What Builders Need to Know about Residential Sprinkler Design

Melisa Rodriguez, P.E., NICET IV
Design Services Supervisor, Fire Safety

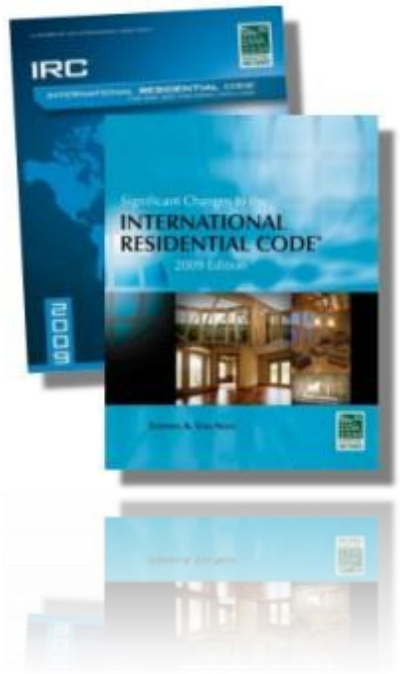
melisa.rodriguez@uponor.com
www.uponor-usa.com

Agenda

- Brief history and standards that govern sprinkler systems
- Ways to add value and reduce costs
  - Underground supplies
  - Builder techniques
  - Design techniques
  - System options

The Residential Sprinkler Opportunity

- Historically, fewer than 2% of new homes have fire sprinklers
- The International Code Council (ICC) vote
  - Mandates fire sprinklers in 2009 International Residential Code (IRC)
    - Effective since Jan. 1, 2011
- 2012 and 2015 Editions of the IRC also require fire sprinklers in one- and two-family dwellings
- State and municipality adoptions are increasing



National Fire Protection Association
The authority on fire, electrical and building safety
NFPA®

- Internationally recognized developer of standards for the fire sprinkler and electrical industries

- NFPA 13
  - Developed in 1896
  - Provides a reasonable degree of life and property protection
  - Commercial, industrial and institutional designs/installations
  - High-rise apartment building
  - Foundation for 13R and 13D

National Fire Protection Association
The authority on fire, electrical and building safety
NFPA®

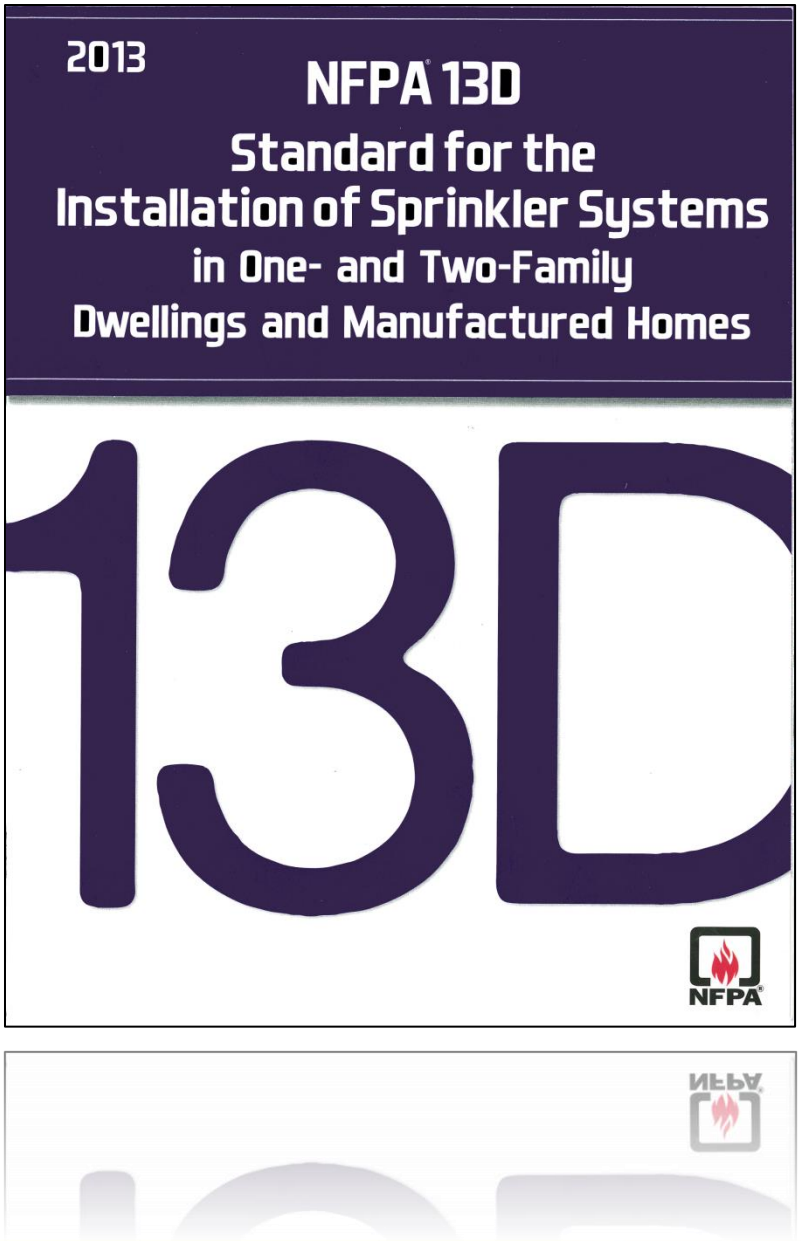
- Internationally recognized developer of standards for the fire sprinkler and electrical industries

- NFPA 13R
  - One of 2 residential NFPA standards
  - Developed in 1989
  - Aids in detection and control of fires in residential occupancies up to and including four stories in height
  - Multifamily residential (four-story apartment building)
  - Tenants all share the same piping system

uponor

National Fire Protection Association
The authority on fire, electrical and building safety
NFPA®

- NFPA 13D
  - Developed subcommittee in 1973
  - Adopted in 1975
  - Purpose is to prevent flashover
  - Improve the chances for escape or evacuation
  - One- and two-family dwellings, manufactured homes and townhomes (defined in 2010 NFPA 13D)
  - Life-safety system



uponor

Adding Value and Reducing Costs

What Adds Costs?

- Pressure losses through supply pipes can mean increased meter sizes or supply pipe sizes are required. If there is inadequate pressure available at the house, costly storage tanks and pumps may be required
- Number of sprinkler heads — Sprinklers make up a significant portion of the total cost of materials in a system
- Installation time — Labor costs are another big cost driver, so easier to install systems can save time and money

Pressure and Flow Requirements

Pressure and Flow is determined by the requirements of the sprinkler

- Minimum is 13 gpm at 7 psi

TABLE A. NFPA 13D & 13R WET PIPE HYDRAULIC DESIGN CRITERIA for Model SS8461

Maximum Coverage Area[(a)] Ft. × Ft. (m ×m)	Maximum Spacing Ft. (m)	Ordinary Temperature Rating 162℉ (72℃)		Intermediate Temperature Rating 175℉ (79℃)		Deflector to Ceiling	Installation Type	Minimum Spacing Ft. (m)
		Flow[(b)] GPM (LPM)	Pressure[(b)] PSI (bar)	Flow[(b)] GPM (LPM)	Pressure[(b)] PSI (bar)			
12×12 (3.7×3.7)	12 (3.7)	13 (49.2)	7.0 (0.48)	13 (49.2)	7.0 (0.48)	Smooth Ceilings 3/8 to 7/8 Inches. Beamed Ceilings per NFPA 13D,13R or 13 Installed in beam 3/8 to 7/8 inches below bottom of beam.	Concealed	9 (2.7)
14×14 (4.3×4.3)	14 (4.3)	13 (49.2)	7.0 (0.48)	14 (53.0)	8.2 (0.57)			
16×16 (4.9×4.9)	16 (4.9)	13 (49.2)	7.0 (0.48)	14 (53.0)	8.2 (0.57)			
18×18 (5.5×5.5)	18 (5.5)	18 (68.1)	13.5 (0.93)	—	—			
20×20 (6.1×6.1)	20 (6.1)	21 (79.5)	18.4 (1.27)	—	—			

(a) For coverage area dimensions less than the above mentioned, it needs to use the minimum required flow for the Next Higher Coverage Area listed.

(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.

(c) For systems with ceiling types smooth flat horizontal, or beamed, or sloped, in accordance with the 2013 Edition of NFPA 13D, 13R or 13 as applicable.

How is Pressure Loss Determined?

NFPA 13D Chapter 10 requires hydraulic calculations flowing a maximum of 2 sprinklers — 26 gpm total for standard residential sprinklers.

Hazen Williams Equation

$$p = \frac{4.52Q^{1.85}}{C^{1.85}d^{4.87}}$$

Where:
p = frictional resistance (psi/ft. of pipe)
Q = flow (gpm)
C = friction loss coefficient (150 for plastic pipe)
d = actual internal diameter of pipe (in.)

