Residential Sprinklers – Issues and Answers

Your Instructor
Jeffrey M. Shapiro, PE
Executive Director
IRC Fire Sprinkler Coalition

The IRC Fire Sprinkler Coalition
• Not-for-profit association representing more than 80 national, state and local code official, fire service and safety organizations, including associations representing 38 states, all of whom support residential sprinklers
• Formed to help mainstream sprinklers into new residential construction

The Goal of Today's Program
• Help you to understand the facts about residential fire sprinkler systems

Two Biggest Obstacles to Residential Sprinklers
1. Momentum
2. Fear of the unknown

Two Biggest Obstacles to Residential Sprinklers
1. Momentum
   - We tend to do things the same old way
   - Effective approaches to pipe sizing (loops), sprinkler spacing, and use of pumps and/or tanks can reduce cost
Two Biggest Obstacles to Residential Sprinklers

2. Fear of the unknown
   - Many folks who oppose residential sprinklers have never seen a residential sprinkler system

THE SOLUTION IS BOTH OBSTACLES IS EDUCATION
What is an NFPA 13D Residential Sprinkler System

Water Supply

Residential Sprinkler System What It’s Not

Smoke alarm is the alarm

Fire Sprinkler Facts

1. Sprinklers operate individually
2. Sprinklers operate based on heat
   - Not smoke
3. Sprinklers use small amounts of water to put out a fire
   - Typically less than 20 gallons/min

It’s All About Time

- From the time that a fire starts in a home, how long do you have to get out?
- It’s a matter of minutes…or less
It's All About Time

Time vs. Products of Combustion

What’s “Flashover”
- Fire is not what Hollywood portrays in TV or movies

By Preventing Flashover
- Residential Sprinklers Save Lives

By Preventing Flashover
- Residential Sprinklers Save Property Too
- A secondary benefit to residential sprinklers is property protection
- This home was not protected with sprinklers

Fire Results
- At the conclusion of the fire, all that remained of the 4,000+ square foot home was the foundation

Difference with Sprinklers
- A similar size home in the same jurisdiction was protected with a residential sprinkler system
- No one died, and there was minimal damage to one room of the house

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Residential Sprinkler Systems
The Technical Stuff

- Discussion Topics
  - Standards
    - Unique Aspects of Residential Sprinklers
    - Sprinkler Location and Spacing
    - Piping Alternatives and Considerations
    - Basic Hydraulics
    - Inspection and Design Considerations

Sprinkler Standards

- There are three nationally recognized standards that govern fire sprinkler systems
  - NFPA 13 – commercial occupancies
  - NFPA 13R – multifamily residential to 4 stories
  - NFPA 13D – one- and two-family dwellings

Purpose of NFPA 13D

- The purpose of NFPA 13D is to:
  - Prevent flashover to assist in escape from a fire (within 10 minutes)
  - Save lives
  - Low cost

NFPA 13D is Based on More than 30 Years of Fire Tests

- Piping and sprinklers for residential sprinkler systems must undergo extensive fire testing
- These tests involve full-scale fires that severely challenge the equipment

Some of the Differences Between NFPA 13R and 13D

- NFPA 13R
  - Any residential building up to 4 stories in height
  - Sized for four sprinklers maximum
  - Many listed components required
  - Piping must be separate system
  - Garages must be sprinklered

- NFPA 13D
  - One and two family dwellings only
  - Sized for two sprinklers maximum
  - Minimal listed components
  - Piping can be separate or multipurpose serving plumbing fixtures
  - Garages do not have to be sprinklered

Discussion Topics

- Standards
- Unique Aspects of Residential Sprinklers
- Sprinkler Location and Spacing
- Piping Alternatives and Considerations
- Basic Hydraulics
- Inspection and Design Considerations
Residential Sprinklers – Issues and Answers

Types of Sprinklers

- Residential systems rely on a special residential sprinkler
- Variety of sprinklers available
- The sprinkler is designed to protect human life
  - Even in the room of fire origin

Residential Sprinklers

- Residential Sprinklers must respond quickly to control the fire
  - Small fire requires less water to control
  - Maintain tenability
  - Be attractive or hidden
- Water spray must be higher on wall

UL 1626 Standard

- UL 1626 provides a test protocol for residential sprinklers
  - A full-scale fire test is included

UL 1626 Fuel Package

- A wood crib
- Two simulated sofa ends covered with foam
- Two sheets of ¼ in (6.3 mm) Douglas fir plywood
- One pan with heptane and two heptane soaked cotton wicks

UL 1626 Pass/Fail Criteria

- Maximum temperature adjacent to the sprinkler 3” below the ceiling and 8” horizontally away is 600°F
- Maximum temperature - 5’-3” above the floor and half the room length away from each wall is 200°F.
  - Temperature cannot exceed 130°F for more than a 2 minute period.
- Maximum temperature ¼” behind the finished surface of the ceiling material directly above the test fire is 500°F.
- No more than two residential sprinklers in the test enclosure can operate.

