NFSA RELATIONSHIPS**

**Relationships matter**

- Inspections – A cooperative effort
- Business relationships are similar to personal ones
  - Sprinkler contractor (foreman)
  - General contractor (superintendent)
- Working with other inspectors



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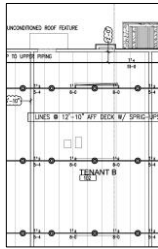
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**NFSA TECHNIQUES**

**Inspection Tips**

- Tag-a-long with other trades or vice versa.
- Use plan review checklist for on-site checklist
- Compare installation to approved plans
- Address changes to approved plans:
  - Minor changes – use your judgement
  - Major changes – what is their solution?



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**NFSA TECHNIQUES**

**More Inspection Best Practices**

- Walk the pipe, floor by floor
- Inspect the same each visit
- "Be the water"
- Use what is best for you
  - Look at it all at once, or
  - Walk just the hangers, then the pipe, etc
- Review missed items on previous inspections, action, corrections as required?



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**NFSA VIOLATIONS / DOCUMENTATION**

**Violations**

- Document them
- Use code section numbers
- Use a checklist!
- Identify to closest "landmark", i.e. column, floor, etc

Lafayette Fire Department	
Specialty "Pre-acceptance" Test Checklist	
<p>THIS CHECKLIST IS FOR USE BY THE INSPECTOR TO VERIFY THAT THE INSTALLATION OF THE SPECIALTY EQUIPMENT IS IN ACCORDANCE WITH THE APPLICABLE CODES AND STANDARDS. IT IS NOT A SUBSTITUTE FOR THE APPLICABLE CODES AND STANDARDS. THE INSPECTOR SHALL BE RESPONSIBLE FOR DETERMINING THE APPLICABLE CODES AND STANDARDS.</p>	
<p>Project Name: _____</p> <p>Inspector: _____</p> <p>Specialty Equipment: _____</p> <p>Address: _____</p> <p>City: _____ State: _____</p>	
<p><b>GENERAL REQUIREMENTS</b></p> <p><input type="checkbox"/> The equipment shall be installed in accordance with the applicable codes and standards.</p> <p><input type="checkbox"/> The equipment shall be installed in a location that is accessible to the fire department.</p> <p><input type="checkbox"/> The equipment shall be installed in a location that is protected from fire and other hazards.</p>	
<p><b>INSTALLATION REQUIREMENTS</b></p> <p><input type="checkbox"/> The equipment shall be installed in accordance with the applicable codes and standards.</p> <p><input type="checkbox"/> The equipment shall be installed in a location that is accessible to the fire department.</p> <p><input type="checkbox"/> The equipment shall be installed in a location that is protected from fire and other hazards.</p>	
<p><b>OPERATION REQUIREMENTS</b></p> <p><input type="checkbox"/> The equipment shall be operated in accordance with the applicable codes and standards.</p> <p><input type="checkbox"/> The equipment shall be operated in a location that is accessible to the fire department.</p> <p><input type="checkbox"/> The equipment shall be operated in a location that is protected from fire and other hazards.</p>	
<p><b>MAINTENANCE REQUIREMENTS</b></p> <p><input type="checkbox"/> The equipment shall be maintained in accordance with the applicable codes and standards.</p> <p><input type="checkbox"/> The equipment shall be maintained in a location that is accessible to the fire department.</p> <p><input type="checkbox"/> The equipment shall be maintained in a location that is protected from fire and other hazards.</p>	
<p><b>TESTING REQUIREMENTS</b></p> <p><input type="checkbox"/> The equipment shall be tested in accordance with the applicable codes and standards.</p> <p><input type="checkbox"/> The equipment shall be tested in a location that is accessible to the fire department.</p> <p><input type="checkbox"/> The equipment shall be tested in a location that is protected from fire and other hazards.</p>	

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**NFSA** JOBSITE FAMILIARITY

**Get to know the site!**

- Familiarize yourself with the building project
- Previous inspection results of other trades
- Pre-inspection visitations



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**NFSA** JOBSITE SAFETY

**Stay Safe on the Jobsite!**

- It is your responsibility
  - Hardhat, boots
  - Eye and ear protection
- Look out, look up, look down
  - You will be looking up a lot!
- Jobsite distractions
  - Radio
  - Loud construction noises



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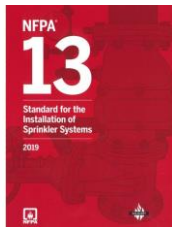
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**NFSA** NFPA 13 – CHAPTERS 1-3

**Administrative**

1. Administration
2. Referenced Publications
3. Definitions



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**NFSA NFPA 13 – CHAPTER 4**

**General Requirements**

- 4. General Requirements
  - Level of protection
  - Owner's certificate
  - Classification of hazard
  - System area
  - Water supply information



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**NFSA NFPA 13 – CHAPTERS 5-6**

**Water Supplies and Underground**

- 5. Water Supplies
- 6. Underground Piping
  - Extracted from NFPA 24



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**NFSA NFPA 13 – CHAPTERS 7-15**

**Rules for System Installation**

- 7. System Components & Hardware
- 8. System Types and Requirements
- 9. Sprinkler Location Requirements
- 10. Installation Requirements – Standard Pendent and Sidewall
- 11. Installation Requirements – EC Pendent and Sidewall
- 12. Installation Requirements – Residential Pendent and Sidewall
- 13. Installation Requirements – CMSA Sprinklers
- 14. Installation Requirements – ESFR Sprinklers
- 15. Installation Requirements – Special Sprinklers



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**NFSA NFPA 13 - CHAPTER 16**

**Rules for Piping and Valves**

- 16. Installation of Piping, Valves and Appurtenances
  - Piping installation
  - Protection of Piping
  - Air venting
  - Valves
  - Drainage
  - FDCs
  - Gauges / System connections
  - Signs



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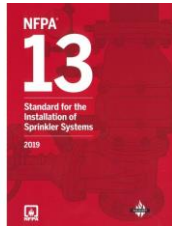
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**NFSA NFPA 13 - CHAPTERS 17-18**

**Hanging and Bracing**

- 17. Installation Requirements for Hanging and Support of System Piping
- 18. Installation Requirements for Seismic Protection

These chapters will eventually be extracted from the new NFPA 200



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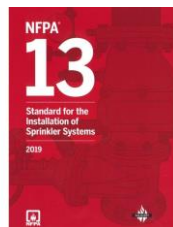
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**NFSA NFPA 13 - CHAPTER 19**

