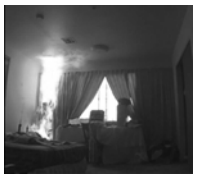
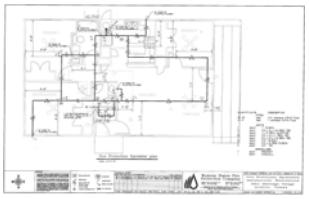
Residential Sprinklers

Issues and Answers





Your Instructor

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

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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

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Two Biggest Obstacles to Residential Sprinklers

1. Momentum
2. Fear of the unknown

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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

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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

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Marble Mountain Demonstration
Orange County, California

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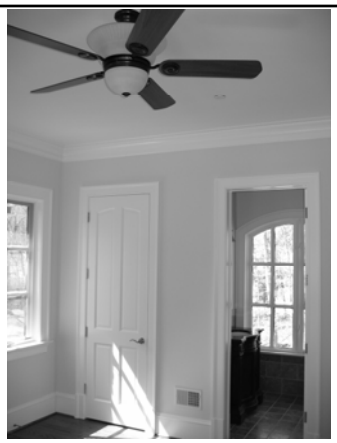

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What is an NFPA 13D Residential Sprinkler System

Water Supply +

+

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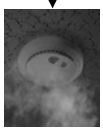
Residential Sprinkler System What It's Not



Smoke alarm is the alarm

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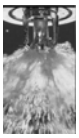
Fire Sprinkler Facts

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



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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

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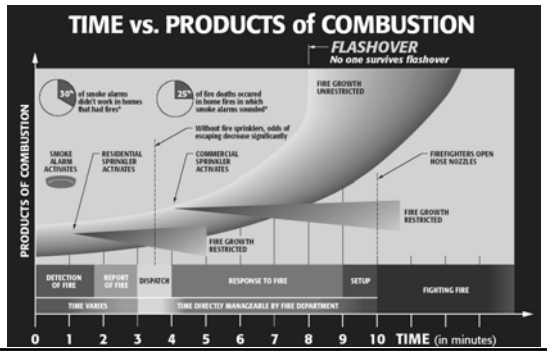
It's All About Time



What's "Flashover"

- Fire is not what Hollywood portrays in TV or movies

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By Preventing Flashover Residential Sprinklers Save Lives

Sprinklered Room
Activation within 60 Seconds

Non-sprinklered Room
After 210 Seconds

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By Preventing Flashover Residential Sprinklers Save Property Too

- A secondary benefit to residential sprinklers is property protection
- This home was not protected with sprinklers

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Fire Results

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

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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

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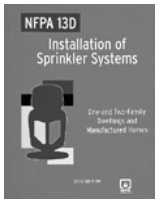
Sprinkler Standards

- 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



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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

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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

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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

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Discussion Topics

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

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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

Standard

QR

Residential

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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

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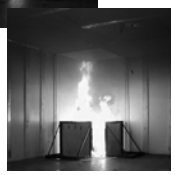
UL 1626 Standard

- 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.

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UL 1626 – Minimum Flow Rate

Minimum rated sprinkler flow rates 0.05 gpm/ft^2

Upright, pendent, recessed pendent, flush, and concealed sprinklers			
Spacing, ft (m)		Minimum flow, gpm (l/m)	
12 × 12	(3.7 × 3.7)	8	(28)
14 × 14	(4.3 × 4.3)	10	(37)
16 × 16	(4.9 × 4.9)	13	(49)
18 × 18	(5.5 × 5.5)	17	(62)
20 × 20	(6.1 × 6.1)	20	(76)
Sidewall sprinklers			
Spacing, ft (m)		Minimum flow, gpm (l/m)	
12 × 12	(3.7 × 3.7)	8	(28)
14 × 14	(4.3 × 4.3)	10	(37)
16 × 16	(4.9 × 4.9)	13	(49)
18 × 18	(5.5 × 5.5)	17	(62)
20 × 20	(6.1 × 6.1)	20	(76)
16 × 18	(4.9 × 5.5)	15	(55)
16 × 20	(4.9 × 6.1)	16	(61)
18 × 20	(5.5 × 6.1)	18	(69)

Note – The minimum rated flows for sidewall sprinkler spacings other than those specified in this table shall not be less than a flow correlating to a 0.05 gpm/ft^2 (2 mm/min) discharge density.

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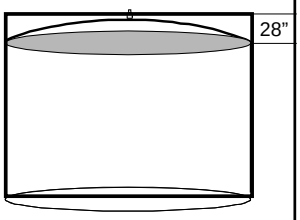
Residential Sprinkler Water Distribution

- 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



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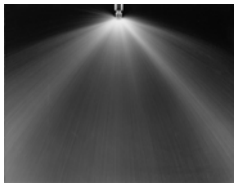
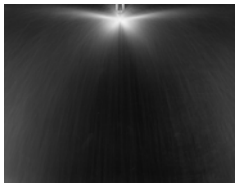
Sprinkler Water Distribution



Standard Spray Sprinkler



Residential Sprinkler

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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

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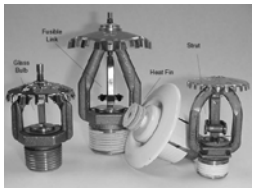
Thermal Sensitivity

- 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”



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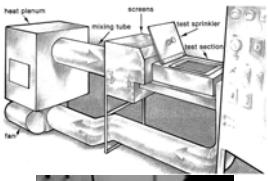
Plunge Test for RTI

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



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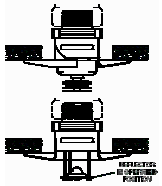
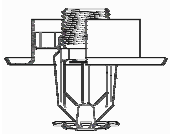
Heat Fin Sprinklers

- 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.