Gives us psi loss per foot of pipe based on flow, internal diameter and roughness of the pipe walls. Smaller pipe sizes mean more friction loss and higher flows also mean higher friction loss.

How to Reduce Costs?

Water Supply

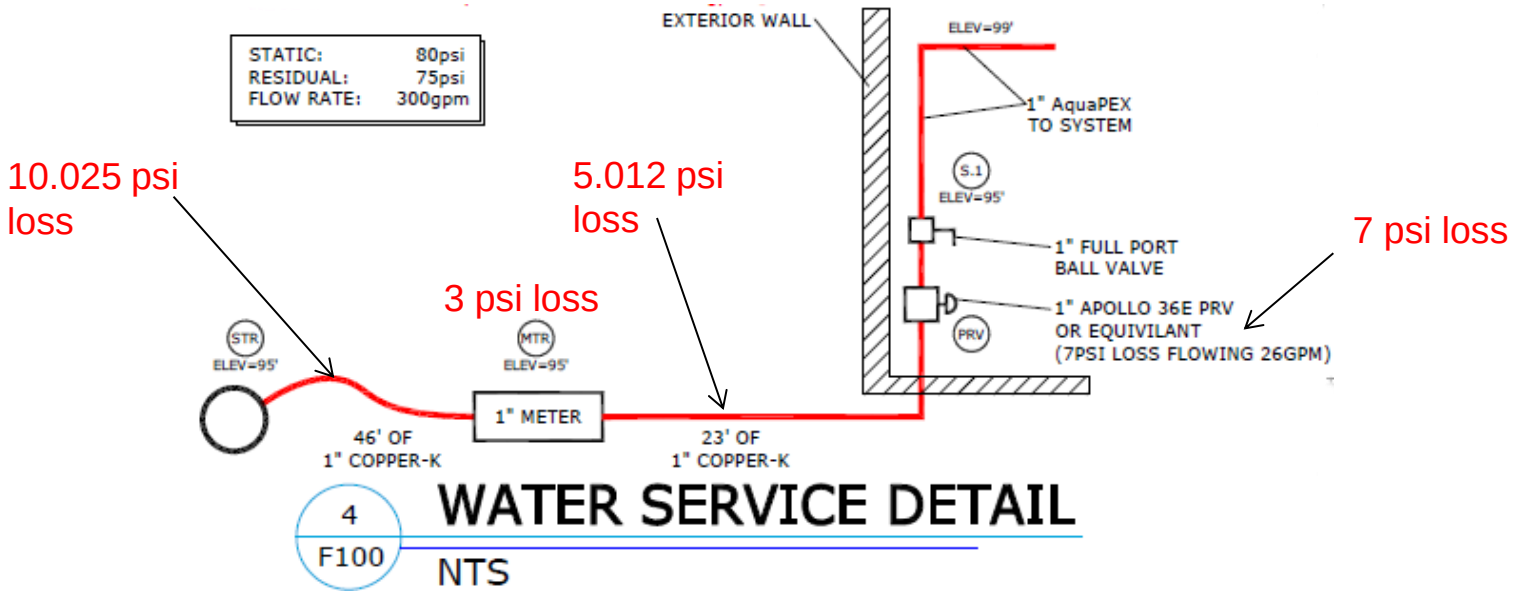
More Sprinkler Omissions

Design Options

Water Supply

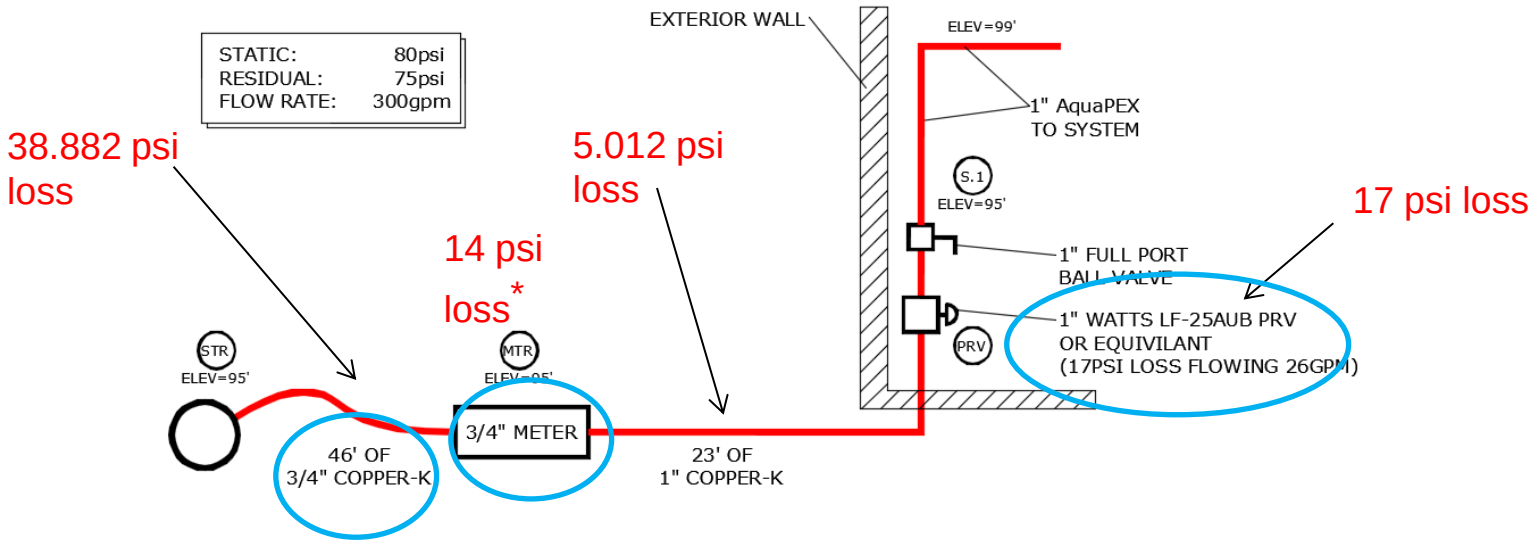
Underground Supply Components

Accurate static pressure readings are crucial



Total pressure loss through underground: 25.037
54.963 remaining at shutoff valve
Adequate for most typical sprinkler systems

Underground Supply Components

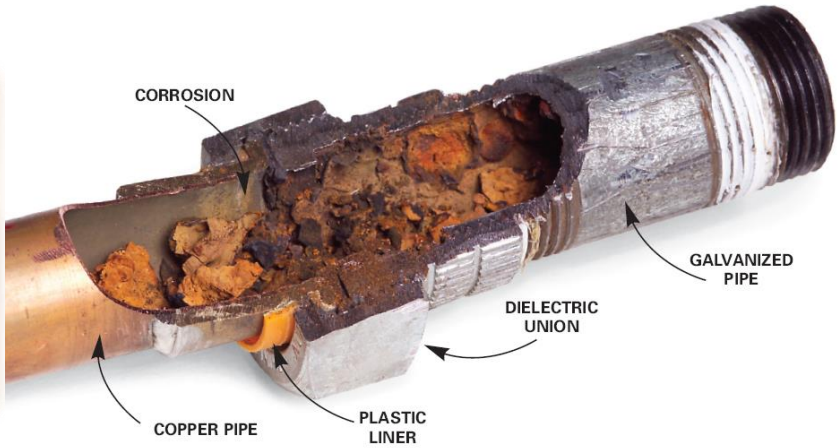


Total pressure loss through underground: 75.894
4.106 remaining at shutoff valve
NOT enough pressure for even a single sprinkler
(7 psi minimum at remote sprinkler)

Common Underground Supplies

Pressure loss per foot at 26 GPM:

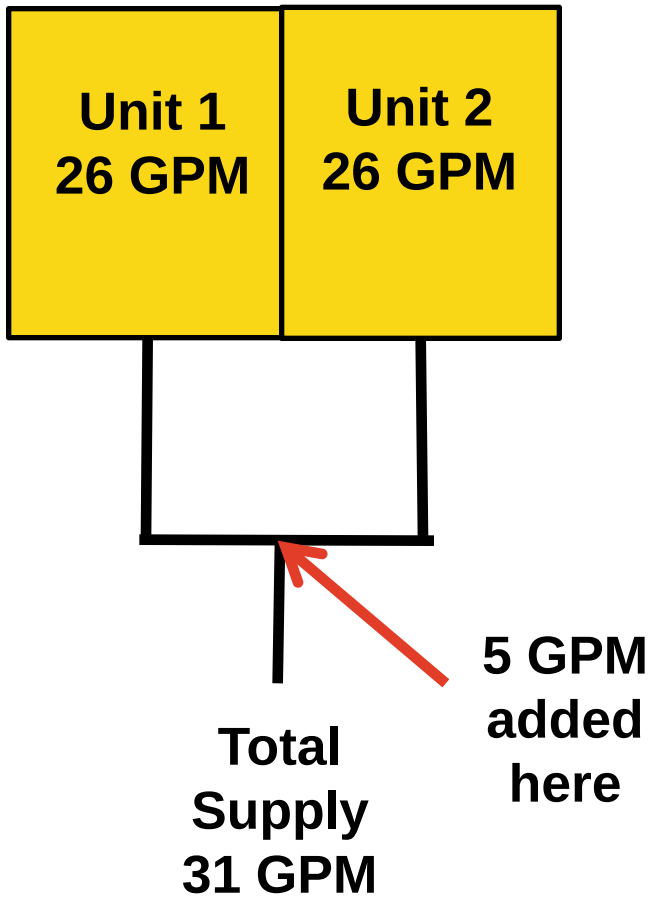
Pipe	Size	ID (in)	psi/ft	10'	50'
CTS Poly	1"	0.911	0.28	2.8	14
SCH40 PVC	1"	1.049	0.141	1.41	7.05
Copper	3/4"	0.745	0.748	7.48	37.4
Copper	1"	0.995	0.182	1.82	9.1



