Residential Fire Sprinklers for Plumbing Officials

ICC PMG Membership Council
October 18, 2016

PURPOSE

Provide plumbing officials the ability to evaluate the important aspects of residential fire sprinkler systems: connections to potable or standalone water supplies, systems components, operational performance and tests/inspections.
LEARNING OBJECTIVES

At the end of the course, you will be able to:

1. Describe the type of occupancies where residential fire sprinkler systems may be installed.
2. List the three primary fire sprinkler design and installation standards for residential sprinkler systems.
3. Identify five different connection means between residential fire sprinkler systems and their water supplies.
4. Identify fundamental components required for residential fire sprinklers.
5. Explain the required tests and inspections for residential sprinkler systems.

APPLICATIONS/STANDARDS
OCCUPANCIES

• Dwelling
• Dwelling unit
• Manufactured home
• Modular construction
• Residential occupancies
  – National Fire Protection Association (NFPA) and International Residential Code (IRC) definitions
• Townhouse

SPRINKLER STANDARDS

• NFPA 13, Standard for the Installation of Sprinkler Systems
  – Commercial and industrial type buildings
  – Residential more than four stories
• NFPA 13R, Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies
  – Multifamily residential up to and including four stories, not to exceed 60 feet above grade
Low-Rise Pedestal Buildings

- Dwelling Floor 4
- Dwelling Floor 3
- Dwelling Floor 2
- Dwelling Floor 1 Type VA (typical)
- Parking Garage Type I or open IV

One-hour separation

Grade entrance

NTE 60 feet

Story count from here

SPRINKLER STANDARDS

- NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*
  - One- and two-family dwellings
  - Manufactured homes
  - Townhouses

- IRC P2904
  - One- and two-family dwellings
  - Townhouses
WATER SUPPLIES

WATER SUPPLY OPTIONS

• Must be from a "reliable" source
• Municipal authority, private provider, or domestic well of adequate capacity
  – Service size
  – Dedicated supply
  – Combined supply
  – Multipurpose system
• Nonpressurized tank with electric pump
• Pressure tank
  – Compressed air or inert gas
ALTERNATE NO. 2

To Sprinkler System

Check Valve

Sprinkler Shutoff (Optional)

To Domestic System

Domestic Shutoff

Pressure Gauge

Pressure Gauge

Main Control Valve

Water Meter

City Control Valve

City Water Main

Drain and Test Connection

Plan View

Source: NFPA 13R/13D

CROSS-CONNECTION CONTROL

- Not required by standards unless connected to potable system and antifreeze is used
WATER METERS/BACKFLOW

- Not required as part of sprinkler design standards
  - Check with local water purveyor
- Can have serious negative affect on waterflow due to friction loss
  - As flow increases, so does friction loss
  - Refer to meter manufacturer for loss values

METER INFLUENCE (SAMPLE)

Pressure Loss (psi) in Various Meter Sizes

<table>
<thead>
<tr>
<th>Meter size (in.)</th>
<th>18 gpm</th>
<th>23 gpm</th>
<th>26 gpm</th>
<th>31 gpm</th>
<th>39 gpm</th>
<th>52 gpm</th>
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<tr>
<td>5/8</td>
<td>9</td>
<td>14</td>
<td>18</td>
<td>26</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>3/4</td>
<td>4</td>
<td>8</td>
<td>9</td>
<td>13</td>
<td>*</td>
<td>*</td>
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<td>2</td>
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<td>4</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>1</td>
<td>**</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>7</td>
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<td>2</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

* Above maximum flow of commonly available meters.
** Less than one pound per square inch (psi).
METER (SAMPLE)

Neptune Model T-10 5/8-inch domestic meter loss

STORED WATER SUPPLIES

• Must meet sprinkler design flow rates for minimum time
• NFPA 13D/IRC P2904
  – Two sprinklers* x 7 minutes
    -- One-story dwelling less than 2,000 ft²
  – Two sprinklers* x 10 minutes
    -- Two- or more story dwelling or more than 2,000 ft²
• NFPA 13R
  – Four sprinklers x 30 minutes