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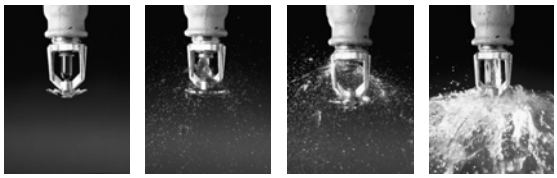
Glass Bulb Activation



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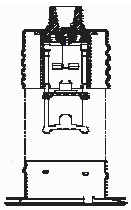
Concealed Sprinklers

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



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Concealed Pendent Sprinkler

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Adjustment of Sprinklers

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

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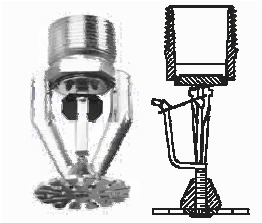
Fusible Link Sprinklers

- 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.



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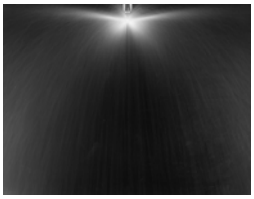
Advances in Technology



- 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

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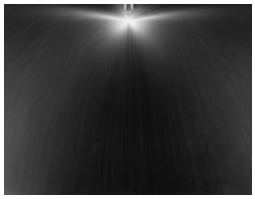
Advances in Technology



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

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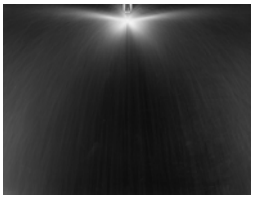
Advances in Technology



- 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

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Listed Sprinkler Flow Rates

Manufacturer Literature Will Specify Maximum Spacing for a Given Flow

Maximum Coverage Area [a] Ft. x Ft. (m x m)	Maximum Spacing Ft. (m)	Minimum Flow [b] and Residual Pressure For Horizontal Ceiling (Max. 2 Inch Rise for 12 Inch Run)	Minimum Flow [b] and Residual Pressure For Sloped Ceiling (Greater Than 2 Inch Rise Up To Max. 4 Inch Rise for 12 Inch Run)		Minimum Flow [b] and Residual Pressure For Sloped Ceiling (Greater Than 4 Inch Rise Up To Max. 8 Inch Rise for 12 Inch Run)	
		155°F/68°C or 175°F/79°C	155°F/68°C	175°F/79°C	155°F/68°C	175°F/79°C
12 x 12 (3,7 x 3,7)	12 (3,7)	13 GPM (49,2 LPM) 7.0 psi (0.48 bar)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)
14 x 14 (4,3 x 4,3)	14 (4,3)	13 GPM (49,2 LPM) 7.0 psi (0.48 bar)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)
16 x 16 (4,9 x 4,9)	16 (4,9)	13 GPM (49,2 LPM) 7.0 psi (0.48 bar)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	13 GPM (49,2 LPM) 7.0 psi (0,48 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)
18 x 18 (5,5 x 5,5)	18 (5,5)	17 GPM (64,3 LPM) 12.0 psi (0.83 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)	17 GPM (64,3 LPM) 12.0 psi (0,83 bar)
20 x 20 (6,1 x 6,1)	20 (6,1)	20 GPM (75,7 LPM) 16.7 psi (1,15 bar)	20 GPM (75,7 LPM) 16.7 psi (1,15 bar)	20 GPM (75,7 LPM) 16.7 psi (1,15 bar)	21 GPM (79,5 LPM) 18.4 psi (1,27 bar)	22 GPM (83,3 LPM) 20.2 psi (1,39 bar)

(a) For coverage area dimensions less than or between those indicated, it is necessary to use the minimum required flow for the next highest coverage area for which hydraulic design criteria are stated.

(b) Requirement is based on minimum flow in GPM (LPM) from each sprinkler. The associated residual pressures are calculated using the nominal K-factor. Refer to Hydraulic Design Criteria Section for details.

TABLE A
NFPA 13D AND NFPA 13R WET PIPE HYDRAULIC DESIGN CRITERIA FOR THE SERIES LFII (TY2234) RESIDENTIAL PENDENT AND RECESSED PENDENT SPRINKLERS

Discussion Topics

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

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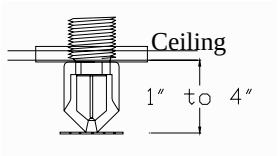
Pendent Requirements

- 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.