Chapter 6: Water Supply

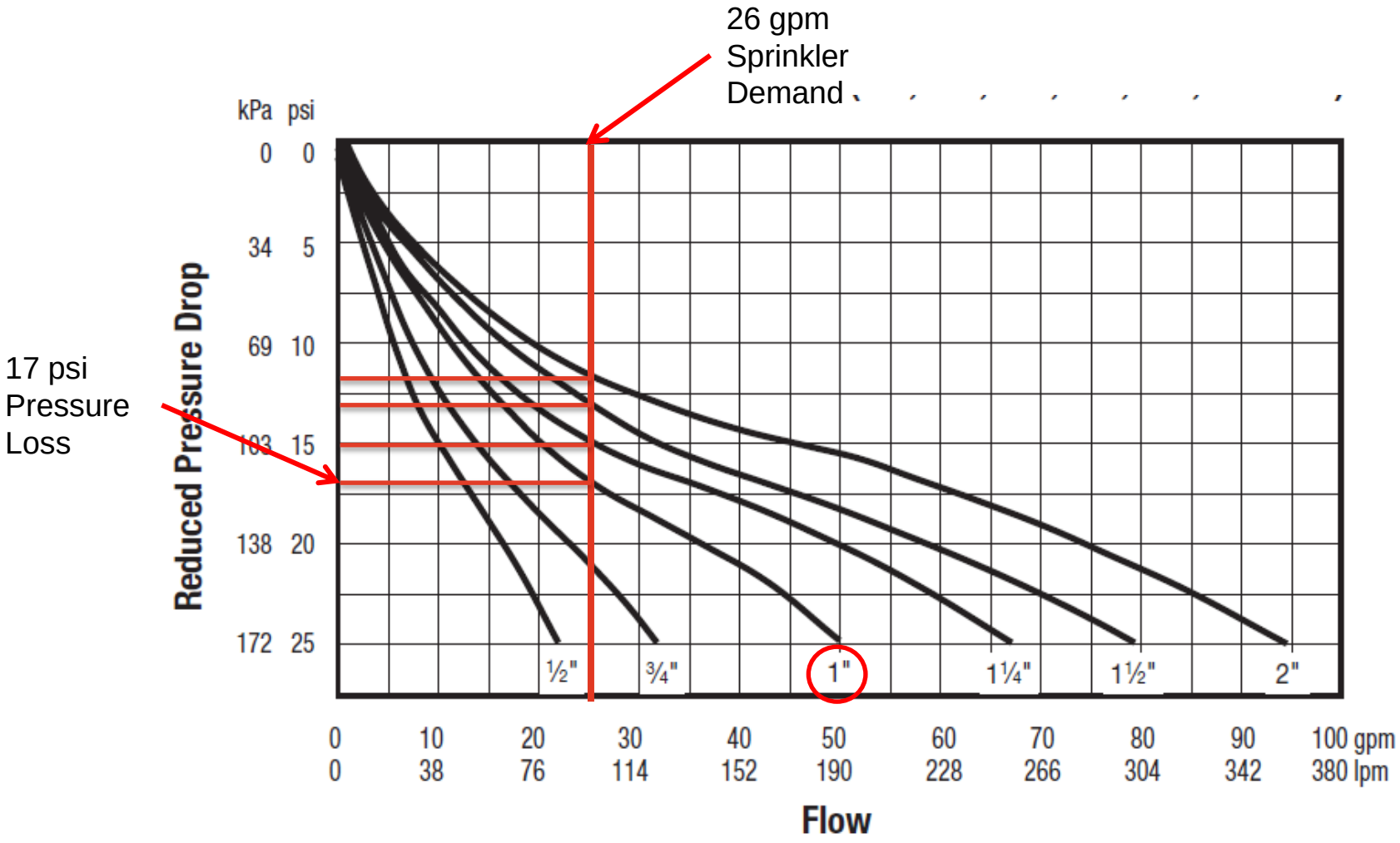
- **6.5 Common Supply Pipes.**

6.5.2 In common water supply connections serving more than one dwelling unit, 5 gpm (19 L/min) shall be added to the sprinkler system demand to determine the size of common piping and the size of the total water supply requirements where no provision is made to prevent flow into the domestic water system upon operation of a sprinkler.



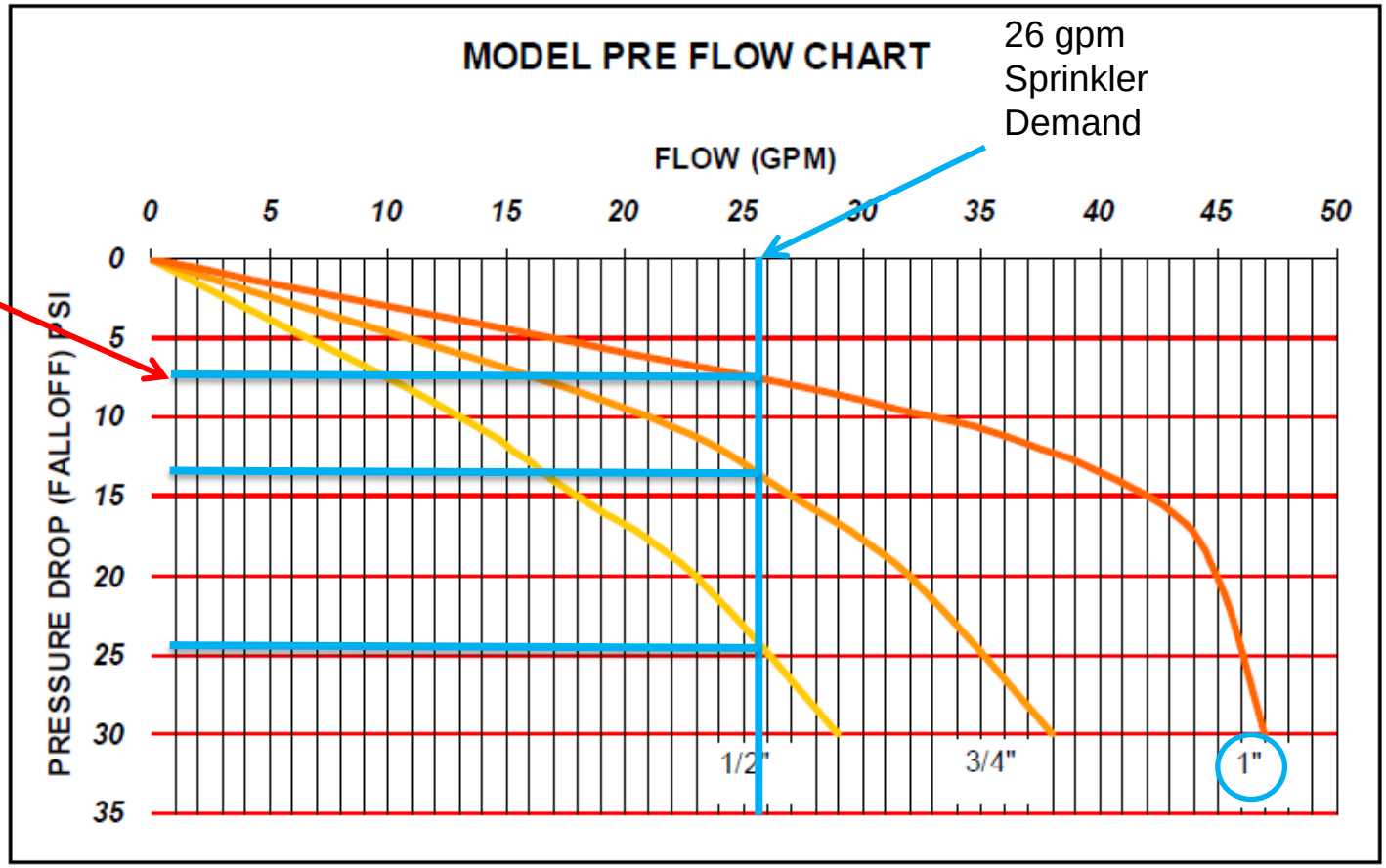
Pressure-reducing Valves

Necessary to keep incoming pressures below fixture ratings



Pressure-reducing Valves

Choose one with favorable flow characteristics



Meters

Maximum-rated flows

	Meter size		
	5/8"	3/4"	1"
Typical Operating Range	1 to 20 gpm	2 to 30 gpm	3 to 50 gpm
Maximum Continuous Operation	10 gpm	15 gpm	25 gpm
Maximum Pressure Loss	7 psi at 20 gpm	9 psi at 30 gpm	7.3 psi at 50 gpm