* See exception for single sprinkler in largest room.
NON-PRESSURIZED TANK

• Plastic or metal container
  – 182-350 gallons
    -- Fit through standard door
    -- Plumbed for refill
• Point load considerations
  -- 8.55 lb/gallon
  -- 62.4 lb/cubic foot

NON-PRESSURIZED TANK

• Electric pump
  – Sized to deliver required flow at needed pressure
  – Separate standby or emergency power not required
  – Fire protection listing not required
  – 240-volt normal circuit
  – Elevated above floor
PRIVATE WELL

Sample system demand = 260 gallons

Well casing capacity and/or refresh rate = 260 gallons

COMBINED WELL / STORAGE

Tank = 200 gallons
Well casing capacity = 60 gallons
Sample system demand = 260 gallons

INTERNATIONAL CODE COUNCIL
SYSTEM DESIGN

SYSTEM TYPES

• Wet pipe
  – Where temperature above 40°F can be maintained
• Dry pipe
  – Must have sprinklers listed for dry-pipe systems
• Pre-action
  – Must have sprinklers listed for dry-pipe systems
• Water/Antifreeze
  – Food grade glycerin
SYSTEM COMPONENTS

- Water supply
- Valves
- Alarm
- Pipe
- Hangers
- Sprinklers

CONTROL VALVES

- Indicating and non-indicating
  - For combined domestic/fire
    -- Control valve must shut off both
  - Multipurpose sprinkler system may not have control valve unless
    -- Electronically supervised, or
    -- Locked in "open" position
DRAIN AND TEST APPARATUS

• All systems must have drain valve
  – Should drain to safe location
    -- Back into tank for stand-alone systems
  – May be combined with flow test valve
    -- If waterflow alarm is provided

PRESSURE GAUGES

• NFPA 13D/P2904
  – Not required on wet pipe
    • Air pressure gauge required on dry-pipe and/or pressure-tank systems

• NFPA 13R
  – On supply and system sides of main control valve
SUPERVISORY/WATERFLOW

• Supervisory **not required** for combined domestic/fire service
  – Locked main control valve for standalone
• NFPA 13D/IRC P2904
  – **not required** if building provided with smoke detection
• NFPA 13R
  – Required
  – If building has fire alarm system, must be connected

ALARM

• Alarm to notify occupants that water is flowing
  – Bell, siren, or horn
  – Required in one- and two-family **only** if no smoke alarms
  – Installed in accordance with NFPA® 72, *National Fire Alarm Code* and manufacturer's specifications
FIRE DEPARTMENT CONNECTION

• NFPA 13D/IRC P2904
  – Not required

• NFPA 13R
  – When building is accessible to fire department, and,
  – More than 2,000 ft², or,
  – More than one story.

SPRINKLER PIPE

• May be one or a combination of:
  – Black iron or steel
  – Type K, L, or M copper

• Plastic
  – CPVC
  – PEX
BLACK IRON OR STEEL

- Schedule 40, 30, 10, 7, or 5
- May be installed exposed
  - Typical unfinished basement
  - NFPA 13D
    -- Generally not larger than 1-inch diameter
  - NFPA 13R
    -- Size dependent on number of sprinklers supplied

COPPER

- Types K, L, M
  - IRC P2904 recognizes Type M only
- May be installed exposed
  - Typical unfinished basement
  - NFPA 13D/IRC P2940
    -- Generally not larger than 1-inch diameter
  - NFPA 13R
    -- Size dependent on number of sprinklers supplied
CHLORINATED POLYVINYL CHLORIDE

• Generally sized 3/4- to 1 1/2-inch
• Listed for fire protection service
• Concealed locations:
  – Must have a thermal barrier
    • 3/8-inch gypsum wallboard
    • 1/2-inch plywood veneer
    • Suspended membrane metal-grid ceiling with lay-in panels or tiles having a minimum weight of not less than 0.35 lb/ft²