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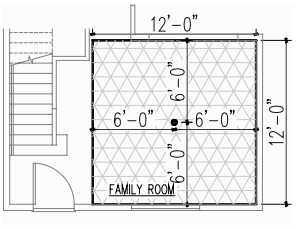
Pendent Sprinkler Coverage



The maximum distance to a wall is one-half the maximum permitted distance between sprinklers

- 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'

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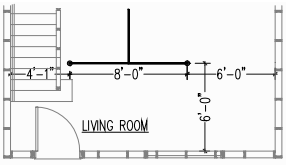
Minimum Spacing Between Sprinklers

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



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Obstructions To Flow

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

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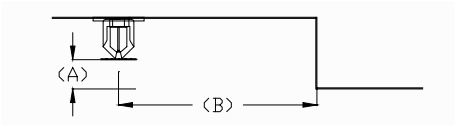

Distance from Sprinkler to side obstruction (B)	Distances from deflector to bottom of obstruction (A)
Less than 1 foot	0"
1 foot to 1-1/2 feet	2-1/2"
1-1/2 feet to 2 feet	3-1/2"
2 feet to 2-1/2 feet	5-1/2"
2-1/2 feet to 3 feet	7-1/2"
3 feet to 3-1/2 feet	9-1/2"
3-1/2 feet to 4 feet	12"
4 feet to 4-1/2 feet	14"
4-1/2 feet to 5 feet	16-1/2"
Greater than 5 feet	18"

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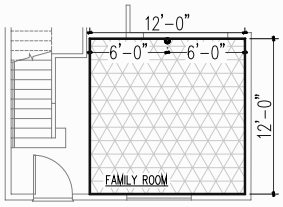
Sidewall Sprinkler Coverage



The maximum distance to a wall is one-half the maximum permitted distance between sprinklers

- 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'

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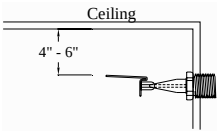
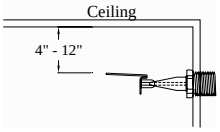
Distance from Ceiling

- 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.





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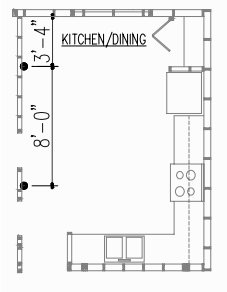
Minimum Spacing Between Sidewall Sprinklers



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

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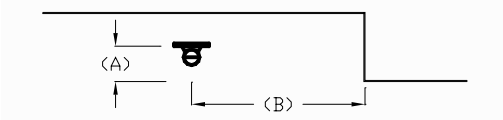
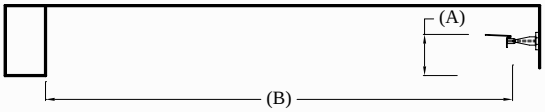
Sidewall Sprinkler Obstructions



Distance from Sprinkler to side obstruction (B)	Distances from deflector to bottom of obstruction (A)
Less than 1-1/2 foot	0"
1-1/2 foot to less than 3 feet	1"
3 feet to less than 4 feet	3"
4 feet to less than 4-1/2 feet	5"
4-1/2 feet to less than 6 feet	7"
6 feet to less than 6-1/2 feet	9"
6-1/2 feet to less than 7 feet	11"
7 feet to less than 7-1/2 feet	14"

77



Distance from Sprinkler to side obstruction (B)	Distances from deflector to bottom of obstruction (A)
Less than 8 foot	Not Allowed
8 foot to 10 feet	1"
10 feet to 11 feet	2"
11 feet to 12 feet	3"
12 feet to 13 feet	4"
13 feet to 14 feet	6"
14 feet to 15 feet	7"
15 feet to 16 feet	9"
16 feet to 17 feet	11"
Greater than 17 feet	14"

78

Spacing - Heat Sources

Heat Source	Minimum Spacing Required from Edge of Source to Sprinkler	
	Ordinary (in)	Intermediate (in)
Side of open or recessed fireplace	36	12
Front of recessed fireplace	84	36
Coal or wood burning stove	42	12
Kitchen range	18	9
Wall oven	18	9
Hot air flues	18	9

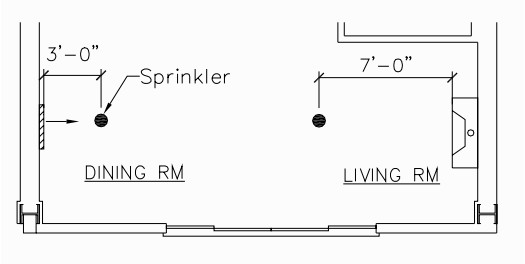
79

Spacing - Heat Sources

Heat Source	Minimum Spacing Required from Edge of Source to Sprinkler	
	Ordinary (in)	Intermediate (in)
Uninsulated heat duct	18	9
Uninsulated hot water pipe	12	6
Side of ceiling or wall mounted hot air diffuser	24	12
Front of wall mounted hot air diffuser	36	18
Water heater or furnace	6	3
Light fixture 0W - 250W 250W - 499W	6 12	3 6