UL 1626 – Minimum Flow Rate

Minimum rated sprinkler flow rates 0.05 gpm/ft²

<table>
<thead>
<tr>
<th>Sprinkler, Standard, and Combination Flow</th>
<th>Minimum Flow, gpm/ft²</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 x 12 (5.7 x 5.7)</td>
<td>9 (gpm)</td>
</tr>
<tr>
<td>14 x 14 (6.3 x 6.3)</td>
<td>11 (gpm)</td>
</tr>
<tr>
<td>16 x 16 (6.3 x 6.3)</td>
<td>13 (gpm)</td>
</tr>
<tr>
<td>18 x 18 (6.3 x 6.3)</td>
<td>17 (gpm)</td>
</tr>
<tr>
<td>20 x 20 (6.3 x 6.3)</td>
<td>20 (gpm)</td>
</tr>
</tbody>
</table>

Note: The table is based on the minimum sprinkler spacing effective for those sprinklers in the table (and not less than the requirements of a full-scale test). Used with permission.
Residential Sprinklers – Issues and Answers

Residential Sprinkler Water Distribution

• In residential uses, contents are typically at the perimeter vs. centered in commercial uses
• To prevent flashover, it is beneficial to throw the water high
  – Must wet all walls within coverage area 28” below the ceiling

Sprinkler Water Distribution

Standard Spray Sprinkler
Residential Sprinkler

Sprinkler Response Time

• There are many factors that affect the response time of an automatic sprinkler:
  – Ceiling height
  – Room size
  – Sprinkler spacing
  – Distance below ceiling
  – Thermal sensitivity

Thermal Sensitivity

• The thermal sensitivity of a sprinkler is determined by a Response Time Index (RTI)
• The RTI establishes how quickly the sprinkler will activate in a fire
• Air temperature at the sprinkler exceeds the rated operating temperature when the sprinkler operates due to “thermal lag”

Plunge Test for RTI

• The plunge test permits determination of the Response Time Index (RTI)
• It records gas velocity, gas temperature, sprinkler operation time & temperature
Heat Fin Sprinklers

- The sprinkler has small fusible solder element
- Heat from a fire melts solder and internal components fall away
- Sprinkler activates; deflector drops into position

Glass Bulb Sprinklers

- Glass bulbs contain fluid.
- Fluid expands when exposed to heat.
- At rated temperature, fluid expands, breaking bulb.
- Water flows on fire.

Glass Bulb Activation

Concealed Sprinklers

- For concealed sprinklers, the cover plate is soldered on.
- The cover plate releases first.
- Followed by the sprinkler link.

Concealed Pendent Sprinkler

Adjustment of Sprinklers

- Concealed sprinklers allow the adjustment of the cover plate.
- Each sprinkler has a certain distance of play to install the sprinkler.
Fusible Link Sprinklers

- Fusible link has two halves joined by solder.
- At temperature, solder melts and two halves separate.
- Design forces the fusible link out of the way of water flow.

Advances in Technology

- The original minimum flow rate for residential sprinklers in 1980 was:
  - 18 gpm for one sprinkler
  - 13 gpm each for two if any room/compartment contains two or more sprinklers
- The original spacing was 12x12

Advances in Technology

- Today, through advances in technology, sprinklers can use 50% less water
- Minimum operating pressure of only 7 psi
- Spacing can be up to 20x20

Advances in Technology

- Reduced water demand and increased spacing has significantly reduced the cost of residential sprinkler systems
- They’ve been in the range of $1.00/sqft since the 1980s

Listed Sprinkler Flow Rates

Manufacturer Literature Will Specify Maximum Spacing for a Given Flow

<table>
<thead>
<tr>
<th>Minimum Cover Area (ft²)</th>
<th>Sprinkler Rating</th>
<th>Minimum Flow Rate (gpm)</th>
<th>Minimum Operating Pressure (psi)</th>
<th>Maximum Spacing (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>1</td>
<td>18</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>13</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>25</td>
<td>1</td>
<td>18</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>25</td>
<td>2</td>
<td>13</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>35</td>
<td>1</td>
<td>18</td>
<td>15</td>
<td>12</td>
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<tr>
<td>35</td>
<td>2</td>
<td>13</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>45</td>
<td>1</td>
<td>18</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>45</td>
<td>2</td>
<td>13</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

Discussion Topics

- Standards
- Unique Aspects of Residential Sprinklers
- Sprinkler Location and Spacing
- Piping Alternatives and Considerations
- Basic Hydraulics
- Inspection and Design Considerations
Pendent Requirements

- A pendent sprinkler must be located within 1 to 4 inches of the finished ceiling.
- When plastic escutcheons are used, they must be specifically listed.