- 5/8” x ¾” Meters still have 5/8” bodies and flow restrictions
- NFPA 13D allows for the use of meters beyond their rated flows, however liability concerns may still exist

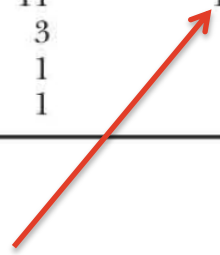
Meters

Pressure loss through meters

- If you don't know the make and model of the meter, use losses given in NFPA 13D Chapter 10

Table 10.4.3(a) Pressure Losses in psi in Water Meters

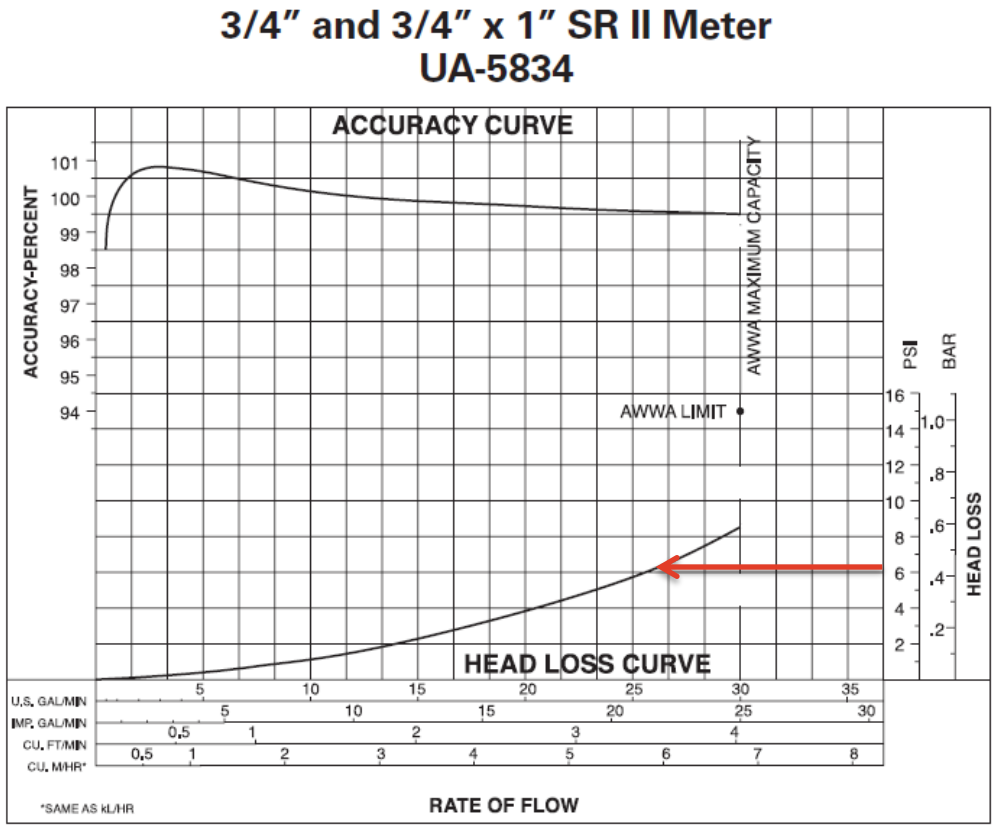
Meter Size (in.)	Flow (gpm)					
	18 or less	23	26	31	39	52
⅝	9	14	18	26	38	*
¾	7	11	14	22	35	*
1	2	3	3	4	6	10
1½	1	1	2	2	4	7
2	1	1	1	1	2	3



Meters

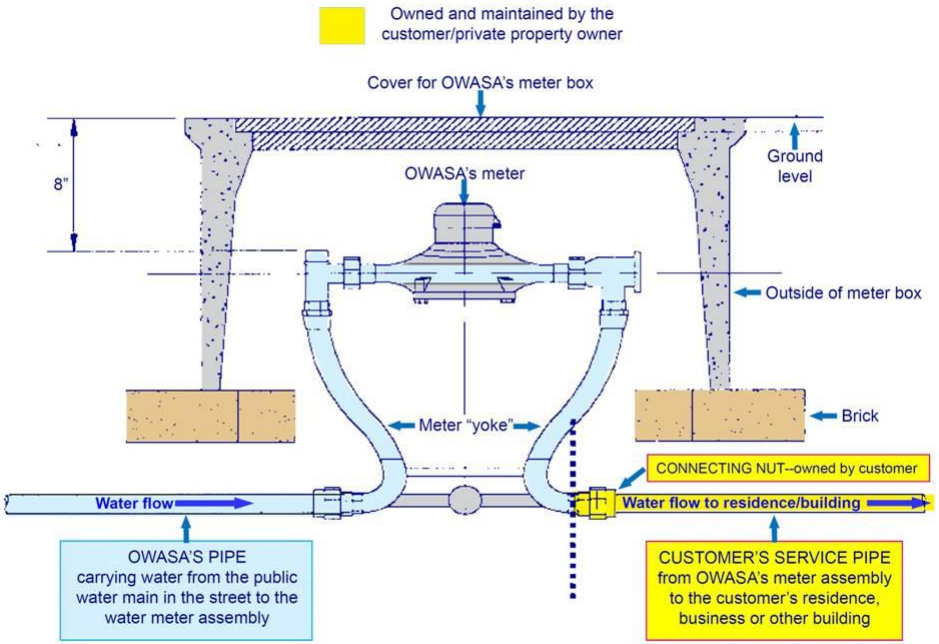
Pressure loss through meters

- NFPA 13D allows you to use the manufacturer's data, if known



Meter Setters

Meter setters can greatly restrict water flow and should be avoided whenever possible — talk to you local water purveyor



Elevation Changes

- Elevation changes lose or gain 0.433 psi per foot of elevation
- If house is above the site of the pressure reading the pressure loss must be accounted for in the calculations

Pressure reading taken at bottom of hill of 60 psi

House at top of hill is 20' higher,
20 x 0.433 = 8.66 psi less, or 51.34

Underground Supply Lessons

- Find out accurate available pressure and water supply information early
- If you have the option to choose supply size, talk to your design professional
- Make sure the meter is rated to supply enough flow
- If pressure reducing valves are required, size, make & model are very important
- All fittings, valves and other pressure restrictive devices must be known before the design is started
- Elevation changes must be included in hydraulic calculations

Builder Techniques

Builder Techniques to Reduce Cost

- Sprinkler may be omitted from certain areas per 13D. Maximizing those omissions can save money by reducing sprinklers.
  - Closets
  - Bathrooms
  - Ceiling pockets
  - Non-accessible concealed spaces
  - Fuel-fired equipment locations

- Slopes and beams can create complications for sprinklers and drastically increase the number of sprinklers needed
  - Pockets created by decorative beams could need a sprinkler located within each pocket
  - False beams may be able to have sprinklers installed at the bottom if certain requirements are met
  - Sidewalls sprinklers located below the beams may be an option (12" max. below ceiling)

8.3 Location of Sprinklers

8.3.4* Sprinklers shall not be required in garages, open attached porches, carports, and similar structures.