**System Design Chapter**

- 19. Design Approaches
  - Occupancy Hazard Fire Control Approach
    - Room Design Method
    - Single Row / Ducts
  - Special Design Approaches
    - Residential
    - Exposure / Water Curtain
    - Steep Combustible Concealed Spaces



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**NFSA NFPA 13 - CHAPTERS 20-26**

**Discharge Rules for Storage and Special Occupancies**

- 20. General Req's for Storage
- 21. Protection of High Piled Storage Using CMDA Sprinklers
- 22. CMSA Requirements for Storage Applications
- 23. ESFR Requirements for Storage Applications
- 24. Alternative System Designs for Chapters 20-25
- 25. Protection of Rack Storage Using In-Rack Sprinklers
- 26. Special Designs of Storage Protection
- 27. Special Occupancy Requirements



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**NFSA NFPA 13 – CHAPTERS 27-31**

**Plans, Calculations and Acceptance**

- 28. Plans and Calculations
- 29. System Acceptance

**Existing Systems, Inspection, Testing and Maintenance**

- 30. Existing System Modifications
- 32. System Inspection, Testing and Maintenance (Bridge to NFPA 25)
- 31. Marine Systems



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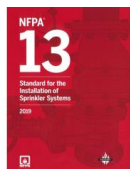
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**NFSA ORGANIZATION OF SECTIONS WITHIN CHAPTERS**

**Organization**

- Each chapter 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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**NFSA** 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 Dry and Preaction for Piers/Wharves
- 8.5 Multi-Cycle Systems
- 8.6 Antifreeze Systems
- 8.7 Outside Sprinklers for Exposure Protection
- 8.8 Refrigerated Spaces
- 8.9 Commercial Type Cooking Equipment
- 8.10 Pilot Line Detectors



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**NFSA** EXAMPLE: STANDARD PENDENT AND UPRIGHT RULES

**Standard Pendent and Upright**

- 102.1-3 General Rules
- 10.2.4 Protection Area Per Sprinkler
- 10.2.5 Sprinkler Spacing
- 10.2.6 Deflector Position
- 10.2.7 Obstructions to Sprinkler Discharge
- 10.2.8 Clearance to Storage
- 10.2.9 Ceiling Pockets



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**NFSA** IBC CHAPTER 3 – USE & OCCUPANCY CLASSIFICATION

**Occupancy in the Building Code vs NFPA 13**

- IBC Classifies the use of the building or space
- Does not correlate with NFPA hazard occupancies
  - Hazard in IBC = Occupant characteristics, materials, etc
  - Hazard in NFPA 13 = Fuel load, heat release, etc
- NFPA13 2022 – Chapter 4
  - Classification of occupancy hazard and commodities



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**NFSA** IBC CHAPTER 4 – SPECIAL USES

**Special Uses**

- Requirements for special uses and occupancies.
- Distinct installation requirements for specific occupancies
  - Covered and Open Malls
  - High Rises
  - Underground Buildings
  - Stages
  - Aircraft Related
  - Etc



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**NFSA** IBC CHAPTER 5 – HEIGHT & AREA  
IBC CHAPTER 6 – TYPES OF CONSTRUCTION

**Allowable Areas and Types of Construction**

- Maximum height and area is a function of the use and how its built
- Types of construction is determined by structural members
- NFPA 13 and 13R systems can increase area and height (13R height only)



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**NFSA** IBC/IFC CHAPTER 9 – FIRE PROTECTION SYSTEMS

**What is the threshold for Sprinkler Installation?**

- Minimum requirements for active systems
- Minimum thresholds for occupancies
- Some installation criteria
  - Balconies in NFPA 13R
- Standpipes
- Fire Pumps
- Fire Department Connection
- Fire Alarm and Detection (Supervision)



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**NFSA** NFPA SYSTEM TYPES – AN OVERVIEW

**Different Types of Sprinkler Systems**

- Wet Pipe System
- Dry Pipe System
- Preaction System
- Deluge System



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**NFSA** WET PIPE SYSTEM

**Most Common Type of System**

- Pressure gauge
- Pressure relief valve
- Flow switch
- Air venting



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**NFSA** DRY PIPE SYSTEM

**Used in Areas Subject to Freezing**

- Pressure Gages
- Pitched Pipe
- Sprinklers
- System Size
- Water Delivery



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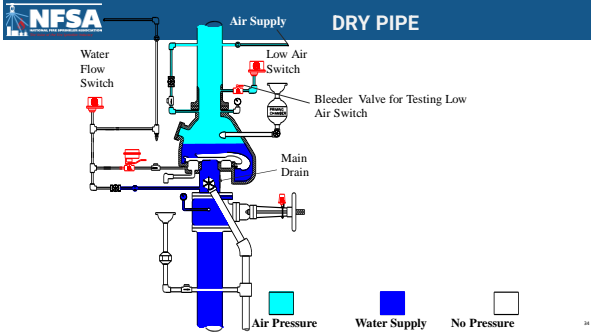
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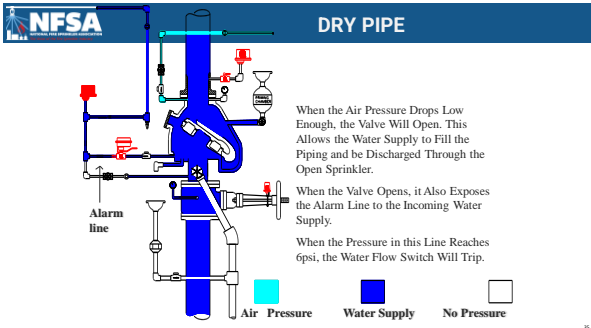
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## MODULE 2 SYSTEM FUNDAMENTALS – SPRINKLERS

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### NFSA WHERE DO WE START? (DESIGN OR REVIEW/INSPECT)

ALL sprinkler systems are dependent upon the answer to this question:

**What Are We Trying To Protect?**

- Is it storage (a warehouse)
- Is it not storage (not a warehouse)



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### NFSA NOT STORAGE IF IT IS STORAGE

#### Occupancy Classification (Hazard Classification)

- Light hazard (LH)
- Ordinary Hazard Group 1 (OH1)
- Ordinary Hazard Group 2 (OH2)
- Extra Hazard Group 1 (EH1)
- Extra hazard Group 2 (EH2)

#### Commodity Classification

- Class I commodity
- Class II commodity
- Class III commodity ← Group C Plastic
- Class IV commodity ← Group B Plastic
- Group A Plastic