Pendent Sprinkler Coverage

- Each residential sprinkler has a listed area of coverage:
  - Cannot exceed 400 sqft
- Typical areas of coverage are:
  - 12’ x 12’ 18’ x 18’
  - 14’ x 14’ 20’ x 20’
  - 16’ x 16’

Minimum Spacing Between Sprinklers

- The minimum spacing between sprinklers is typically 8 feet:
  - Prevents a "cold solder" condition due to wetting from adjacent sprinkler

Obstructions To Flow

- Obstructions to water flow must be considered when locating sprinklers:
  - Soffits
  - Light fixtures
  - Ceiling fans

Sidewall Sprinkler Coverage

- Each residential sprinkler has a listed area of coverage defined by the listing:
  - Cannot exceed 400 sqft
- Typical areas of coverage are:
  - 12’ x 12’ 16’ x 18’
  - 14’ x 14’ 16’ x 20’
  - 16’ x 16’
Residential Sprinklers – Issues and Answers

Distance from Ceiling

- The standard distance of a sidewall sprinkler from the ceiling to the deflector is 4 to 6 inches.
- Certain listed sidewall sprinklers allow that distance to be extended to 12 inches.

Minimum Spacing Between Sidewall Sprinklers

- The minimum distance permitted between sidewall sprinklers is 8 feet.
  - Unless listed for another distance

Sidewall Sprinkler Obstructions

<table>
<thead>
<tr>
<th>Distance from Sprinkler to side obstruction (B)</th>
<th>Distance from deflector to bottom of obstruction (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1-1/2 feet</td>
<td>0&quot;</td>
</tr>
<tr>
<td>1-1/2 feet to less than 3 feet</td>
<td>1&quot;</td>
</tr>
<tr>
<td>3 feet to less than 4 feet</td>
<td>2&quot;</td>
</tr>
<tr>
<td>4 feet to less than 6-1/2 feet</td>
<td>3&quot;</td>
</tr>
<tr>
<td>6-1/2 feet to less than 8 feet</td>
<td>7&quot;</td>
</tr>
<tr>
<td>8 feet to less than 10 feet</td>
<td>9&quot;</td>
</tr>
<tr>
<td>10 feet to less than 12 feet</td>
<td>11&quot;</td>
</tr>
<tr>
<td>12 feet to less than 14 feet</td>
<td>14&quot;</td>
</tr>
</tbody>
</table>

Spacing - Heat Sources

<table>
<thead>
<tr>
<th>Heat Source</th>
<th>Minimum Spacing Required from Edge of Source to Sprinkler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side of open or recessed fireplace</td>
<td>36 12</td>
</tr>
<tr>
<td>Front of recessed fireplace</td>
<td>84 36</td>
</tr>
<tr>
<td>Coal or wood burning stove</td>
<td>42 12</td>
</tr>
<tr>
<td>Kitchen range</td>
<td>18 9</td>
</tr>
<tr>
<td>Wall oven</td>
<td>18 9</td>
</tr>
<tr>
<td>Hot air ducts</td>
<td>18 9</td>
</tr>
</tbody>
</table>

Spacing - Heat Sources

<table>
<thead>
<tr>
<th>Heat Source</th>
<th>Minimum Spacing Required from Edge of Source to Sprinkler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninsulated heat duct</td>
<td>18 9</td>
</tr>
<tr>
<td>Uninsulated hot water pipe</td>
<td>12 6</td>
</tr>
<tr>
<td>Side of ceiling or wall mounted hot air diffuser</td>
<td>24 12</td>
</tr>
<tr>
<td>Front of wall mounted hot air diffuser</td>
<td>36 18</td>
</tr>
<tr>
<td>Water heater or furnace</td>
<td>6 3</td>
</tr>
<tr>
<td>Light fixture 0W - 250W</td>
<td>6 3</td>
</tr>
<tr>
<td>250W - 499W</td>
<td>12 6</td>
</tr>
</tbody>
</table>
Sprinklers Not Required

- Certain areas within a dwelling are not required to be sprinklered (NFPA 13D):
  - Attic and crawl space without fuel fired equipment
  - Closets less than 24 square feet; not more than 3 feet in depth
  - Bathrooms less than 55 square feet in area

Pendent Sprinkler Layout

- Sprinklers listed for 16x16 foot spacing.
- Three sprinklers cover the common areas of the dwelling unit.
- Sprinklers are not provided in the bathroom.