80

Spacing to Heat Source

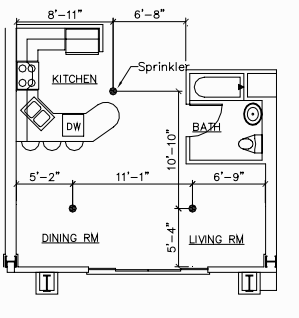


Sprinklers Not Required

- 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

82

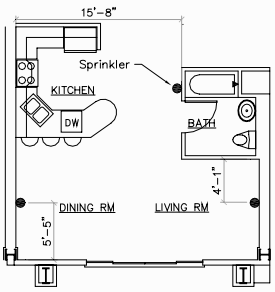
Pendent Sprinkler Layout



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

83

Dwelling with Sidewall



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

84

Discussion Topics

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

85

Typical Piping Materials

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

CPVC Blazemaster Shown

86

Joining Methods

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

87

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

88

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

89

CPVC Spacing Table

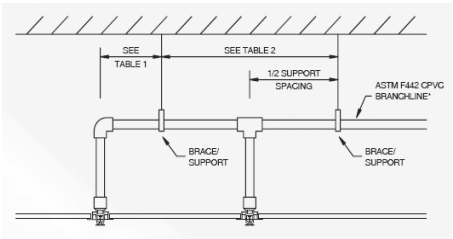
Table 1 Maximum Support Spacing Distance End Line Sprinkler Head Drop Elbow		
Pipe Size	System Pressure	
inches	<100 psi	>100 psi
3/4"	9"	6"
1"	12"	9"
1-1/4"	16"	12"
1-1/2" – 3"	24"	12"

Table 2 Maximum Support Spacing Distance Inline Sprinkler Head Drop Tee		
Pipe Size	System Pressure	
inches	<100 psi	>100 psi
3/4"	4'	3'
1"	5'	4'
1-1/4"	6'	5'
1-1/2" – 3"	7'	7'

Courtesy of Noveon

90

CPVC Hanger Spacing



Courtesy of Noveon

91

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.

92

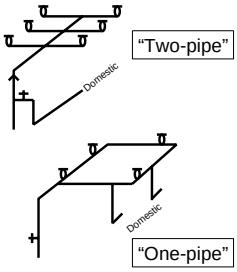
Framing Protection

- 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

94

Piping Layout Approaches

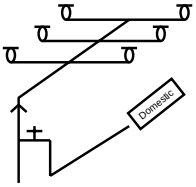
- Traditionally, fire sprinkler systems are designed and installed as separate systems by a fire sprinkler contractor
- New design approaches and materials permit today's residential sprinkler systems to be simple, less expensive and more easily integrated into a home than traditional "two pipe" designs



95

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



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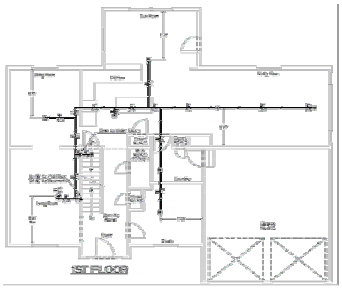
Two Pipe (Stand Alone) System



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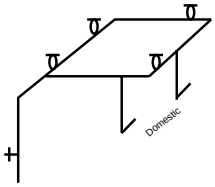
Piping Layout Approaches

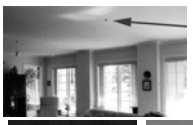


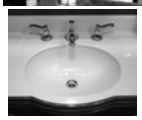
- Multipurpose Piping (one pipe)
  - Piped with the potable cold water distribution system
  - Potable water piping material required
  - No backflow protection is necessary
  - Can reduce material and labor costs

98

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

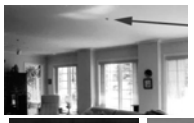


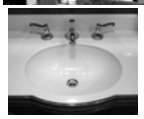


99

Mainstreaming Dwelling Sprinklers

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

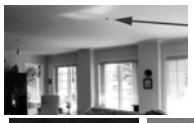


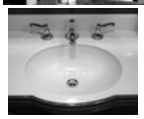


100

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



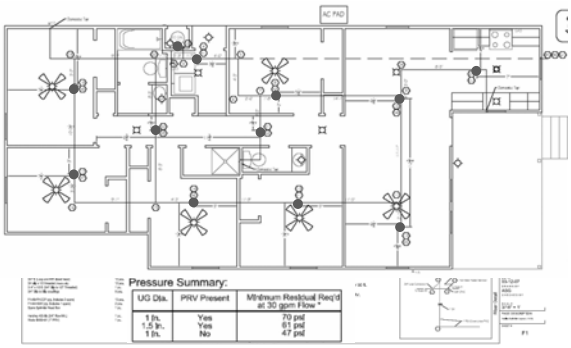


101

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

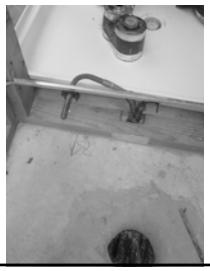
Multipurpose Piping Systems



Multipurpose Piping Systems (CPVC-PEX)

104

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

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Multipurpose Piping Systems (Blazemaster CPVC – FlowGuard CPVC)

107

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

108

Transition Adapters

109

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.