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### CLASSIFICATION OF OCCUPANCIES (HAZARD CLASSIFICATIONS)

Hazard Definition	Light Hazard	Ordinary Hazard Group One	Ordinary Hazard Group Two	Extra Hazard Group One	Extra Hazard Group Two
Product Combustibility	Low	Low	Moderate to High	Very High	Very High
Quantity of Combustibles	Low	Moderate (8' high max)	Moderate to High (12' high max)	Very High	Very High
Heat Release Rates	Low	Moderate to High	Moderate to High	High & Rapidly Developing	High & Rapidly Developing
Flammable Liquids	None	None	None (Limited)	None (Limited)	Moderate to Substantial
Shielding of Combustibles	None	None	None	None	Anticipated

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### COMMODITY CLASSIFICATIONS

Non-combustible	<b>Class I</b> Glass jars in a single layer box	<b>Class II</b> Glass jars in multiple layer cardboard box	
	<b>Class III</b> Paper cups in a box	<b>Class IV</b> Paper and Polystyrene cups in a box	
Plastics	<b>Group C</b>	<b>Group B</b>	<b>Group A</b> Polystyrene cups in a box

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### STANDARD SPRAY



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**CMSA & ESFR SPRINKLERS**



CMSA



ESFR

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**EXTENDED COVERAGE SPRINKLERS**



Courtesy of Globe

Courtesy of Tyco

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**RESIDENTIAL SPRINKLERS**



Courtesy of Reliable Sprinkler



Courtesy of Tyco Fire Products

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**NFSA RESIDENTIAL SPRINKLERS**



Residential Sprinkler Summary						Table A
Sprinkler Model	Sprinkler Identification Number (SIN)	Orientation	K-Factor (gpm/ft <sup>2</sup> (l/min/m <sup>2</sup> ))	Thread Size (NPT or ISO7-1)	Installation Options	Max. Coverage Area ft x ft (m x m)
KFwa30	FS301	Pendant	3.0 (43)	1/2	Pendant or Recessed	18 x 18 (4.9 x 4.9)
KFwa49	FS495	Pendant	4.9 (71)	1/2	Pendant or Recessed	20 x 20 (6.1 x 6.1)
KFwa58	FS583	Pendant	5.8 (86)	1/2	Pendant or Recessed	20 x 20 (6.1 x 6.1)
KFwa44 HSW	RA301	Horizontal Sidewall	4.4 (63)	1/2	Sidewall or Recessed	16 x 20 (4.9 x 6.1)
KFwa58 HSW	RA303	Horizontal Sidewall	5.8 (84)	1/2	Sidewall or Recessed	16 x 20 (4.9 x 6.1)
KFwa 58 HSWX	RA303	Horizontal Sidewall	5.8 (84)	1/2	Sidewall or Recessed	14 x 20 (4.3 x 7.3)

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**NFSA APPLICATION OF SPECIAL SPRINKLERS**

When evaluated and listed

- Window sprinklers
- Combustible concealed
- Attic sprinklers
- Institutional
- Conventional



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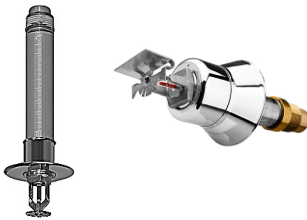
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**NFSA DRY SPRINKLERS**



Courtesy of Tyco Fire Products

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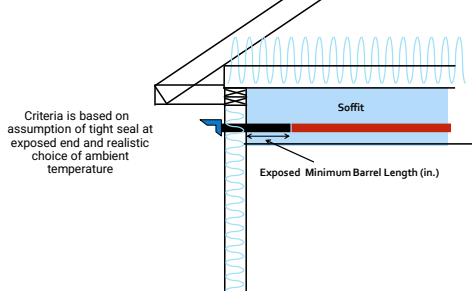
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**NFSA APPLICATION OF DRY BARREL SPRINKLERS**



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**NFSA APPLICATION OF DRY BARREL SPRINKLERS**

Ambient Temp. at Discharge End of Sprinkler (°F)	EXPOSED BARREL AMBIENT TEMP (°F)		
	40°F	50°F	60°F
	Exposed Minimum Barrel Length (in.)		
40	0	0	0
30	0	0	0
20	4	0	0
10	8	1	0
0	12	3	0
-10	14	4	1
-20	14	6	3
-30	16	8	4
-40	18	8	4
-50 +	20	10	6



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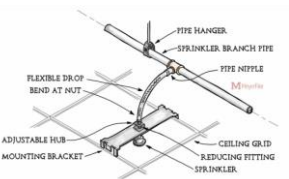
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**NFSA FLEXIBLE SPRINKLER DROPS**



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PENDANT

UPRIGHT



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HORIZONTAL SIDEWALL  
SIDEWALL

VERTICAL



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RESPONSE CHARACTERISTICS

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

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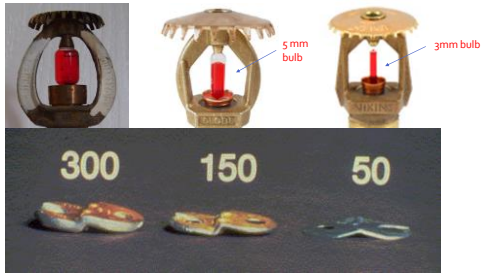
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**NFSA** STANDARD RESPONSE (PAST) STANDARD RESPONSE (PRESENT) FAST RESPONSE



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**NFSA** TEMPERATURE RATING RULES

- Ordinary or intermediate temperature sprinklers shall be used throughout:
  - Higher temperature sprinklers are required by other sections.
- High temperature sprinklers are permitted to be used in:
  - Ordinary hazard
  - Extra hazard
  - Storage occupancies
  - As permitted by other NFPA documents

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**NFSA** SPRINKLER TEMPERATURE RATINGS

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

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**NFSA** HIGH TEMPERATURE SPRINKLER (250-300 F)



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**NFSA** TEMPERATURE RATINGS



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**NFSA** ORIFICE SIZE

- Sprinklers are made in at least 13 different orifice sizes  
– See Table 6.2.3.1 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”

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**NFSA SAMPLE OF ORIFICE SIZES**



K 4.2      K 5.6      K 14.0      K 25.2

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**NFSA BASIC INSTALLATION REQUIREMENTS**

The requirements for:

- Spacing
- Location
- Positioning

**Chapter 9 Sprinkler Location Requirements**

**9.1\* Basic Requirements.**

9.1.1\* The requirements for spacing, location, and position of sprinklers shall be based on the following principles:

- (1) Sprinklers shall be installed throughout the premises.
- (2) Sprinklers shall be located so as not to exceed the maximum protection area per sprinkler.
- (3)\* Sprinklers shall be positioned and located so as to provide satisfactory performance with respect to activation time and discharge.
- (4) Sprinklers shall be permitted to be omitted from areas specifically allowed by this standard.
- (5) When sprinklers are specifically tested and test results demonstrate that deviation from basic requirements in structural members do not impair the ability of the sprinkler to control or suppress a fire, their positioning and locating in accordance with the test results shall be permitted.
- (6) Distance between sprinklers and ceiling exceeding the maximum specified in this standard shall be permitted, provided that tests or calculations demonstrate compliance, occupancy and performance of the sprinklers so those installed in conformance with these actions.