Dwelling with Sidewall

- A similar layout can have sidewall sprinklers
- The location must meet the spacing requirements
- The sprinkler must completely cover area

Discussion Topics

- Standards
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- Basic Hydraulics
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Typical Piping Materials

- Common residential sprinkler piping materials:
  - CPVC
  - PEX
  - Copper
  - Steel
- Plastic pipe must be listed

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Joining Methods

- CPVC
  - Solvent Cementing
- PEX
  - Mechanical Connections
- Copper
  - Solder
  - Press Connect
- Steel
  - Threaded
  - Mechanical Connections

Protection of Plastic Pipe

- PEX requires protection
- CPVC can be exposed subject to the installation rules in its listing
- When required, protection is by 15 minute thermal barrier
  - 3/8 inch gypsum
  - ½ inch plywood
  - Ceiling tile held in place

Hanger Requirements

NFPA 13D requires pipe to be supported in accordance with Plumbing Code requirements.
- Spacing for water pipe and tube
- Plastic pipe must be supported in accordance with the listing.
  - CPVC has special requirements
  - PEX is in accordance with the Plumbing Code

CPVC Spacing Table

| Table 1: Maximum Support Spacing Distance Excl. Line Sprinkler Head Drop Elbow |
|-----------------------------|-----------------------------|
| Pipe Size                | Maximum Support Spacing Distance |
|                           | 500 psi | 1000 psi |
| 3/4"                      | 12"     | 24"      |
| 1"                        | 18"     | 24"      |

| Table 2: Maximum Support Spacing Distance Incl. Line Sprinkler Head Drop Tee |
|-----------------------------|-----------------------------|
| Pipe Size                | Maximum Support Spacing Distance |
|                           | 500 psi | 1000 psi |
| 3/4"                      | 9"      | 9"       |
| 1"                        | 12"     | 12"      |

Attachment at Drop

- The sprinkler piping must be adequately supported at the drop to the sprinkler.
- The are many methods of securing the pipe and/or sprinkler.
Framing Protection

- Penetrations of wood members must be protected
- Protection is by 16 gauge plates
- Not required if more than 1-1/2 inch from the edge

Piping Layout Approaches

- Traditionally, fire sprinkler systems are designed and installed as separate systems by a fire sprinkler contractor
- New design approaches and materials permit today’s residential sprinkler systems to be simple, less expensive and more easily integrated into a home than traditional “two pipe” designs

Piping Layout Approaches

- Stand Alone (two pipe)
  - Separate piping for sprinklers and domestic plumbing
  - Can be piped in any acceptable material
  - Backflow required if:
    - Black pipe
    - Fire department connection
    - Antifreeze system

Piping Layout Approaches

- Multipurpose Piping (one pipe)
  - Piped with the potable cold water distribution system
  - Potable water piping material required
  - No backflow protection is necessary
  - Can reduce material and labor costs

Mainstreaming Dwelling Sprinklers

- Sprinklers can be incorporated as part of the plumbing system, just like a toilet or sink
  - Sprinkler contractors need to get in to residential plumbing
  - Plumbing contractors need to get into residential sprinklers

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Mainstreaming Dwelling Sprinklers

• Systems can be made simple enough for plumbers to design and install (pipe schedule)

Mainstreaming Dwelling Sprinklers

• Multipurpose systems allow for
  – Plumbing contractors to do both sprinklers and potable water
  – Plumbing inspectors to do inspection of sprinklers
  – No different than electricians and electrical inspectors installing and inspecting smoke alarms

Mainstreaming Dwelling Sprinklers

• Multipurpose piping materials
  – CPVC
  – PEX
  – Copper

• In multipurpose systems, stagnant water is prevented by flow through domestic fixtures
  – What about dead end outriggers or sprigs?
    • Hose bibs
    • "Future use" plumbing

Multipurpose Piping Systems

Multipurpose Piping Systems (CPVC-PEX)
Multipurpose Piping Systems (CPVC-PEX)

- Compatibility of Thermoplastic Piping
  - Flowguard Gold and Blazemaster can be joined together; both are CPVC
  - Both are permitted for potable water

Multipurpose Piping Systems (Blazemaster CPVC – FlowGuard CPVC)

Conversion to Water Piping

- Blazemaster is converted to Flowguard Gold
- Flowguard Gold facilitates connection to plumbing fixtures
- Blazemaster can be used for the entire plumbing system if the contractor prefers

Transition Adapters

Multipurpose Oddities

- Typically, the hot and cold water are installed parallel.
- For multipurpose piping, they are not.
- The cold follows the route of the sprinklers.