8.3 Location of Sprinklers

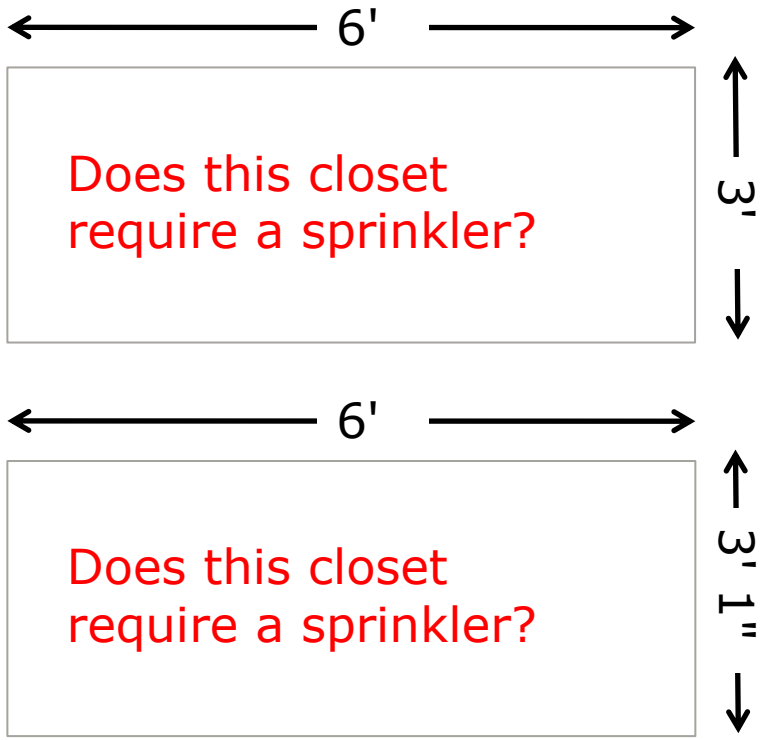
8.3.3 Sprinklers shall not be required in clothes closets, linen closets, and pantries that meet all of the following conditions:

(1) The area of the space does not exceed 24 ft^2 (2.2 m^2).
(2) The shortest dimension does not exceed 3 ft (0.9 m).
(3) The walls and ceilings are surfaced with noncombustible or limited-combustible materials as defined in NFPA 220.

8.3 Location of Sprinklers

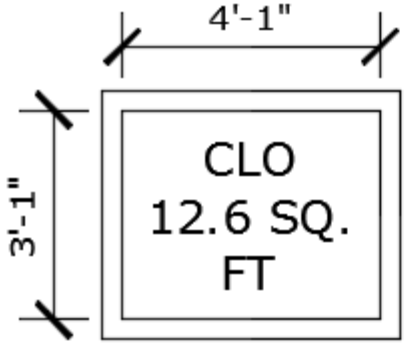
8.3.3 Sprinklers shall not be required in clothes closets, linen closets, and pantries that meet all of the following conditions:

(1) The area of the space does not exceed 24 ft^2 (2.2 m^2).
(2) The shortest dimension does not exceed 3 ft (0.9 m).
(3) The walls and ceilings are surfaced with noncombustible or limited-combustible materials as defined in NFPA 220.

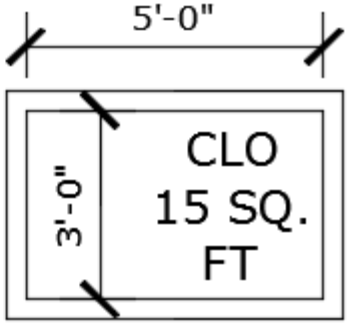


8.3 Location of Sprinklers

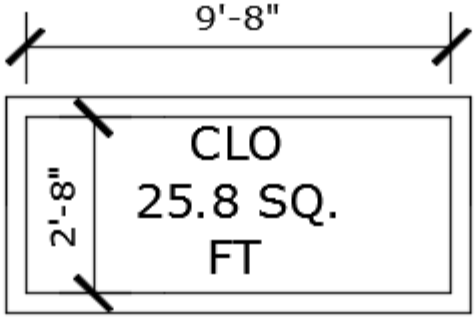
The least dimension exceeds 3 ft (0.9 m)
Sprinkler Required



Square footage does not exceed 24 ft² (2.2 m²).
Sprinkler Not Required



Square footage exceeds 24 ft² (2.2 m²).
Sprinkler Required

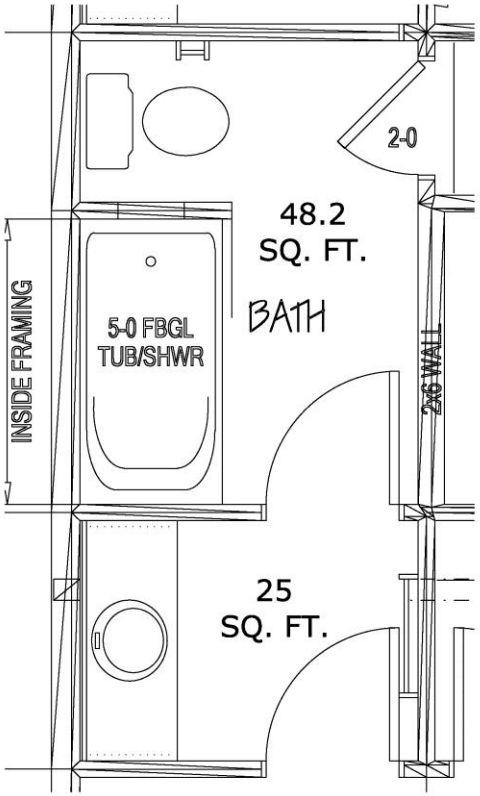


8.3 Location of Sprinklers

8.3.2 Sprinklers shall not be required in bathrooms of 55 ft^2 and less.

8.3 Location of Sprinklers

8.3.2 Sprinklers shall not be required in bathrooms of 55 ft^2 and less.



No Sprinkler Required

Sprinkler Required

8.3 Location of Sprinklers

8.3.7 Sprinklers shall not be required for ceiling pockets that meet the following conditions:

(1) The total volume of all unprotected ceiling pockets in a compartment does not exceed 100 ft^3 (2.83 m^3).

(2) The entire floor under the unprotected ceiling pocket is protected by the sprinklers at the lower ceiling elevation.

(3)*The interior finish of the unprotected ceiling pocket excluding decorative treatments is noncombustible or limited-combustible material.

(4) Skylights not exceeding 32 ft^2 (2.97 m^2) shall be permitted to have a plastic cover.

8.3 Location of Sprinklers

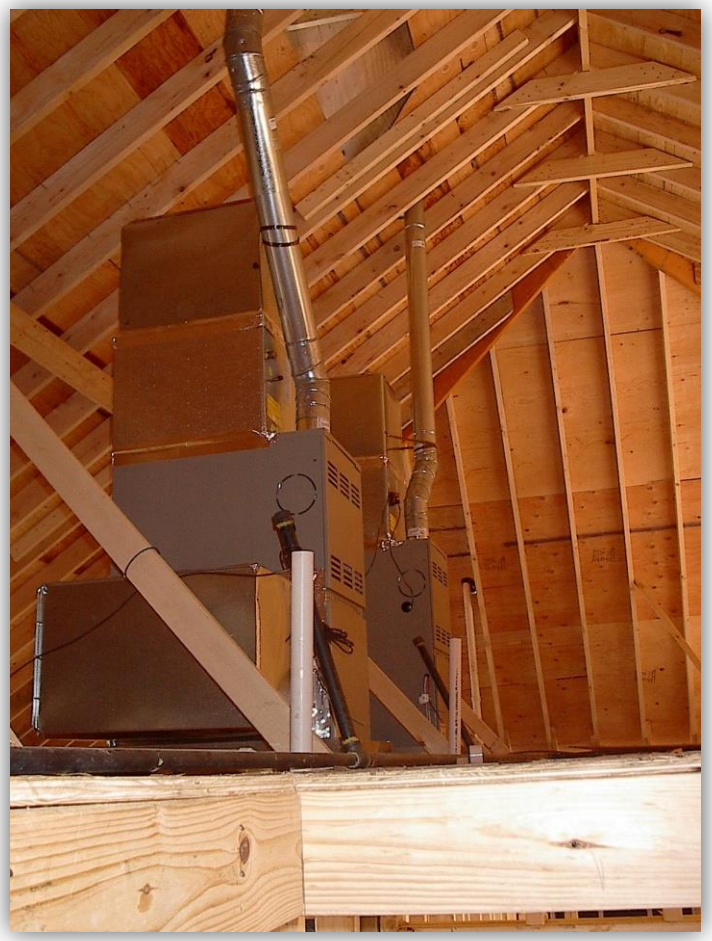
8.3.5 Sprinklers shall not be required in attics with or without storage, penthouse equipment rooms, elevator machine rooms, concealed spaces dedicated exclusively to and containing only dwelling unit ventilation equipment, floor/ceiling spaces, elevator shafts, crawl spaces, and other concealed spaces that are not used or intended for living purposes.