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**NFSA AREA OF COVERAGE**

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

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66

**NFSA** CEILING CONSTRUCTION: NFPA 13

**Materials**

- Non-combustible
- Limited Combustible
- Combustible

**Potential Obstructions / Delay**

- Obstructed
- Unobstructed



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67

**NFSA** COMBUSTIBLE AND NON-COMBUSTIBLE

**Non-Combustible:** A material that will not ignite, burn, support combustion, or release flammable vapors, when subjected to fire or heat.

**Combustible:** the opposite of non-combustible

**Limited Combustible:** Refers to a building construction material not complying with the definition of noncombustible material, but does have some combustible elements.

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**NFSA** UNOBSTRUCTED CONSTRUCTION

- Construction where beams, trusses, or other members do not impede heat flow or water distribution in a manner that materially affects the ability of sprinklers to control or suppress a fire.
- Horizontal structural members are not solid and openings are at least 70% of the cross section area and the depth of the member does not exceed the least dimension of the opening.
- All construction where the spacing of structural members exceeds 7.5 ft on center.

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**NFSA 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. (3.3.43.1)

**Our definition**

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

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**NFSA PROTECTION AREAS & MAXIMUM SPACING (SSP & SSU LIGHT HAZARD)**

Construction Type	System Type	Maximum Protection Area	Maximum Spacing
Non-Combustible Unobstructed	Hyd. Calc.	225 sf	15 ft
Non-Combustible Obstructed	Hyd. Calc.	200 sf	15 ft
Combustible Unobstructed with no exposed members	Hyd. Calc.	225 sf	15 ft
Combustible Unobstructed with exposed members 3 feet or more on center	Hyd. Calc.	225 sf	15 ft
Combustible Unobstructed with members less than 3 feet on center	All	130 sf	15 ft
Combustible obstructed with exposed members 3 feet or more on center	All	168 sf	15 ft
Combustible obstructed with members less than 3 feet on center	All	130 sf	15 ft
Combustible concealed spaces in accordance with 8.6.4.1.4	All	130 sf	15 ft parallel to slope 10 ft perpendicular to slope

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**NFSA DETERMINATION OF "AREA OF COVERAGE"**

Based upon the "S x L rule"

•  $AS = S \times L$

• AS = Area of Coverage

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

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

Maximum area of coverage of any sprinkler shall not exceed 400 s.f.

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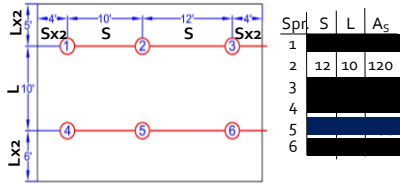
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**NFSA** AREA OF COVERAGE FOR EACH SPRINKLER



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**NFSA** MAXIMUM SPACING OF SPRINKLERS (SSP/SSU/SSS)

- 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 haz: 10 feet



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**NFSA** 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.



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**NFSA** MINIMUM DISTANCES

**From Walls**

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

**Between Sprinklers**

Based upon specific styles, but typically no less than 6 feet, unless provide baffles. (Cold Soldering & Skipping)

In-rack sprinklers are exempt from 6 ft. minimum rules.

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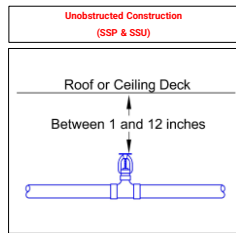
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**NFSA** DEFLECTOR POSITIONING BELOW CEILING

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



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**NFSA** DEFLECTOR POSITIONING BELOW CEILING

Unobstructed Construction (SP & SSU)



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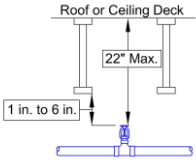
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**NFSA OBSTRUCTED CONSTRUCTION**

**Obstructed Construction (SSP & SSU)**



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

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**NFSA OBSTRUCTED CONSTRUCTION**

**Obstructed Construction (SSP & SSU)**



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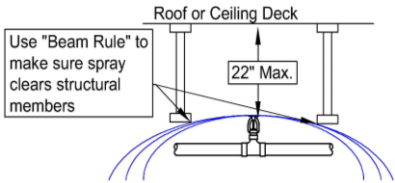
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**NFSA EXCEPTION TO OBSTRUCTED CONSTRUCTION RULE**



Sprinklers are allowed to be installed with deflectors at or above members where the distances meet section 10.2.7.2 (beam rule)

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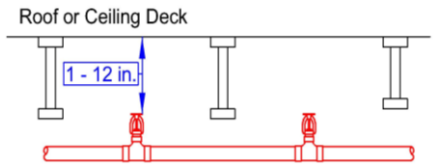
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**NFSA** EXCEPTION TO OBSTRUCTED CONSTRUCTION RULE

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



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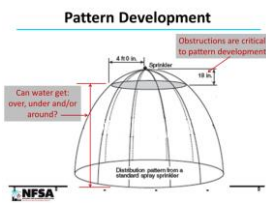
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**NFSA** SPRINKLER PATTERN DEVELOPMENT (SSP & SSU)



**Upper Zone (>18 inches)**

- Obstructions to Sprinkler Pattern Development
- > Beam, Soffit, 3x rule

**Lower Zone (>18 inches)**

- Obstructions that Prevent Sprinkle Discharge from Reaching Hazard
- > Partition Rule

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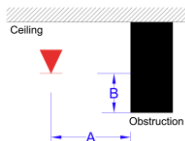
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**NFSA** BEAM RULE (SSP & SSU)

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



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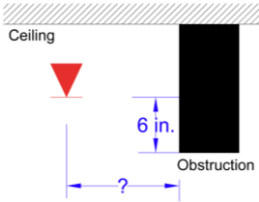
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**NFSA BEAM RULE: EXAMPLE**

If deflector is 6 in above bottom of obstruction – how far does sprinkler need to be to meet the beam rule?