NFPA 13D Other Piping Requirements

- Drain required
  - On system side of control valve
  - For multipurpose systems, a plumbing fixture is acceptable
- Shut off for all water
  - A shut-off valve cannot isolate the sprinkler system
PEX Systems

- Two approaches to PEX
  - Rehau (direct feed)
  - Wirsbo (network)
- Wirsbo tubing is ¼ inch in diameter.
- Multiple tubing connections must supply each sprinkler.

PEX Multipurpose

- In a manifolded PEX system, the manifold can serve sprinklers and the cold water supply to plumbing fixtures.
- The manifold often has a "home run" for each fixture or area.

Manifold Network System

Is Freezing a Big Concern

- A sprinkler system poses no greater risk of freezing than domestic plumbing if the system is properly designed and installed.
- Freeze-ups result from design or installation errors that can occur with any plumbing system, and it is incorrect to suggest that sprinkler systems in cold climates are predisposed to freezing.

Is Freezing a Big Concern

- Jurisdictions with severely freezing climates in mountainous and northern states from New York to Alaska have adopted residential sprinkler ordinances.
- Widespread freezing problems with sprinklers would generate an enormous political backlash in jurisdictions where sprinklers have been mandated.
- This simply hasn’t happened.

Cold Weather Exposure

- In cold areas, the system can be dry, dry sprinkler, or antifreeze
- Dry sprinklers must be quick acting or residential
- Antifreeze system must use appropriate antifreeze
  - Glycerin only for CPVC
  - Glycol or glycerin for other materials
- Reduced pressure principle backflow preventer required for antifreeze systems
Discussion Topics

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Sizing a Residential System

- Sizing a system is based on pressure demand
- Each sprinkler has a minimum pressure requirement at the listed flow rate
- The piping system must be designed for the required flow rate providing the required pressure
- Flow is based on number of sprinklers on a given pipe

Minimize Water Demand

- Reducing flow demand can dramatically reduce cost and complexity
  - Less water flow =
  - Standard meter =
  - No infrastructure recovery fee =
  - Works on a well =
  - Smaller tank if needed =
  - Smaller pipes =
  - Smaller fittings =
  - No need for looped piping =
  - Prescriptive designs =
  - No engineers
- What about a "single sprinkler" design basis?

Design Flow Rate

- Residential system must be sized for the maximum number of sprinklers in a room or space
  - NFPA 13D - max 2
- An 8 inch lintel creates a separate room
  - Lintel between living room and kitchen and stairs could lower number of sprinklers required to be calculated from two to one

Rule of Thumb

- Sizing of Piping System
  - One Sprinkler Discharge – ¾"
  - Two Sprinkler discharge – ½” or 1"
  - Low pressure…loop pipe

NFPA 13D Water Supply

- Must have enough to meet demand for 10 minutes, except that 7 minutes is allowed for one story dwellings not exceeding 2,000 sqft in area
- Acceptable are:
  - Connections to a reliable waterworks system
  - An elevated tank
  - A pressure tank
  - A stored water source with an automatically operated pump
Water Demand

- Public Supply
  - Water service must provide capacity of sprinkler system
  - Pressure losses occur in piping and through meter
  - Meter can be 5/8” or ¾” (use big pipe...small meter)

- Well System
  - Well must have the capacity of the sprinkler flow rate, or
  - System must provide a means of flowing at required capacity

Types of Wells

- There are different types of wells systems.
  - Dug
  - Bored
  - Drilled
  - Driven
- Each type of well has different capacities of water flow.

Developed Well

- When well capacity is low, one option is to develop the well
- This can increase the capacity of the well for a high 10 minute flow.

Deep Wells

- In certain parts of the country deep wells are required
- The well must be drilled deep enough to have water capacity.
- These types of wells are best served with a tank system.

Well Options

- Storage tank in basement or lower level.
- Double pump.
- Pump sized for sprinkler capacity.
Constant Pressure

- One available option is a constant pressure pump.
- The pump will flow a wide range at a constant pressure.
- Constant pressure pumps are a higher price.

Pressure Calculation

\[ P_p \leq P_s - P_r \]

- All pressure losses must be determined
- Pressure losses in system are:
  - Pipe, fitting, and valves
  - Meter
  - Backflow preventer
  - Elevation
- Pressure loss based on Hazen Williams equation

P2904 Proposal Hydraulics

\[ P_i = P_{sdp} - P_{l_{out}} - P_{l_{in}} - P_{l_{e}} - P_{lep} \]

Where:

- \( P_i \): Pressure used in applying Tables P2904.6.2(4) through P2904.6.2(9).
- \( P_{sdp} \): Pressure available from the water supply source.
- \( P_{l_{out}} \): Pressure loss in the water-service pipe.
- \( P_{l_{in}} \): Pressure loss in the water meter.
- \( P_{l_{e}} \): Pressure loss from devices other than the water meter.
- \( P_{lep} \): Pressure loss associated with changes in elevation.
- \( P_{lep} \): Maximum pressure required by a sprinkler

Step 1 - Determine \( P_{lep} \)

Obtain the supply pressure that will be available from the water main from the water purveyor, or for an individual source, the available supply pressure shall be in accordance with Section P2904.5.1. The pressure shall be the residual pressure available at the flow rate used when applying Table P2904.6.2(1).