CHLORINATED POLYVINYL CHLORIDE

• Chemical/product compatibility
• Use only manufacturer-approved
  – Solvents
  – Cements
  – Sealants

For latest:
www.systemcompatible.com

Avoid
  – Cutting and packing oils
  – Non-water-based paints
  – Pipe thread paste and dope
  – Adhesive tape
EXPOSED INSTALLATIONS

• Beneath smooth, flat ceiling with FS-5 one-step solvent.
• Listed, quick-response sprinklers
  – Max. temperature rating 170°F
  – Deflectors within 8 inches of ceiling
• Listed, quick-response pendent sprinklers
  – Max. temperature rating 170°F
  – Max. distance between sprinklers 15 feet
  – Pipe ceiling mounted
• Refer to manufacturer’s installation guide for other applications

CROSS-LINKED POLYETHYLENE

• Must have a thermal barrier
  – Same as exposed CPVC
  – Size ranges from 1/2- to 2-inch
• Listed for fire protection service in one- and two-family
• Intended for network combination systems
  – Must meet National Sanitation Foundation (NSF) potability standards
SYSTEM LAYOUTS

• Tree

SYSTEM LAYOUTS

• Grid
NETWORK OR LOOPED

Plan View

NETWORK SYSTEM

• Aquasafe®
• Network
  – Proprietary design
  – ≥ 1/2-inch cross-linked polyethylene (PEX)
    • Limited number of domestic connections between sprinklers
PIPE HANGERS

HANGER SPACING

• Prevent routine pipe movement or vertical displacement when sprinkler operates
  – Black iron/steel: One hanger per pipe section
  – Copper: Follow plumbing code
  – Nonmetallic: Follow manufacturer guidelines

2016 ICC Annual Conference Education Programs
Kansas City, MO
NFPA 13D/13R OMISSIONS

• Attics
• Garages and carports
• Open porches or balconies*
• Bathrooms less than 55 ft²
• Closets/pantries less than 24 ft²
  • Least dimension less than 3 feet
  • Walls/ceilings
  • N/C or limited combustible materials

*I-Codes have requirement for Group R balconies and decks, plus open-ended corridors.

OMISSIONS

• No sprinklers required in:
  – Floor/ceiling spaces
  – Elevator shafts
  – Crawlspace, and
  – Other concealed spaces not used or intended for living purposes and do not contain fuel-fired equipment.
OPEN-ENDED CORRIDOR

Elevation View

Plan View

SPRINKLER SELECTION
UL SPRINKLER STANDARDS

• UL Standard for Automatic Sprinklers for Fire Protection Service

• UL 1626 Standard for Residential Sprinklers for Fire Protection Service

• UL 1767 Standard for Early-Suppression Fast-Response Sprinklers

RESIDENTIAL SPRINKLERS

• Must be listed by Underwriters Laboratories (UL) or other agency for residential use
  – Bear mark "Residential Sprinkler" or "RES SPKR"
  – Operational range 135 to 170 °F in most occupied spaces
  – May be exposed or concealed

• Response Time Index (RTI)
• Water distribution pattern
WATER DISTRIBUTION PATTERN

Control Mode: Property Protection

Control Mode: Residential

Courtesy: Tyco Fire Suppression & Building Products

SPRINKLER ID NUMBER (SIN)

- Sprinkler manufacturer's proprietary 5- or 6-character identification for:
  - Manufacturer
  - K-factor
  - Application (use)
  - Response characteristics
- Refer to manufacturer's technical literature for guidance
PLACEMENT DETAILS

• Always follow listing details
• For residential sprinklers without specific positioning criteria:
  – Pendent and upright
    -- 1 to 4 inches from ceiling
    -- In closets within 12 inches of ceiling
  – Sidewall
    -- 4 to 6 inches from ceiling