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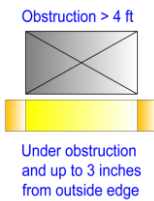
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**NFSA WIDE OBSTRUCTION RULES**



If sprinkler is not directly under obstruction – use intermediate rack type sprinkler  
 12 in maximum below bottom of obstruction  
 Sprinkler under obstruction must be same type as ceiling system (except for underneath overhead doors)



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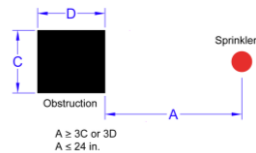
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**NFSA THREE TIMES RULE**



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

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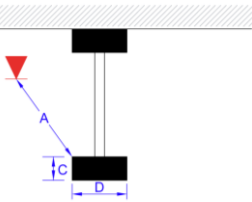
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### THREE TIMES RULE



A ≥ 3C or 3D  
up to 24 inch max.

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### TEMPERATURE RATING RULES

- Ordinary or **intermediate** temperature sprinklers shall be used throughout:
- Higher temperature sprinklers are required by other sections.
- High temperature sprinklers are permitted to be used in:
  - Ordinary hazard
  - Extra hazard
  - Storage occupancies
  - As permitted by other NFPA documents

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### PROXIMITY TO HEAT SOURCES



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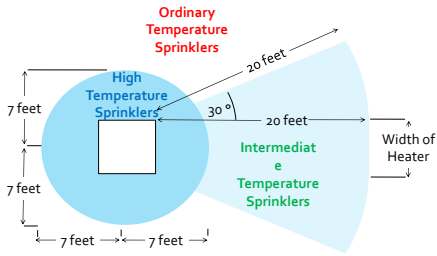
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**NFSA** HORIZONTAL UNIT HEATER – PLAN VIEW



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**NFSA** DOWNWARD DISCHARGE DIFFUSER



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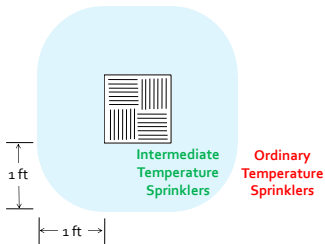
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**NFSA** DOWNWARD DISCHARGE DIFFUSER: PLAN VIEW



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## MODULE 3 SYSTEM FUNDAMENTALS – HANGING AND BRACING

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### NFSA HANGING AND SUPPORT

#### Hangers – Basic Support Rule

- Listed, or
- Performance based alternative via design professional
- Designed to support 5x weight of water-filled pipe plus 250 lbs at each point of piping support
- Attachment points adequate to support system
- Spacing not exceeded
- Components are ferrous
- Detailed calculations provided as required



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### NFSA HANGING AND SUPPORT

#### Hangers – Listing

- Unless otherwise allowed in the standard:
- Components of hanger assemblies that directly attach to pipe or building structure shall be listed
- Exceptions:
  - Mild steel hanger rods formed from mild steel rods
  - Certain fasteners identified in the standard for:
    - Concrete
    - Steel
    - Wood



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**NFSA HANGING AND SUPPORT**

**Hangers – Assembly**

- Can be a single component, or
- Separate components consisting of:
  - Attachment to building structure
  - Connecting material (e.g. rod)
  - Attachment to piping



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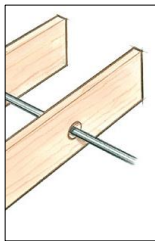
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**NFSA HANGING AND SUPPORT**

**Hangers – Components**

- Shall be ferrous, or:
  - Nonferrous if proven by fire tests
- Holes through solid structural members if:
  - Allowed by building code
  - Spacing and support rules of NFPA 13 are met



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Photo: Meyer Fire

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**NFSA HANGER INSTALLATION**

**Flexible Sprinkler Hose Fittings**

- If the flexible hose is less than 6 ft. and is supported by a suspended ceiling:
  - No hanger required



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**NFSA HANGER INSTALLATION**

**Maximum Distance Between Hangers**

- Steel pipe:
  - 1 and 1 ¼ in.: 12 ft.
  - 1 ½ in. and above: 15 ft



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**NFSA HANGER INSTALLATION**

**Maximum Distance Between Hangers**

- CPVC:
  - 3/4 in.: 5 ft 6 in.
  - 1 in.: 6 ft.
  - 1 ¼ in.: 6 ft 6 in.
  - 1 ½ in.: 7 ft.
  - 2 in.: 8 ft.
  - 2 ½ in.: 9 ft.
  - 3 in.: 10 ft



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**NFSA HANGER INSTALLATION**

**Hangers – Location**

- At least one hanger on cross mains between each two branch lines
- Exception: Steel mains in bays
- Maximum distance between hangers applies
- Not less than one hanger for each section of pipe
- Exception: Lengths less than 6 ft



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**NFSA HANGER INSTALLATION**

**Clearance to Hangers**

- The distance between a hanger and the centerline of an upright sprinkler shall not be less than 3 in.



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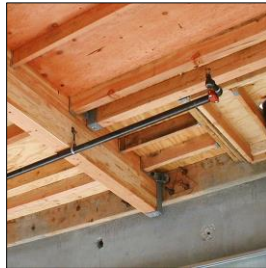
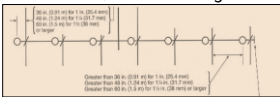
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**NFSA HANGER INSTALLATION**

**Unsupported Lengths**

- Unsupported length for steel pipe at end of branch lines limited to:
  - 36 in. for 1-inch pipe
  - 48 in. for 1-1/4-inch pipe
  - 60 in. for 1-1/2-inch and larger



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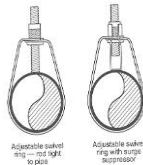
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**NFSA HANGER INSTALLATION**

**Support of Ends of Lines**

- Pendent sprinklers at 100 psi or higher under ceilings:
  - Closest hanger must prevent upward movement
  - Unsupported length limited to 12 in. for steel or 6 in. for copper
- Not applicable if flexible hose fittings are used



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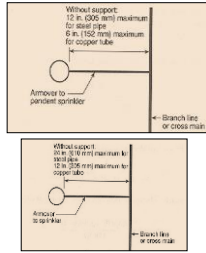
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**NFSA HANGER INSTALLATION**