8.3 Location of Sprinklers

8.3.5.1 Such spaces that contain fuel-fired equipment shall also comply with 8.3.5.1.1 or 8.3.5.1.2.

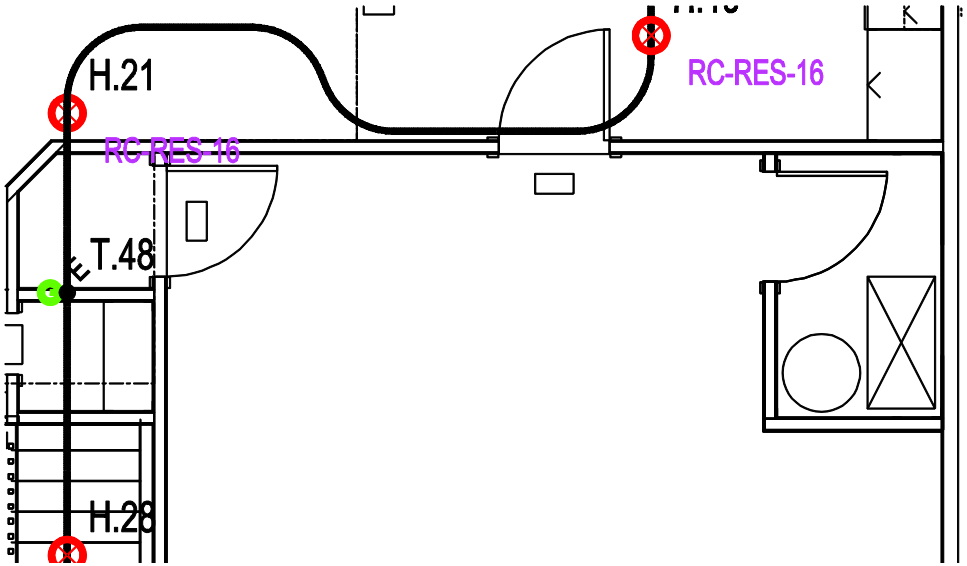
8.3.5.1.1 Where the fuel-fired equipment is above all of the occupied areas of the dwelling unit, no sprinkler protection shall be required in the concealed space.

8.3.5.1.2 Where fuel-fired equipment is below or on the same level as occupied areas of the dwelling unit, at least one quick response intermediate temperature sprinkler shall be installed above the equipment or at the wall separating the space with the fuel-fired equipment from the occupied space.



8.3 Location of Sprinklers

8.3.8 Sprinklers shall not be required in closets in garages and exterior closets (regardless of size) located on exterior balconies, exterior breezeways/corridors, or accessed from outdoors where the closet does not have doors or unprotected penetrations directly into the dwelling unit.



8.3.9 Sprinklers shall be installed in any closet used for heating and/or air-conditioning equipment, washers and/or dryers, or water heaters except as allowed by 8.3.8.

Design Techniques

Design Techniques to Reduce Costs

- Material Selection
  - Some materials have compatibility or liability issues
  - Exposed applications can get costly
- Piping Configuration
  - Tree versus loop piping configuration can change pipe sizes and pressure loss
- System Type
  - Standalone requires additional valves and riser components
  - Multipurpose doesn’t require anything more than the main shutoff valve because the cold water plumbing and fire sprinkler systems are integrated

Types of Pipe

CPVC

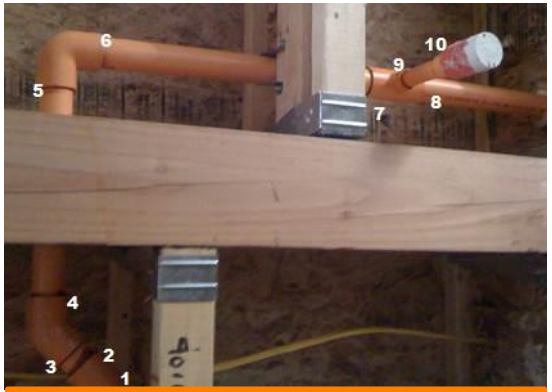
Copper

Steel

PEX

PEX-a vs. CPVC

- Flexible, easier to work with
- Fewer fittings, reduces potential leak point liability
- Cannot be dry fit
- Fast, easy connections; no solvents or other toxic chemicals
- Connections not affected by rain or high-humidity conditions
- Ability to air test, will not shatter
- Greater impact strength
- Expands up to 3X its diameter, minimizing potential freeze damage



10 connections for CPVC

2 connections for PEX-a

CPVC Freeze Cracking

PEX-a Intact After Freeze

uponor

PEX-a vs. CPVC

- Flexible, easier to work with
- Fewer fittings, reduces potential leak point liability
- Cannot be dry fit
- Fast, easy connections; no solvents or other toxic chemicals
- Connections not affected by rain or high-humidity conditions
- Ability to air test, will not shatter
- Greater impact strength
- Expands up to 3X its diameter, minimizing potential freeze damage

10 connections for CPVC

2 connections for PEX-a

CPVC Freeze Cracking

PEX-a Intact After Freeze

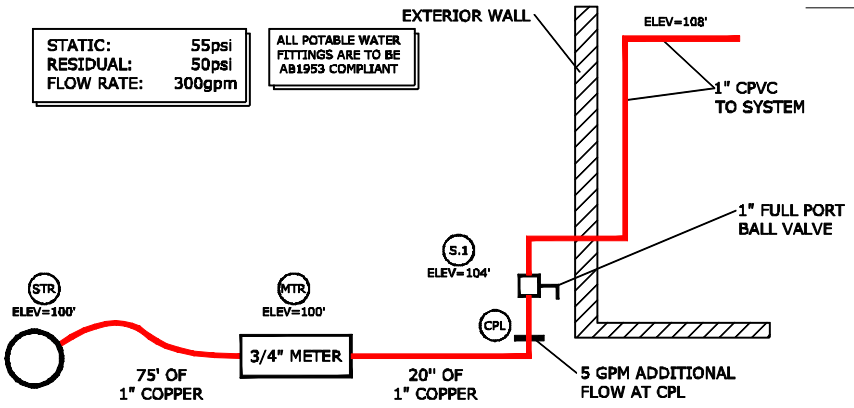
uponor

System Changes

Rigid pipe (CPVC) System

- 1" riser and branch lines
- 2-head calculation
- Demand = 50.8

H.2	13.00	0.874	1O	3.0	5.000	7.040	K Factor = 4.90
to		150.0		0.0	3.000	0.0	
T.5	13.0	0.0944		0.0	8.000	0.755	Vel = 6.95
T.5	0.0	1.101	1R	1.0	15.000	7.795	
to		150.0		0.0	1.000	0.0	
T.4	13.0	0.0307		0.0	16.000	0.491	Vel = 4.38
T.4	13.41	1.101	1R	1.0	20.000	8.286	
to		150.0	1T	9.563	10.563	1.732	
S.1	26.41	0.1138		0.0	30.563	3.478	Vel = 8.90
S.1	0.0	0.995	2E	4.673	5.000	13.496	
to		150.0		0.0	4.673	1.732	
BOR	26.41	0.1863		0.0	9.673	1.802	Vel = 10.90
BOR	5.00	0.995		0.0	20.000	17.030	Qa = 5
to		150.0		0.0	0.0	7.000	* Fixed loss = 7
MTR	31.41	0.2568		0.0	20.000	5.135	Vel = 12.96
MTR	0.0	0.995	1E	2.336	75.000	29.165	
to		150.0	1T	5.841	9.345	0.0	
STR	31.41	0.2567	1G	1.168	84.345	21.654	Vel = 12.96
	0.0						
	31.41					50.819	K Factor = 4.41
H.1	13.41	0.874	1O	3.0	5.000	7.487	K Factor = 4.90
to		150.0		0.0	3.000	0.0	
T.4	13.41	0.0999		0.0	8.000	0.799	Vel = 7.17
	0.0						
	13.41					8.286	K Factor = 4.66



System Changes

Rigid pipe (CPVC) System

- Changes made to offset around conflicting trade
- 4 elbows cause a higher friction loss in the line leading to sprinkler 2
- Sprinkler 1 has a higher flow now
- New demand = 58.4
- **7.6psi higher**