Step 2 - Determine \( P_{l_{out}} \)

Use Table P2904.6.2(1) to determine the pressure loss in the water service pipe based on the selected size of the water service.

Step 3 - Determine \( P_{lep} \)

Use Table P2904.6.2(2) to determine the pressure loss from the water meter.

<table>
<thead>
<tr>
<th>Flow Rate (gpm)</th>
<th>50 Water Pressure Loss (psi)</th>
<th>34 Water Pressure Loss (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
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<td>3</td>
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<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

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\[ P_t = P_{in} - \left( P_{loss} - P_{loss} - P_{loss} \right) \]

Step 4 – Determine \( P_t \)
Determine the pressure loss from devices other than the water meter, installed in the piping system supplying sprinklers, such as pressure-reducing valves, backflow preventers, water softeners or water filters. Device pressure losses shall be based on the device manufacturer's specifications. The flow rate used to determine pressure loss shall be the rate from Section P2004.4.2, except that 5 gpm shall be added where the device is installed in a water-service pipe that supplies more than one dwelling. As an alternative to deducting pressure loss for a device, an automatic bypass valve shall be installed to divert flow around the device when a sprinkler activates.

\[ P_{ud} = \text{Pressure loss from devices other than the water meter.} \]

Step 5 – Determine \( P_{ud} \)
Use Table P2004.4.2(1) to determine the pressure loss associated with changes in elevation. The elevation used in applying the table shall be the difference between the elevation where the water source pressure was measured and the elevation of the highest sprinkler.

<table>
<thead>
<tr>
<th>Elevation (ft)</th>
<th>Pressure Loss (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>35</td>
<td>10</td>
</tr>
</tbody>
</table>

Step 6 – Determine \( P_{ud} \)
Determine the maximum pressure required by any individual sprinkler based on the flow rate from Section P2004.4.1. The required pressure is provided in the sprinkler manufacturer's published data for the specific sprinkler model based on the selected flow rate.

\[ P_{uc} = \text{Maximum pressure required by a sprinkler} \]

Step 7 – Calculate \( P_e \)
Laying Equation 29, calculate the pressure available to offset friction loss in water distribution piping between the service valve and the sprinklers.

Step 8 – Determine the maximum allowable pipe length
Use Tables P2004.4.2(1) through P2004.6.2(1) to select a material and size for water distribution lines. The sprayer material and size shall be acceptable if the developed length of pipe between the service valve and the most remote sprinkler does not exceed the maximum allowable length specified by the applicable table. If the pressure available between the sprinklers is less than the required minimum pressure, an increase of pipe fittings and additional friction losses associated with pipe fittings shall be required.

Smith Family Home

9' flat ceilings throughout

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Or Use Spreadsheet

Residential Sprinkler Sizing Table

<table>
<thead>
<tr>
<th>Pressure Safety Factor (psi)</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe Fittings Factor (%)</td>
<td>40.00%</td>
</tr>
<tr>
<td>Sprinkler K Factor</td>
<td>4.2</td>
</tr>
<tr>
<td>Water Service</td>
<td>PE</td>
</tr>
<tr>
<td>PE SDR</td>
<td>11</td>
</tr>
<tr>
<td>Input Diameter (in)</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>150</td>
</tr>
<tr>
<td>Water Distribution</td>
<td>Blazemaster</td>
</tr>
<tr>
<td>Sprinkler Flow Rates to Investigate (gpm)</td>
<td>12, 13, 18</td>
</tr>
<tr>
<td>Well System?</td>
<td>No</td>
</tr>
<tr>
<td>Water Service Length (ft)</td>
<td>40, 40</td>
</tr>
<tr>
<td>5/8'' Meter Loss (psi)</td>
<td>9, 9</td>
</tr>
<tr>
<td>3/4'' Meter Loss (psi)</td>
<td>4, 4</td>
</tr>
</tbody>
</table>

For The Sizing Table

Discussion Topics

- Standards
- Unique Aspects of Residential Sprinklers
- Sprinkler Location and Spacing
- Piping Alternatives and Considerations
- Basic Hydraulics
- Inspection and Design Considerations

NFPA 13D Design and Inspection Checklist

- Maximum sprinkler spacing to each other/walls
- Minimum spacing between sprinklers
- Ceiling clearance to sprinkler deflector (per 13D or listing)
- Obstructions, complex ceilings, soffits
- Drain provided
- If water flow alarm provided - not mandatory
  - Is inspectors test connection provided?
  - Is inspectors test location adequate for discharge?