**Unsupported Armovert Lengths**

- Cumulative horizontal length of unsupported armovert must not exceed 24 inch for steel...
- Exception: For pendent sprinklers at 100 psi or higher under ceilings, length limited to 12 inch for steel and closest hanger must prevent upward movement



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**NFSA HANGER INSTALLATION**

**Sprigs**

- Sprigs 4 ft or longer shall be restrained against lateral movement



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**NFSA SEISMIC PROTECTION**

**Applicability of Seismic Protection**

- NFPA 13 says "how", not "where"
- Building code generally says "where", or insurance or other AHJ may require
- Based on Risk Category and possible forces
- Most of west coast and New England, and parts of central and southeast are considered to have moderate to high earthquake potential
- Insurers such as FM have worldwide maps



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## MODULE 4 ROUGH INSPECTION OF SPRINKLER SYSTEMS

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### NFSA UNDERGROUNDS

#### Undergrounds – Piping and Fittings

- As permitted by NFPA 13 and 24
- Ductile Iron (C104)
- Plastic (C900)
- Additional piping per standard



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### NFSA UNDERGROUNDS

#### Undergrounds:

##### Protection from Freezing

- Bury Depth
  - Not less than 12" below frost line
  - Top of pipe to final grade
- If listing requires more, use that
- Heat tracing is allowed



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**NFSA UNDERGROUNDS**

**Undergrounds – Testing**

- Hydrostatic Testing
  - 200 psi for 2 hours
  - +/- 5 psi allowed
- Flushing
  - Required before connection to downstream piping
  - Flush until flow is clear of debris
  - Flow rate per NFPA 24 or max flow rate available



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**NFSA REMOTE FIRE DEPARTMENT CONNECTIONS**

**Remote Fire Department Connections**

- Located near FD access or approved location
- Drainage
  - Approved automatic drip in accessible location unless not subject to freezing
  - Approved automatic drip can be buried if discharges onto crushed stone or gravel
- When serving multiple buildings:
  - Sign provided indicating the buildings, structures or locations served



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**NFSA UNDERGROUND CERTIFICATE**

- Required prior to the aboveground piping connection to the underground.
- Documents that a flush was completed.
- May not be necessary for a rough inspection (get it prior to final).

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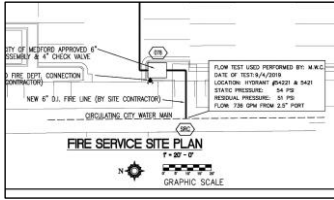
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# Check The Plans!



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## NFSA ROUGH INSPECTION

### Rough Inspection – What Is It?

- Visual comparison of installation vs plans
- Typically required as a permit condition
- Concealment of work (IBC)
- Types of Rough Inspections
  - Partial (hard lids, some rooms)
  - Full floors / systems



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## NFSA ROUGH INSPECTION

### What To Look At – Piping / Fittings

- Steel Pipe
  - Required to be listed if it does not meet one of the standards
- Specially listed if it uses a different joining technique than in NFPA 13



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**NFSA** ROUGH INSPECTION

Other Piping Materials



- CPVC – UL Listed
- Manufacturer Installation Instructions
- Copper – Type K, L, M
- Joint methods
- Hanger spacing
- Galvanized steel schedule 10 e.g.

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**NFSA** ROUGH INSPECTION

- CPVC**
- Chemical Compatibility
  - Follow manufacturer
  - Hybrid CPVC and Steel Systems



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**NFSA** ROUGH INSPECTION

- CPVC**
- Solvent Cement
  - Sprinklers not installed until fitting is cemented into place
  - Cure time
  - Follow manufacturer



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**NFSA** ROUGH INSPECTION

- CPVC**
- On-Site Storage
  - Needs UV protection
  - Follow manufacturer



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**NFSA** ROUGH INSPECTION

- What To Look At – Routing of Piping**
- Compare to drawings
  - Look for
    - Trapped sections
    - Pipe sizing
  - Minor modifications OK
- Use your judgement



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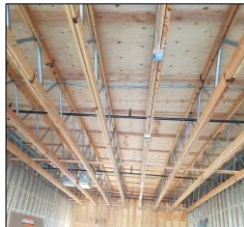
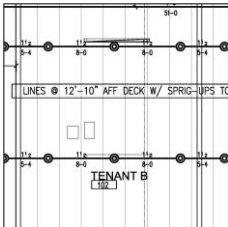
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**Check The Plans!**



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**NFSA** ROUGH INSPECTION

**What To Look At – Drainage for Wet Systems**

- Auxiliary drains required
- When pipe changes direction and will not drain through main drain
- Wet systems (above freezing)
  - 50+ gallons – 1" valve piped to accessible location
  - 5-50 gallons – min ¾" valve with cap or plug
- Less than 5 gallons:
  - Min ½" cap or plug
  - Removal of pendent sprinkler
  - Flexible coupling or similar



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**NFSA** ROUGH INSPECTION

**What To Look At – Drainage for Dry Systems**

- Auxiliary drains required
- When pipe changes direction and will not drain through main drain
- Dry systems (below freezing)
  - Must be accessible for service
- Less than 5 gallons:
  - Min 1/2" valve with cap or plug
- 5+ gallons:
  - 1 inch valves (2) and 12" piece of 2 inch pipe with cap or plug (drum drip)



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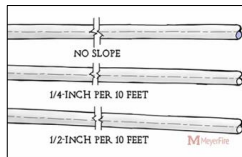
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**NFSA** ROUGH INSPECTION

**What To Look At – Drainage for Dry Systems**

- Pitching of pipe
- Allows water to drain from dry systems
- Pitched back toward the riser or valves
- 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



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Photo: Meyer Fire

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**NFSA** ROUGH INSPECTION

- What To Look At – Sprinkler Drops**
- Extends down to supply a sprinkler
  - 'Hard' drops of steel, CPVC, etc
  - Suspended ceilings may have special clearance rules in seismic zones
  - 3" clearance from drops to structural members and other mechanical elements, or use a flex drop (IBC 2018)



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**NFSA** ROUGH INSPECTION

- What To Look At – Sprinkler Drops**
- Extends down to supply a sprinkler
  - Flexible sprinkler hose fittings
  - Specific listing rules
  - Length
  - Maximum number of bends



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**NFSA** ROUGH INSPECTION

- What To Look At – Sprinkler Drops**
- Flexible sprinkler hose fittings
  - 'zip tied' to branch line piping during rough-in prior to dropped ceiling installation
  - Notice protective 'paint caps' provided to protect sprinkler



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**Concealed After the Rough Inspection**

- Upright Sprinklers
- Spacing
- Deflector distance
- Obstructed vs Unobstructed
- Special listing? Use the cut sheet!
- Attic sprinklers
- Comb. Concealed Interstitial
- Obstruction criteria



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**It's OK!**

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



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**UH OH!**

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



132

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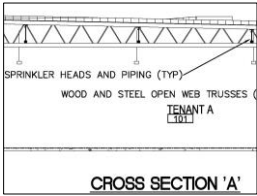
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## Check The Plans!