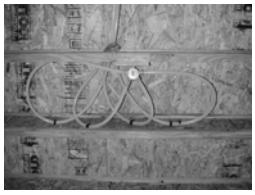
110

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 shutoff valve cannot isolate the sprinkler system

111

PEX Systems



- Two approaches to PEX
  - Rehau (direct feed)
  - Wirsbo (network)
- Wirsbo tubing is ½ inch in diameter.
- Multiple tubing connections must supply each sprinkler.

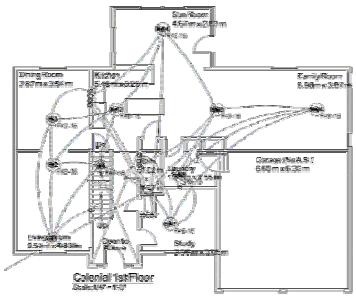
113

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.

114

Manifold Network System



115

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.

118

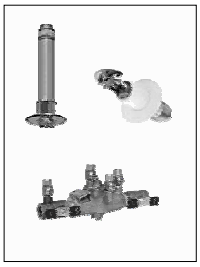
Is Freezing a Big Concern

- 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.

119

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

120

Discussion Topics

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

122

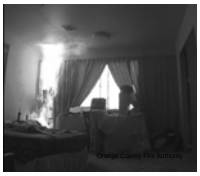
Sizing a Residential System

- 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

123

Minimize Water Demand

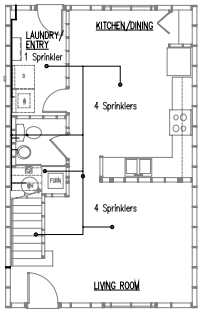
- Reducing flow demand can dramatically reduce cost and complexity
  - Less water flow =
  - Standard meter =
  - No infrastructure recovery fee =
  - Works on a well =
  - Smaller tank if needed =
  - Smaller pipes =
  - Smaller fittings =
  - No need for looped piping =
  - Prescriptive designs =
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



124

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 – ¾" or 1"
  - Low pressure…loop pipe

Rules of Thumb Don't Always Work.

126

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

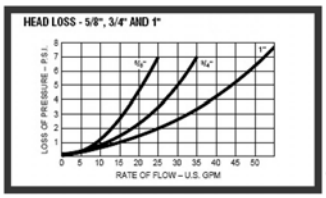
127

Water Demand

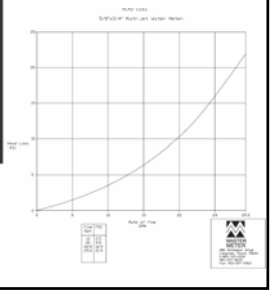
- Public Supply
  - Water service must provide capacity of sprinkler system
  - Pressure losses occur in piping and through meter
  - Meter can be 5/8" or ¾" (use big pipe…small meter)
- Well System
  - Well must have the capacity of the sprinkler flow rate, or
  - System must provide a means of flowing at required capacity

128

Meter Pressure Loss Curves

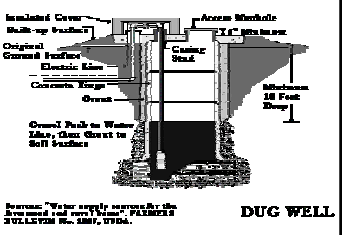


Hersey Meter



Types of Wells

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



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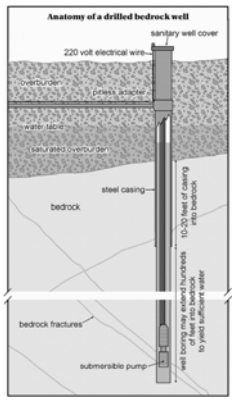
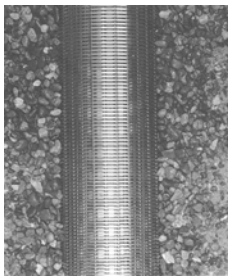
Deep Wells



- 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.

132

Developed Well

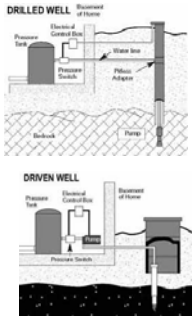


- When well capacity is low, one option is to develop the well
- This can increase the capacity of the well for a high 10 minute flow.

133

Well Options

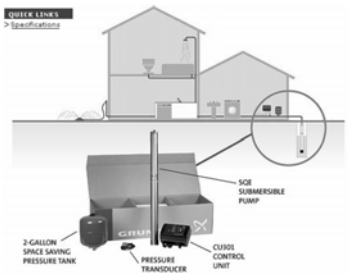
- Storage tank in basement or lower level.
- Double pump.
- Pump sized for sprinkler capacity.



134

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.



135

Pressure Calculation

$$P_{sp} \leq P_{su} - P_p$$

- 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

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P2904 Proposal Hydraulics

$$P_t = P_{sup} - PL_{svc} - PL_m - PL_d - PL_e - P_{sp}$$

Where:

P_t = Pressure used in applying Tables P2904.6.2(4) through P2904.6.2(9).

P_{sup} = Pressure available from the water supply source.