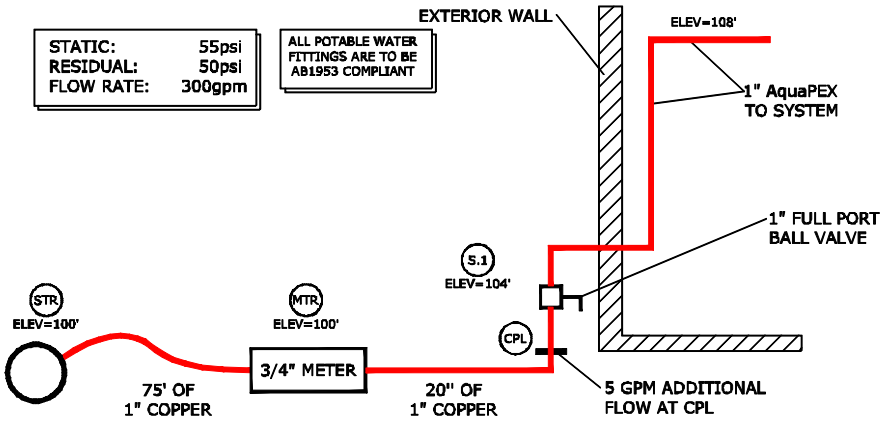
H.2	13.00	0.874		0.0	2.000	7.040	K Factor = 4.90
to		150.0		0.0	0.0	0.0	
T.3	13.0	0.0945		0.0	2.000	0.189	Vel = 6.95
T.3	0.0	0.874	1N	7.0	2.000	7.229	
to		150.0		0.0	7.000	0.0	
T.4	13.0	0.0944		0.0	9.000	0.850	Vel = 6.95
T.4	0.0	0.874	1N	7.0	2.000	8.079	
to		150.0		0.0	7.000	0.0	
T.6	13.0	0.0943		0.0	9.000	0.849	Vel = 6.95
T.6	0.0	0.874	1N	7.0	2.000	8.928	
to		150.0		0.0	7.000	0.0	
T.5	13.0	0.0944		0.0	9.000	0.850	Vel = 6.95
T.5	0.0	0.874	1O	3.0	1.000	9.778	
to		150.0	1N	7.0	10.000	0.0	
T.9	13.0	0.0945		0.0	11.000	1.039	Vel = 6.95
T.9	0.0	1.101	1R	1.0	15.000	10.817	
to		150.0		0.0	1.000	0.0	
T.8	13.0	0.0306		0.0	16.000	0.490	Vel = 4.38
T.8	15.68	1.101	1R	1.0	20.000	11.307	
to		150.0	1T	9.563	10.563	1.732	
S.1	28.68	0.1326		0.0	30.563	4.052	Vel = 9.66
S.1	0.0	0.995	2E	4.673	5.000	17.091	
to		150.0		0.0	4.673	1.732	
BOR	28.68	0.2170		0.0	9.673	2.099	Vel = 11.83
BOR	5.00	0.995		0.0	20.000	20.922	Qa = 5
to		150.0		0.0	0.0	7.000	* Fixed loss = 7
MTR	33.68	0.2922		0.0	20.000	5.844	Vel = 13.90
MTR	0.0	0.995	1E	2.336	75.000	33.766	
to		150.0	1T	5.841	9.345	0.0	
STR	33.68	0.2921	1G	1.168	84.345	24.641	Vel = 13.90
	0.0						
	33.68					58.407	K Factor = 4.41
H.1	15.68	0.874	1O	3.0	5.000	10.239	K Factor = 4.90
to		150.0		0.0	3.000	0.0	
T.8	15.68	0.1335		0.0	8.000	1.068	Vel = 8.39
	0.0						
	15.68					11.307	K Factor = 4.66

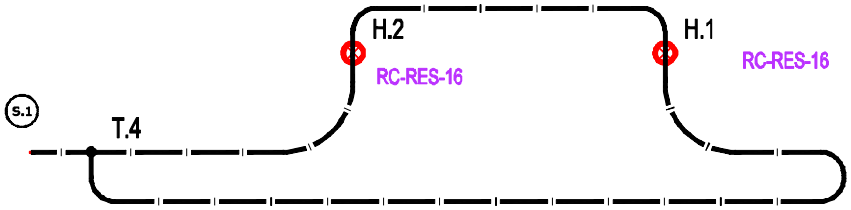
System Changes

Uponor AquaPEX® System

- 1" riser and branchlines
- 2-head calculation
- Demand = 52.5

H.1	9.98	0.862	1Utb	17.0	32.000	7.040	K Factor = 4.90
to		150.0	1Utr	2.0	16.000	0.0	
T.3	9.98	0.0619		0.0	48.000	2.973	Vel = 5.49
T.3	16.13	0.862	1T	7.528	8.000	10.013	
to		150.0		0.0	2.904	1.732	
S.1	26.11	0.3669		0.0	10.904	4.001	Vel = 14.35
S.1	0.0	0.995	2E	4.673	5.000	15.746	
to		150.0		0.0	4.673	1.732	
BOR	26.11	0.1824		0.0	9.673	1.764	Vel = 10.77
BOR	5.00	0.995		0.0	20.000	19.242	Qa = 5
to		150.0		0.0	0.0	7.000	* Fixed loss = 7
MTR	31.11	0.2522		0.0	20.000	5.045	Vel = 12.84
MTR	0.0	0.995	1E	2.336	75.000	31.287	
to		150.0	1T	5.841	9.345	0.0	
STR	31.11	0.2522	1G	1.168	84.345	21.273	Vel = 12.84
	0.0						
	31.11					52.560	K Factor = 4.29
H.1	3.02	0.862	1Utr	2.0	15.000	7.040	
to		150.0		0.0	2.000	0.0	
H.2	3.02	0.0068		0.0	17.000	0.115	Vel = 1.66
H.2	13.10	0.862	1Utr	2.0	17.000	7.155	K Factor = 4.90
to		150.0		0.0	2.000	0.0	
T.3	16.12	0.1504		0.0	19.000	2.858	Vel = 8.86
	0.0						
	16.12					10.013	K Factor = 5.09



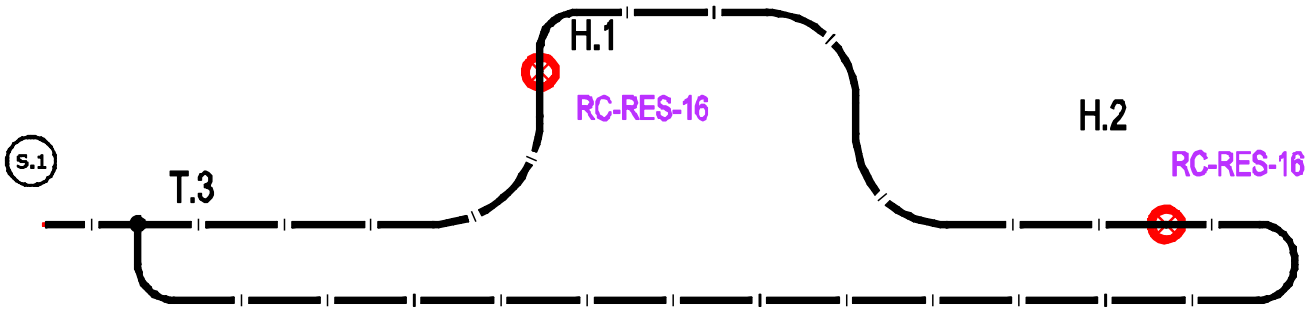


System Changes

Uponor AquaPEX® System

- Obstruction causes relocation of sprinkler
- No additional fittings
- New demand = 52.6
- **0.1psi higher**

H.2	10.11	0.862	1Utb	17.0	31.000	7.040	K Factor = 4.90
to		150.0	1Utr	2.0	16.000	0.0	
T.3	10.11	0.0634		0.0	47.000	2.979	Vel = 5.56
T.3	16.03	0.862	1T	7.528	8.000	10.019	
to		150.0		0.0	2.904	1.732	
S.1	26.14	0.3677		0.0	10.904	4.009	Vel = 14.37
S.1	0.0	0.995	2E	4.673	5.000	15.760	
to		150.0		0.0	4.673	1.732	
BOR	26.14	0.1829		0.0	9.673	1.769	Vel = 10.79
BOR	5.00	0.995		0.0	20.000	19.261	Qa = 5
to		150.0		0.0	0.0	7.000	* Fixed loss = 7
MTR	31.14	0.2527		0.0	20.000	5.054	Vel = 12.85
MTR	0.0	0.995	1E	2.336	75.000	31.315	
to		150.0	1T	5.841	9.345	0.0	
STR	31.14	0.2527	1G	1.168	84.345	21.314	Vel = 12.85
	0.0						
	31.14					52.629	K Factor = 4.29
H.2	2.90	0.862		0.0	24.000	7.040	
to		150.0		0.0	0.0	0.0	
H.1	2.9	0.0063		0.0	24.000	0.151	Vel = 1.59
H.1	13.13	0.862	1Utr	2.0	17.000	7.191	K Factor = 4.90
to		150.0		0.0	2.000	0.0	
T.3	16.03	0.1488		0.0	19.000	2.828	Vel = 8.81
	0.0						
	16.03					10.019	K Factor = 5.06