93

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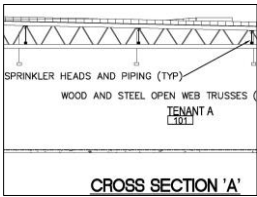
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## Check The Plans...UH OH!



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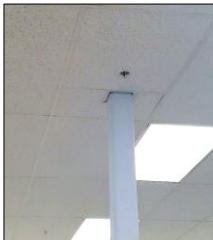
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## UH OH!

- Obstructed?
- 3 x Rule?



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**NFSA FINAL WALKTHROUGH**



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**NFSA HEAT COLLECTORS**



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**NFSA ROUGH INSPECTION**

**Concealed After the Rough Inspection**

- Dry Sprinklers
- Deflector distance
- Exposed barrel length?



Ambient Temp. at Sprinkler (°F)	EXPOSED BARREL AMBIENT TEMP (°F)		
	5°F	30°F	50°F
44	2	2	4
54	4	4	6
64	6	6	8
74	8	8	10
84	10	10	12
94	12	12	14
104	14	14	16
114	16	16	18
124	18	18	20
134	20	20	22
144	22	22	24
154	24	24	26



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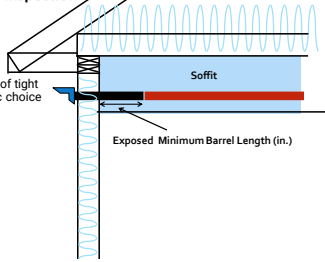
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**NFSA APPLICATION OF DRY BARREL SPRINKLERS**

**Concealed After the Rough Inspection**

- Dry Sprinklers
- Deflector distance
- Exposed barrel length?
- Criteria is based on assumption of tight seal at exposed end and realistic choice of ambient temperature



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**NFSA ROUGH INSPECTION**

**Concealed After the Rough Inspection**

- Venting
- Required for wet systems utilizing metallic piping
- Can be manual or automatic
  - Manual – min. ½" valve
  - Automatic air vent
  - Remote inspectors test valve
  - Other approved means
- Manual should be accessible
- Located near a high point



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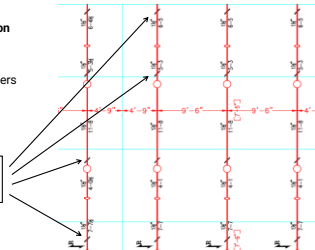
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**NFSA ROUGH INSPECTION**

**Concealed After the Rough Inspection**

- Hangers
- Attachments
- Maximum distance between hangers
- Unsupported lengths
- Unsupported armovers

Hanger Symbols



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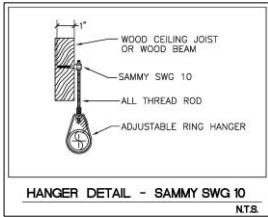
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## Check The Plans!



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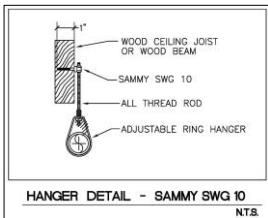
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## Check The Plans...UH OH!



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## UH OH!

•Allowed Hanger?



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# UH OH!

• Allowed Hanger?



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## NFSA ROUGH INSPECTION

### Concealed After the Rough Inspection

- Hangers
- Max. distance between hangers
- Steel pipe:
  - 1 and 1 ¼ in.: 12 ft.
  - 1 ½ in. and above: 15 ft.



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## NFSA ROUGH INSPECTION

### Concealed After the Rough Inspection

- Hangers
- Unsupported lengths at end of branch line
  - 36 in. for 1-inch pipe
  - 48 in. for 1-1/4-inch pipe
  - 60 in. for 1-1/2-inch and larger pipe



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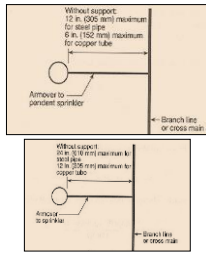
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**NFSA** ROUGH INSPECTION

**Concealed After the Rough Inspection**

- Hangers
- Unsupported armovers
- Max cumulative 24" for steel, or
- Max 12" for pendent in ceiling with 100 psi or higher, and;
- Must prevent upward movement



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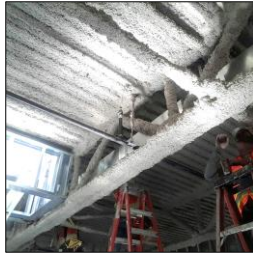
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**NFSA** ROUGH INSPECTION

**Concealed After the Rough Inspection**

- Hangers
- Spray-on fireproofing
- It is concealed work
- Hangers and fireproofing might be installed months before piping



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**NFSA** ROUGH INSPECTION

**Concealed After the Rough Inspection**

- Bracing
- Compare to drawings
- Spaced via a brace calculation
- Lateral
- Longitudinal



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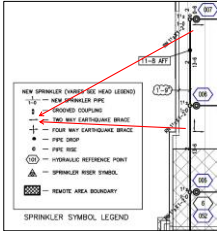
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# Check The Plans!