PL_{svc} = Pressure loss in the water-service pipe.

PL_m = Pressure loss in the water meter.

PL_d = Pressure loss from devices other than the water meter.

PL_e = Pressure loss associated with changes in elevation.

P_{sp} = Maximum pressure required by a sprinkler

$$P_t = P_{sup} - PL_{svc} - PL_m - PL_d - PL_e - P_{sp}$$

P_t = Pressure used in applying Tables P2904.6.2(4) through P2904.6.2(9).

P_{sup} = Pressure available from the water supply source.

Step 1 - Determine P_{sup}
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).

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$$P_t = P_{sup} - PL_{svc} - PL_m - PL_d - PL_e - P_{sp}$$

PL_{svc} = Pressure loss in the water-service pipe.

Step 2 – Determine PL_{svc}
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.

Table P2904.6.2(1)
Water Service Pressure Loss (PL_{svc})[a,b]

Flow Rate[c]	3/4" Water Service Pressure Loss (psi)				1" Water Service Pressure Loss (psi)				1-1/4" Water Service Pressure Loss (psi)			
(gpm)	40' or less	41' to 70'	70' to 100'	101' to 150'	40' or less	41' to 70'	70' to 100'	101' to 150'	40' or less	41' to 70'	70' to 100'	101' to 150'
8	5.1	8.7	11.8	17.4	1.5	2.5	3.4	5.1	0.6	1.0	1.3	1.9
10	7.7	13.1	17.8	26.3	2.3	3.8	5.2	7.7	0.9	1.4	2.0	2.9
12	10.8	18.4	24.9	NP	3.2	5.4	7.3	10.7	1.2	2.0	2.7	4.0
14	14.4	24.5	NP	NP	4.2	7.1	9.6	14.3	1.6	2.7	3.6	5.4
16	18.4	NP	NP	NP	5.4	9.1	12.4	18.3	2.0	3.4	4.7	6.9
18	22.9	NP	NP	NP	6.7	11.4	15.4	22.7	2.5	4.3	5.8	8.6
20	27.8	NP	NP	NP	8.1	13.8	18.7	27.6	3.1	5.2	7.0	10.4
22	NP	NP	NP	NP	9.7	16.5	22.3	NP	3.7	6.2	8.4	12.4
24	NP	NP	NP	NP	11.4	19.3	26.2	NP	4.3	7.3	9.9	14.6
26	NP	NP	NP	NP	13.2	22.4	NP	NP	5.0	8.5	11.4	16.9
28	NP	NP	NP	NP	15.1	25.7	NP	NP	5.7	9.7	13.1	19.4
30	NP	NP	NP	NP	17.2	NP	NP	NP	6.5	11.0	14.9	22.0
32	NP	NP	NP	NP	19.4	NP	NP	NP	7.3	12.4	16.8	24.8
34	NP	NP	NP	NP	21.7	NP	NP	NP	8.2	13.9	18.8	NP
36	NP	NP	NP	NP	24.1	NP	NP	NP	9.1	15.4	20.9	NP

NP - Not permitted. Pressure loss exceeds reasonable limits
a. Values are applicable for underground piping materials listed in Table P2904.4 and are based on an SDR of 11 and a Hazen Williams C Factor of 150.
b. Values include the following length allowances for fittings: 25% length increase for actual lengths up to 100 feet and 15% length increase for actual lengths over 100 feet.
c. Flow rate from Section P2904.4.2. Add 5 gpm to the flow rate required by Section P2904.4.2 where the water-service pipe supplies more than one dwelling.

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$$P_t = P_{sup} - PL_{svc} - PL_m - PL_d - PL_e - P_{sp}$$

PL_m = Pressure loss in the water meter.

Step 3 – Determine PL_m
Use Table P2904.6.2(2) to determine the pressure loss from the water meter, based on the selected water meter size.

Table P2904.6.2(2)
Minimum Water Meter Pressure Loss (PL_m)[a]

Flow Rate (gpm)[b]	5/8" Meter Pressure Loss (psi)	3/4" Meter Pressure Loss (psi)
8	2	1
10	3	1
12	4	1
14	5	2
16	7	3
18	9	4
20	11	4
22	NP	5
24	NP	5
26	NP	6
28	NP	6
30	NP	7
32	NP	7
34	NP	8
36	NP	8

NP - Not permitted unless the actual water meter pressure loss is known.
a. Table 2904.6.2(2) establishes conservative values for water meter pressure loss for installations where the water meter loss is unknown. Where the actual water meter pressure loss is known, P_m shall be the actual loss.
b. Flow rate from Section P2904.4.2. Add 5 gpm to the flow rate required by Section P2904.4.2 where the water-service pipe supplies more than one dwelling.

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$$P_t = P_{sup} - PL_{svc} - PL_m - PL_d - PL_e - P_{sp}$$

PL_d = Pressure loss from devices other than the water meter.

Step 4 – Determine PL_d
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 P2904.4.2, except that 5 gpm shall be added where the device is installed in a water-service pipe that supplies more than one dwelling. As 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.

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$$P_t = P_{sup} - PL_{svc} - PL_m - PL_d - PL_e - P_{sp}$$

PL_e = Pressure loss associated with changes in elevation.