NFPA 13D Design and Inspection Checklist

- Sprinklers
  - Listed residential sprinklers installed (7.5.1)
    - Listed dry sprinklers in areas subject to freezing (7.5.3)
  - Listed quick response sprinklers allowed for mechanical closets (7.5.4)
  - Appropriate temperatures of sprinklers have been selected (7.5.5)
    - Proximity to heat sources, See Table 7.5.5.3 and/or Manufacturer's Literature
- Protection of piping from freezing

NFPA 13D Design and Inspection Checklist

- All required areas protected with sprinklers
  - Allowed Areas of omission of sprinklers are:
    - Bathrooms of 55 sq. ft or less (8.6.2)
    - Clothes closets, linen closets, pantries less than 24 sq. ft. and least dimension is less than 3 ft. and walls and ceilings are of non-combustible surface (8.6.3)
    - Garages, open porches, carports, etc. (8.6.4)
    - Attics, crawl spaces and other concealed areas not intended for living purposes (8.6.5)
    - Covered, unheated egress projections from the building if a second means of egress exists (8.6.6)

More than 30 Years of Experience

- It has been more than 30 years since the concept of residential sprinklers was born,
- In that time, roughly 100,000 Americans have lost their lives in residential fires.
- This is essentially equivalent to wiping out the entire population of the City of Albany, New York in just 30 years.
- The solution to this problem, fire sprinklers in one- and two-family dwellings, is the last significant piece still missing from America’s fire safety plan.

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Is the Populous Ready for Sprinklers?

- With all multi-family housing now being built with sprinklers, the home buying public has become familiar with and supports residential sprinkler technology
- This was confirmed by survey conducted by HFSC in December 2005 that included 1,019 U.S. adults (620 of whom own a house)

HFSC Survey Results

- 63 percent of homeowners were aware fire sprinklers are available for home use
- 45 percent of homeowners said a sprinklered home is more desirable than an unsprinklered home
- 48 percent of homeowners would not install a sprinkler system because of fear of water damage

HFSC Survey Results

- 63 percent of homeowners were aware fire sprinklers are available for home use
- 45 percent of homeowners said a sprinklered home is more desirable than an unsprinklered home
- 48 percent of homeowners would not install a sprinkler system because of fear of water damage

HFSC Survey Results

- 38 percent of homeowners say they would be more likely to purchase a new home with sprinklers than one without
- 69 percent of homeowners believe having a fire sprinkler system increases the value of a home

HFSC Survey Results

- If building a new home, 39 percent of homeowners said they would be more likely to hire a builder who offers sprinklers over a builder that does not offer sprinklers as a standard feature

HFSC Survey Results

- Given a choice, homeowners would install a fire sprinkler system over other amenities, such as
  - Cabinet upgrades (35%)
  - Hardwood floors (36%)
- Confirmed by a 2006 NAHB sponsored national survey of 800 likely voters
  - Given the option of sprinklers as a free upgrade, 34 percent selected sprinklers over a finished basement, granite counters or upgraded flooring

HFSC Survey Results

- NAHB’s survey also revealed that more than 1/3 of the survey group believed that residential sprinklers should be mandatory, as opposed to optional, among democrats, the number jumped to 41%
- This is extraordinary considering HFSC’s survey revealed that 48% of homeowners who didn’t want sprinklers cited a fear of water damage, which is unfounded
Should Sprinklers Be Optional?

- Maybe, but it’s not really an option
- Why does the first homeowner get to choose for everyone who later owns the same home
- There’s an impact on the community…who should pay?

Aren’t Older Homes the “Real” Problem?

- The fact that more fire deaths occur in “older” homes than newer homes is related in part to the fact that the median age of homes in the U.S., according to a recent HUD study, is 32 years. By sheer numbers, a lot of people live in older homes.
- A home’s age has low correlation to fire risk:
  - Socio-economic factors, age, crowding are better determinants

Aren’t Older Homes the “Real” Problem?

- Builders suggest that new homes are safer because of smoke alarms and better construction methods
- New lightweight construction is actually more dangerous than dimensional lumber

Aren’t Smoke Alarms Enough?