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# NFSA ROUGH INSPECTION

- Concealed After the Rough Inspection**
- Hydrostatic Testing
  - Piping and fittings
  - 200 psi for 2 hours without loss
  - Loss determined by drop in gauge pressure or visual leakage
  - Leaks? Retest or correct as noted?
  - Use your judgement
  - Phasing:
    - Sections of floors, etc, keep track



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# NFSA DOCUMENTATION

- Documentation**
- Keep track of 'phased' installations
  - Hydrostatic test(s) on each floor?
  - Specialty components installed?
    - Do an internet search for the cut sheet

Lafayette Fire Department Sprinkler "Pre-Acceptance" Test Checklist	
<p><small>This checklist is for use by the Fire Department and is not intended to be used as a substitute for the NFPA 13 code. The Fire Department is not responsible for any damage to property or injury to persons resulting from the use of this checklist.</small></p>	
<p>Project Name: _____</p> <p>Address: _____</p> <p>Contractor Name: _____</p> <p>Contractor License No.: _____</p> <p>Inspector Name: _____</p> <p>Inspector License No.: _____</p> <p>Inspector Title: _____</p>	
<p><b>GENERAL INFORMATION</b></p>	
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	1. All areas to be tested shall be on the same floor, level, and area.
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	2. All areas to be tested shall be on the same floor, level, and area.
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	3. All areas to be tested shall be on the same floor, level, and area.
<p><b>TESTING PROCEDURE</b></p>	
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	1. Verify that the test pressure is 200 psi for 2 hours.
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	2. Verify that the test pressure is 200 psi for 2 hours.
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	3. Verify that the test pressure is 200 psi for 2 hours.
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	4. Verify that the test pressure is 200 psi for 2 hours.
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	5. Verify that the test pressure is 200 psi for 2 hours.
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	6. Verify that the test pressure is 200 psi for 2 hours.
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	7. Verify that the test pressure is 200 psi for 2 hours.
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	8. Verify that the test pressure is 200 psi for 2 hours.

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## MODULE 5 FINAL INSPECTION OF SPRINKLER SYSTEMS

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### NFSA FINAL WALKTHROUGH

#### Occupancy Hazard / Commodities

- Does the installation correlate with the Owner's Certificate and stated use?
- 'Spec' or 'Shell' building?
- Have some areas been fitted out / improved?
- If so, additional permitting may be needed



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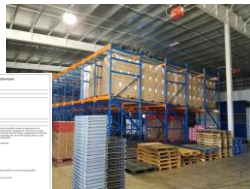
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### NFSA FINAL WALKTHROUGH

#### Occupancy Hazard / Commodities

- Does the installation correlate with the Owner's Certificate and stated use?
- Storage application?
- IFC Approved storage layout
- Rack layout, top of storage, commodities, pallet types, etc



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**NFSA** FINAL WALKTHROUGH

**Obstructions**

- Not present during the rough inspection



Ducts and other building systems



Building features that weren't built yet

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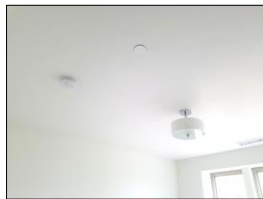
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**NFSA** FINAL WALKTHROUGH

**Escutcheons / Trim**

- Escutcheons on
- Caps/straps removed?
- Painted sprinklers?



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**UH OH!**

**What Happened?**

- Write it down for correction



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## UH OH!

- What Happened?
- Write it down for correction



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## UH OH!

- What Happened?
- Write it down for correction



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## It's OK!

- Escutcheon in place



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## 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



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## UH OH!

•Sprigs 4 feet or longer need restraint against lateral movement



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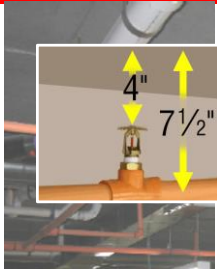
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## UH OH!



- Per the listing for CPVC
- 4" maximum from ceiling to deflector and 7.5" from ceiling to CPVC

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## UH OH!

- Bends are too tight



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## UH OH!

- Sidewall sprinklers cannot be installed back-to-back without a lintel or soffit.
- Section 8.7.3.1.4



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## UH OH!

- Ball drip installed at wrong location



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# UH OH!

- Paddle-type flow switches not permitted on dry systems



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## NFSA FINAL WALKTHROUGH

### Heat Sources

- Radiant heaters
  - Located where indicated on plans?
- Fireplaces
- Diffusers
  
- Appropriate temperature rating for sprinklers?
- Intermediate temperature can be used throughout ordinary and light hazard



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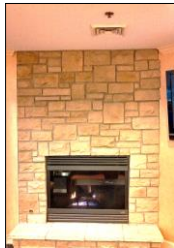
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## NFSA FINAL WALKTHROUGH

### Heat Sources

- Radiant heaters
  - Located where indicated on plans?
- Fireplaces
- Diffusers
  
- Appropriate temperature rating for sprinklers?
- Intermediate temperature can be used throughout ordinary and light hazard



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**NFSA** FINAL WALKTHROUGH

**Signage**

- Control valves
- Drain valves
- Venting and test connection valves
- Permanently marked metal or rigid plastic signs.
  - Secured with corrosion resistant means



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**NFSA** FINAL WALKTHROUGH

**Signage**

- Control Valve
  - Identifies portion of the building served
  - Multiple valves



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**NFSA** FINAL WALKTHROUGH

**Signage**

- Test connections
- Drains



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**NFSA FINAL WALKTHROUGH**

- Signage**
- Test & Drain



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**NFSA FINAL WALKTHROUGH**

- Signage**
- Hydraulic Nameplate
  - Installed by contractor
  - Install near or on valve:
  - Alarm valve / Wet system
  - Dry
  - Preaction
  - Deluge



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**NFSA FINAL WALKTHROUGH**

- Signage**
- General Information Sign
  - Installed by contractor
  - System control riser, antifreeze loop and auxiliary control valves.
  - Required by NFPA 25 also



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**NFSA FINAL WALKTHROUGH**

**Approved Storage Layout**

- New to the 2018 IFC
- Required when building use falls under provisions of Chapter 32 High Piled Combustible Storage
- All of the storage-related design info posted on the wall
  - Commodities
  - Top of storage
  - Aisles / array, etc
  - More



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**NFSA FINAL WALKTHROUGH**

**Pump and Riser Rooms**

- IBC
- Space
  - Requires 'adequate' space for:
    - Repair, service replacement of equipment
- Access
  - Can be locked, but key needs to be available
- Marking of Door
  - Labeled with approved sign
    - Contrast to background
    - 2 inch letters, min 3/8" stroke



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**NFSA FINAL WALKTHROUGH**

**Stock of Spare Sprinklers**

- Minimum number of spare sprinklers
  - Under 300 sprinklers in premises: Min 6
  - 300-1000 sprinklers in premises: Min 12
- Sprinklers shall correspond to types and temperatures of installed sprinklers
- Kept in cabinet in conditioned space
- One wrench for each type
- List provided in cabinet
  - Head legend from drawing has the info



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**THANK YOU!!**

John Swanson, CPFS  
Codes & Standards Specialist  
National Fire Sprinkler Association  
Swanson@nfsa.org  
443-863-4406



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