Step 5 – Determine PL_e
Use Table P2904.6.2(3) 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 P2904.6.2(3)
Elevation Loss (PL_e)

Elevation (feet)	Pressure Loss (psi)
5	2.2
10	4.4
15	6.5
20	8.7
25	10.9
30	13
35	15.2
40	17.4

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$$P_t = P_{sup} - PL_{svc} - PL_m - PL_d - PL_e - P_{sp}$$

P_{sp} = Maximum pressure required by a sprinkler

Step 6 – Determine P_{sp}
Determine the maximum pressure required by any individual sprinkler based on the flow rate from Section P2904.4.1. The required pressure is provided in the sprinkler manufacturer's published data for the specific sprinkler model based on the selected flow rate.

Maximum Coverage Area [a] Ft. x Ft. (m x m)	Maximum Spacing Ft. (m)	Minimum Flow [b] and Residual Pressure For Horizontal Ceiling (Max. 2 Inch Rise for 12 Inch Run) 155°F/68°C or 175°F/79°C
12 x 12 (3.7 x 3.7)	12 (3.7)	13 GPM (49.2 LPM) 7.0 psi (0.48 bar)
14 x 14 (4.3 x 4.3)	14 (4.3)	13 GPM (49.2 LPM) 7.0 psi (0.48 bar)
16 x 16 (4.9 x 4.9)	16 (4.9)	13 GPM (49.2 LPM) 7.0 psi (0.48 bar)
18 x 18 (5.5 x 5.5)	18 (5.5)	17 GPM (64.3 LPM) 12.0 psi (0.83 bar)
20 x 20 (6.1 x 6.1)	20 (6.1)	20 GPM (75.7 LPM) 16.7 psi (1.15 bar)

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$$P_t = P_{sup} - PL_{svc} - PL_m - PL_d - PL_e - P_{sp}$$

Step 7 – Calculate P_t
Using Equation 29-1, 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 P2904.6.2(4) through P2904.6.2(9) to select a material and size for water distribution piping. The piping material and size shall be acceptable if the developed length of pipe between the service valve the most remote sprinkler does not exceed the maximum allowable length specified by the applicable table. Interpolation of P_t between the tabular values shall be permitted.

The maximum allowable length of piping in Tables P2904.6.2(4) through P2904.6.2(9) incorporates an adjustment for pipe fittings, and no additional consideration of friction losses associated with pipe fittings shall be required.

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Table P2904.6.2(7)
Allowable Pipe Length for 1 inch CPVC Pipe

Sprinkler Flow Rate[a] (gpm)	Water Distribution Size (inch)	Available Pressure - P_t (psi) 15	20	25	30	35	40	45	50	55	60
		Allowable Length of Pipe from Service Valve to Farthest Sprinkler (feet)									
8	1	1049	1398	1748	2098	2447	2797	3146	3496	3845	4195
9	1	843	1125	1406	1687	1968	2249	2530	2811	3093	3374
10	1	694	925	1157	1388	1619	1851	2082	2314	2545	2776
11	1	582	776	970	1164	1358	1552	1746	1940	2133	2327
12	1	495	660	826	991	1156	1321	1486	1651	1816	1981
13	1	427	570	712	854	997	1139	1281	1424	1566	1709
14	1	372	497	621	745	869	993	1117	1241	1366	1490
15	1	328	437	546	656	765	874	983	1093	1202	1311
16	1	291	388	485	582	679	776	873	970	1067	1164
17	1	260	347	433	520	607	693	780	867	954	1040
18	1	234	312	390	468	546	624	702	780	858	936
19	1	212	282	353	423	494	565	635	706	776	847
20	1	193	257	321	385	449	513	578	642	706	770
21	1	176	235	293	352	410	469	528	586	645	704
22	1	161	215	269	323	377	430	484	538	592	646
23	1	149	198	248	297	347	396	446	495	545	595
24	1	137	183	229	275	321	366	412	458	504	550
25	1	127	170	212	255	297	340	382	425	467	510
26	1	118	158	197	237	276	316	355	395	434	474
27	1	111	147	184	221	258	295	332	368	405	442
28	1	103	138	172	207	241	275	310	344	379	413
29	1	97	129	161	194	226	258	290	323	355	387
30	1	91	121	152	182	212	242	273	303	333	364
31	1	86	114	143	171	200	228	257	285	314	342
32	1	81	108	134	161	188	215	242	269	296	323
33	1	76	102	127	152	178	203	229	254	280	305
34	1	72	96	120	144	168	192	216	240	265	289
35	1	68	91	114	137	160	182	205	228	251	273
36	1	65	87	108	130	151	173	195	216	238	260
37	1	62	82	103	123	144	165	185	206	226	247
38	1	59	78	98	117	137	157	176	196	215	235
39	1	56	75	93	112	131	149	168	187	206	224
40	1	53	71	89	107	125	142	160	178	196	214

a. Flow rate from Section P2904.4.2.