- Smoke alarms are only alerting devices. On their own, they do nothing to stop the spread of fire, protect property or protect firefighters
- As smoke alarms age, their reliability declines
- Manufacturers now stamp an expiration date on each unit indicating a 10-year replacement cycle

Aren’t Smoke Alarms Enough?

- 96% of U.S. homes with telephones now have at least one smoke alarm, in roughly 25% of reported fires in smoke alarm equipped homes, the devices didn’t work
- In contrast, residential sprinkler systems can have a life expectancy of 50 years, and they require essentially no maintenance, particularly for multipurpose systems

Aren’t Smoke Alarms Enough?

- 2006, only 58% of a test group of children ages 6-12 awakened when a standard smoke alarm sounded, and only 38% of the test group successfully evacuated
- 34% of fire deaths in one- and two-family dwellings occur in homes with a working smoke detector.
- Fire death rates indicate that the young and the elderly, those who are least likely to be capable of self-preservation even if they are awakened by a smoke detector, are roughly twice as likely to die in a fire as compared to individuals in the remaining age group.
- To protect individuals in these high-risk age groups, we need residential sprinklers.
The Issue of Cost

- The cost of sprinkler systems will prevent many people from becoming home buyers.
- "What drives the price of a new home?"
  - In many, if not most, markets, the answer to this question is not construction costs, but instead, what the market will bear, with sales prices rising and falling based on what buyers are willing to pay.
  - In such markets, costs associated with sprinklers are absorbed into the price by adjusting other costs or builder markup.

NAHB's Own Survey

- According to NAHB's 2006 survey, when asked what they would pay for a fire sprinkler system in a 3-bedroom home
  - 38% of respondents were willing to pay $2300 or more for a fire sprinkler system
  - 63% of respondents were willing to pay $1200 or more for a fire sprinkler system

Scottsdale, Arizona

- How cheap must sprinklers be to be cost effective?
- 20 years after enacting a comprehensive residential sprinkler ordinance, Scottsdale, Arizona reported
  - 40,000+ homes sprinklered
  - Average cost $0.55 to $0.75 cents per square foot
  - Final cost of sprinklers, taking into account savings from trade-ups, is less than $200 per unit
  - Average loss in sprinklered vs. nonsprinklered reduced by 90+ percent (roughly $3k vs. $45k)
  - 92-percent of fires controlled by 1-2 sprinklers
- Scottsdale’s experience clearly demonstrates that a competitive marketplace greatly reduces sprinkler costs.

The Issue of Cost

- NAHB repeatedly states that sprinkler systems need to be "low cost"… what constitutes low cost?
- At a meeting with NAHB's Code Committee, I asked "Is there anyone in the room who would install sprinklers in homes for:
  - $2000+?
  - $1000?
  - $500?
  - $250?
  - NO COST?"

Sprinklers Must Not Have an Adverse Impact on Affordable Housing

- The added cost of sprinklers in a 3-bedroom Habitat home is about $500 for equipment and materials
  - Less than $4/month on a 30-year note, not incl. insurance credit
- The systems meet NFPA 13D, the national standard
Sprinklers Must Not Have an Adverse Impact on Affordable Housing

- I’ve personally overseen the installation of 30+ sprinkler systems in Austin Habitat Homes…and that’s when I became a believer in the future of residential sprinklers…no big deal

Bottom Line on Cost

- It has been demonstrated many times in the many jurisdictions throughout the country where residential sprinklers are required that housing markets are not affected by fire sprinklers
- These local experiences show us that, once the IRC requires residential sprinklers, home building will continue as it always has.
  - Home prices will fluctuate based on the law of supply and demand
  - Home builders will adjust their products to meet consumer preferences and trends
  - Home buyers will continue to buy homes.

Won’t Sprinklers Leak and Cause Mold Damage?

- Sprinklers and sprinkler piping are more thoroughly tested than any other plumbing component in a home
- Testing includes
  - Hydrostatic strength – 700 psi
  - Leakage – 500 psi
  - Water hammer – 100,000 cycles
  - Temperature cycling – 35-125°F
  - Freezing – 20 below for 24 hours
  - And many others

What About Builder Liability?

- Builder liability
  - Smoke alarms are statistically less reliable than fire sprinkler systems
  - Smoke alarms have been required in new residential construction for 30 years
  - Current builders have installed several smoke alarms in EVERY home built
  - How many builders have been successfully sued over a failed smoke detector?

Resources

The Home Fire Sprinkler Coalition
www.homefiresprinkler.org

- DVD presentation and info kits

Resources

Residential Fire Safety Institute
www.firesafefamily.org

- Model ordinances
- Statistics
- History
- General support information for working on a local ordinance
Resources
IRC Fire Sprinkler Coalition

- Supporting national and local adoption of residential sprinkler requirements