INTERMEDIATE TEMPERATURE
(175 to 225 °F)

<table>
<thead>
<tr>
<th>Heat Source</th>
<th>Range (inches)</th>
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<tbody>
<tr>
<td>Fireplace, side of open or recessed</td>
<td>12 to 36</td>
</tr>
<tr>
<td>Fireplace, front of recessed</td>
<td>36 to 60</td>
</tr>
<tr>
<td>Coal or wood stove</td>
<td>12 to 42</td>
</tr>
<tr>
<td>Kitchen range top</td>
<td>9 to 18</td>
</tr>
<tr>
<td>Oven</td>
<td>9 to 18</td>
</tr>
<tr>
<td>Vent or chimney connector</td>
<td>9 to 18</td>
</tr>
<tr>
<td>Uninsulated heat duct</td>
<td>9 to 18</td>
</tr>
<tr>
<td>Uninsulated hot water pipe</td>
<td>6 to 12</td>
</tr>
<tr>
<td>Side of ceiling or wall warm air register</td>
<td>12 to 24</td>
</tr>
<tr>
<td>Front of wall warm air register</td>
<td>18 to 36</td>
</tr>
<tr>
<td>Water heater, furnace or boiler</td>
<td>3 to 6</td>
</tr>
<tr>
<td>Luminaire up to 250 watts</td>
<td>3 to 6</td>
</tr>
<tr>
<td>Luminaire 250 to 499 watts</td>
<td>6 to 12</td>
</tr>
</tbody>
</table>
HYDRAULIC DESIGN

• Uses sophisticated mathematical calculations to verify that the water supply’s pressure and volume are able to:
  – Provide enough flow at the correct pressure to each sprinkler to control a fire
  – Develop enough flow at the correct pressure to all the sprinklers to that are likely to open in a fire
A FEW WORDS ABOUT WATER MIST

- High, intermediate and low pressure water mist systems may be proposed as an alternative to sprinklers
  - Must meet NFPA 750 Standard on Water Mist Fire Protection Systems
  - Listed for Light and Ordinary Hazard occupancies

INSPECTIONS/TESTS
INSPECTIONS/TESTS

• Pre-conceal
  – Sprinklers installed in all required areas
  – Obstructions are addressed
    • Cabinets, fans, luminaires
  – Correct sprinklers and temperature rating
  – Pipe sizes and length are per plans or tables
  – Non-metallic pipe is listed for fire service
  – Pipe is supported per manufacturer’s requirements

INSPECTIONS/TESTS

• Final
  – Sprinklers not painted, damaged or hindered
  – Pump, if installed, starts and runs on system flow
    • Open test and drain assembly
  – Other impairments not installed
    • PRV, water softeners, water filters
  – Required signage in place for combination systems
  – Owner’s manual provided
WARNING

The water system for this home supplies fire sprinklers that require certain flows and pressures to fight a fire.

Devices that restrict the flow or decrease the pressure or automatically shut off water to the sprinkler system, such as water softeners, filtration systems and automatic shutoff valves, shall not be added to this system without a review of the fire sprinkler system by a fire protection specialist.

Do not remove this sign.

INSPECTIONS/TESTS

• Tests
  – If no fire department connection
    • Normal system pressure for 15 minutes, or,
    • Air test at 50 psi for 15 minutes
  – If fire department connection installed
    • 200 psi for two hours taken at system low point
  – Standalone water supply
    • Pump starts automatically and runs for 10 minutes
  – “Bucket” test
    • Proprietary, not required by codes or standards
SUMMARY

You should be able to:

1. Describe the type of occupancies where residential fire sprinkler systems may be installed.

2. List the three primary fire sprinkler design and installation standards for residential sprinkler systems.

3. Identify five different connection means between residential fire sprinkler systems and their water supplies.

4. Identify fundamental components required for residential fire sprinklers.

5. Explain the required tests and inspections for residential sprinkler systems.

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