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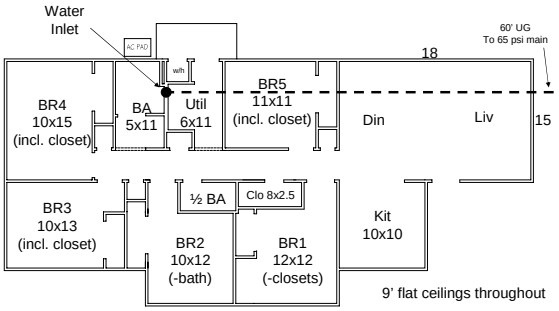
Smith Family Home



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Or Use Spreadsheet

Residential Sprinkler Sizing Table

Input Data	
Pressure Safety Factor (psi) :	3
Pipe Fittings Factor (%) :	40.00%
Sprinkler K Factor :	4.2
Water Service :	PE
PE SDR :	11
Input Diameter (in) :	1
C =	150
Water Distribution :	Blazemaster
Input Diameter	1
C =	150
Sprinkler Flow Rates to Investigate (gpm) :	12 13 18
Well System?	No
Water Service Length (ft) :	40
5/8" Meter Loss (psi) :	9
3/4" Meter Loss (psi) :	4
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

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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?

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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

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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)

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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)

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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

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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

161

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

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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

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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

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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?

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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

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Aren't Older Homes the "Real" Problem?

- Builders suggest that new homes area 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

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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

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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.

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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.*

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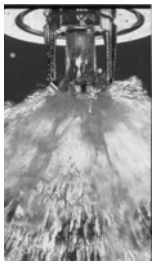
The Issue of Cost

- 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?"



185

The Issue of Cost
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

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The Issue of Cost
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.

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The Issue of Cost
True Impact

- Consider
  - $300,000 home
  - $3,000 sprinkler system
  - 6.5% mortgage
  - 5% credit on a $2,000/year insurance bill
  - Combined Federal/State income tax rate of 33%
  - The net cost of fire sprinklers, after mortgage related tax deductions, would be $4.37 per month.
- This represents a 0.23% increase in the monthly payment
  - Roughly equates to the cost of a premium beverage at your local coffee shop
- Just how cheap do sprinklers have to become before they're considered cost-effective?

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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

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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

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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.

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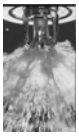
Won't Sprinklers Leak and Cause Mold Damage?

- 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 – 35-125F
  - Freezing – 20 below for 24 hours
  - And many others



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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?

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Resources
The Home Fire Sprinkler Coalition

www.homefiresprinkler.org

- DVD presentation and info kits

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Resources
Residential Fire Safety Institute

www.firesafehome.org

- Model ordinances
- Statistics
- History
- General support information for working on a local ordinance

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Resources
IRC Fire Sprinkler Coalition


IRC FIRE SPRINKLER COALITION

- Home
- Supporting Organizations
- Downloads
- Support This Effort
- Industry Links
- Contact Us

Welcome

The IRC Fire Sprinkler Coalition was formed in 2007 to support and coordinate efforts of firesafety advocates to change the International Residential Code (IRC) to require fire sprinklers in one- and two-family dwellings and townhouses. The IRC is a model code published by the International Code Council and this document is adopted by jurisdictions nationwide as the code governing most residential construction in the U.S. Currently, the IRC is adopted in 45 states plus the District of Columbia.

It has been more than 30 years since the concept of residential sprinklers was born, and in that time, the goal of the fire sprinkler community has been to reduce residential fires. Those who argue that the residential fire problem is "not that bad" only get away with making such statements because residential fires typically kill by ones and twos, dulling national attention.

Putting the residential fire death toll into perspective, it is roughly equivalent to wiping out the entire population of Rochester, NY, every year. The problem remains a solvable - and the solution is at hand: the sprinklers in one- and two-family dwellings and townhouses. This is the last significant piece still missing from America's fire safety plan.

At the International Code Council's May 2007 final action hearing in Rochester, NY, voting governmental members will be asked to approve a proposal (RB112) to the IRC that would be a historic contribution to fire safety that directly addresses the root of America's fire problem, dwelling fires. If you are a government employee who hopes to one day have a residential sprinkler ordinance in your jurisdiction, the best way to accomplish this goal is to attend the Rochester meeting to vote for this change.

The residential sprinkler requirement will be on the agenda as item RB112. If this item is accepted by ICC's voting governmental members, the residential sprinkler requirement will be slated to become a part of the 2009 edition of IRC. As a government employee, YOUR attendance in Rochester is critical because, to pass, this recommendation will require support by a two-thirds majority of voting governmental members present at the meeting.

Even if you've never attended an ICC hearing, you will find many federal, state and local officials there who will be happy to assist you in understanding and participating in the process. EVERY vote will be important because a two-thirds majority is a very high hurdle to overcome.

The specific date for the hearing on item RB112 has not yet been set. It will occur sometime during the May 21-26, 2007 ICC meeting. We will provide more detailed information on the likely hearing dates on this website after ICC announces the hearing schedule.

If you would like to support this effort, click here for more information on ICC voting governmental membership, which is required to vote at the hearing. You can also click here for information on attending the hearing in Rochester.

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- Supporting national and local adoption of residential sprinkler requirements

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Questions ?

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