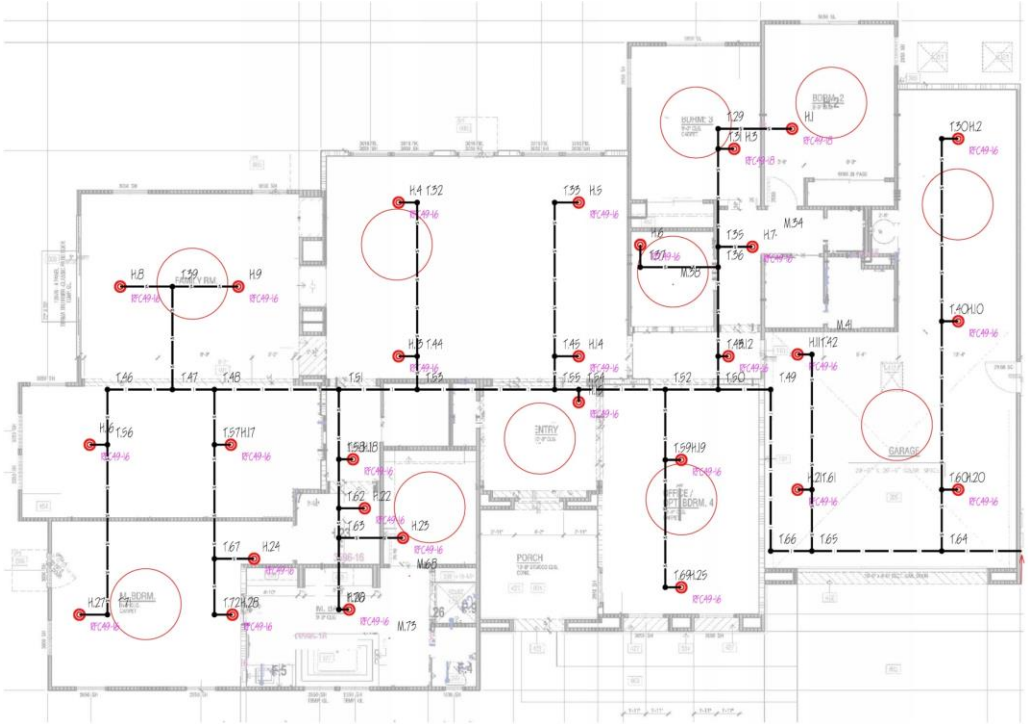


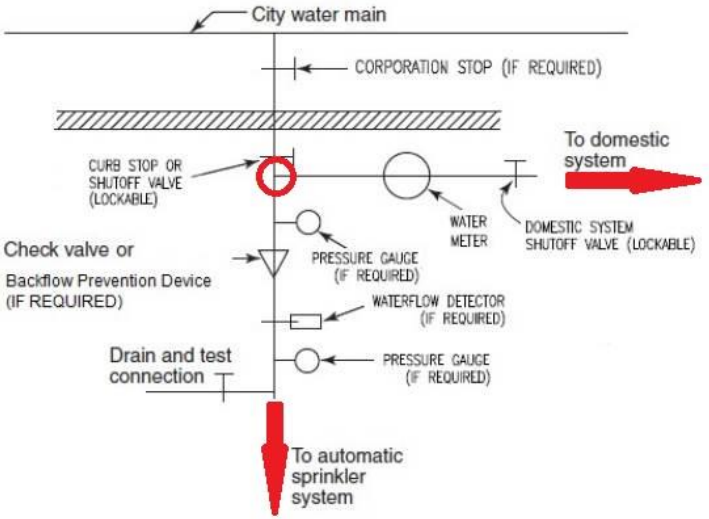
System Options

Loop	Tree
Pros • **Uniform sizing** • **Minor changes don't affect hydraulics** • **Smaller pipe sizes** • **Water circulation**	**Pros** • **Less pipe** • **Prescriptive sizing acceptable** • **Easy to follow hydraulics**
Cons • Slightly more pipe • More complicated Calculations • Can't use prescriptive sizing method	Cons • Larger pipe sizes • Variety of sizes • Stagnant water • Changes have larger impact

Standalone

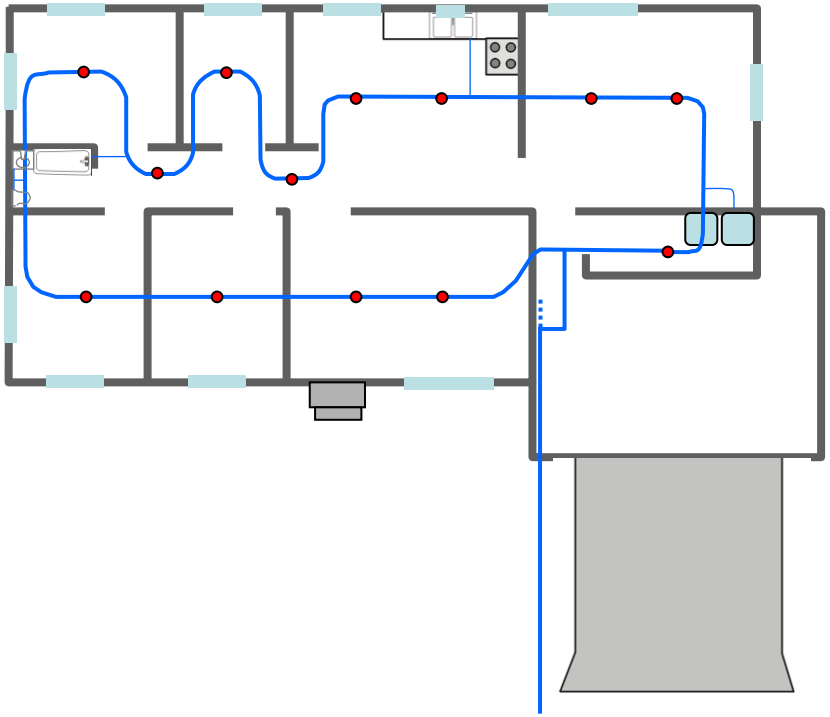
3.3.11.9* ***Standalone Sprinkler System.*** A sprinkler system where the aboveground piping serves only fire sprinklers



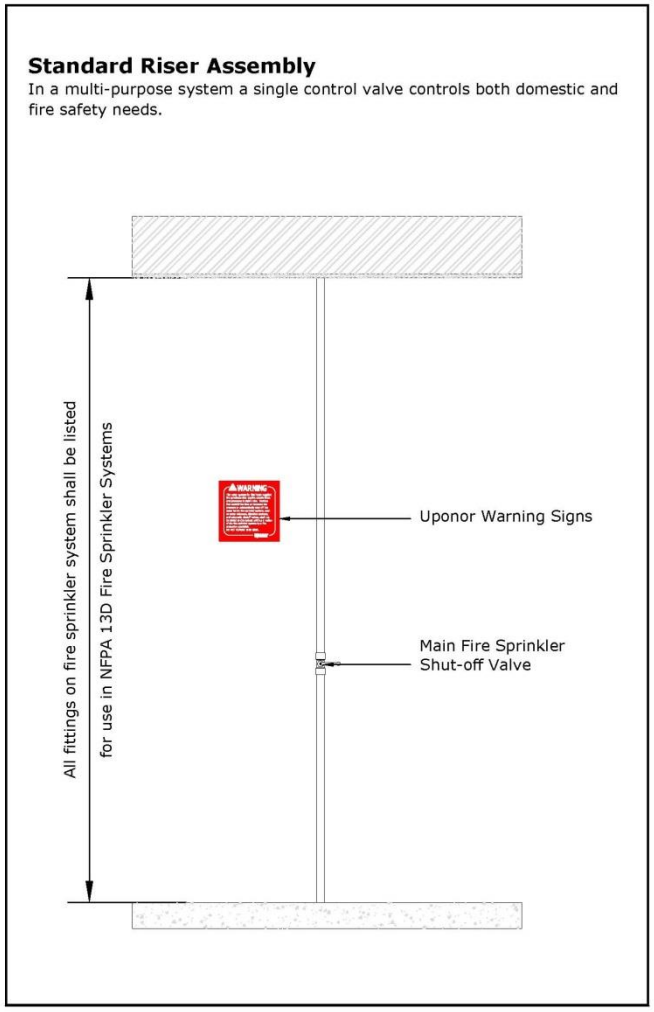


Multipurpose

3.3.11.3* ***Multipurpose Piping Sprinkler System.*** A piping system intended to serve both domestic needs in excess of a single fixture and fire protection needs from one common piping system throughout the dwelling unit(s).



Multipurpose



Design Techniques to Limit Pressure

- Limit use of residential sprinklers spaced beyond 16' except in separate compartments to keep the total gpm required low.

TABLE A. NFPA 13D & 13R WET PIPE HYDRAULIC DESIGN CRITERIA for Model SS8461

Maximum Coverage Area[a] Ft. × Ft. (m ×m)	Maximum Spacing Ft. (m)	Ordinary Temperature Rating 162°F (72°C)		Intermediate Temperature Rating 175°F (79°C)		Deflector to Ceiling	Installation Type	Minimum Spacing Ft. (m)
		Flow[b] GPM (LPM)	Pressure[b] PSI (bar)	Flow[b] GPM (LPM)	Pressure[b] PSI (bar)			
12×12 (3.7×3.7)	12 (3.7)	13 (49.2)	7.0 (0.48)	13 (49.2)	7.0 (0.48)	Smooth Ceilings 3/8 to 7/8 Inches. Beamed Ceilings per NFPA 13D,13R or 13 Installed in beam 3/8 to 7/8 inches below bottom of beam.	Concealed	9 (2.7)
14×14 (4.3×4.3)	14 (4.3)	13 (49.2)	7.0 (0.48)	14 (53.0)	8.2 (0.57)			
16×16 (4.9×4.9)	16 (4.9)	13 (49.2)	7.0 (0.48)	14 (53.0)	8.2 (0.57)			
18×18 (5.5×5.5)	18 (5.5)	18 (68.1)	13.5 (0.93)	—	—			
20×20 (6.1×6.1)	20 (6.1)	21 (79.5)	18.4 (1.27)	—	—			

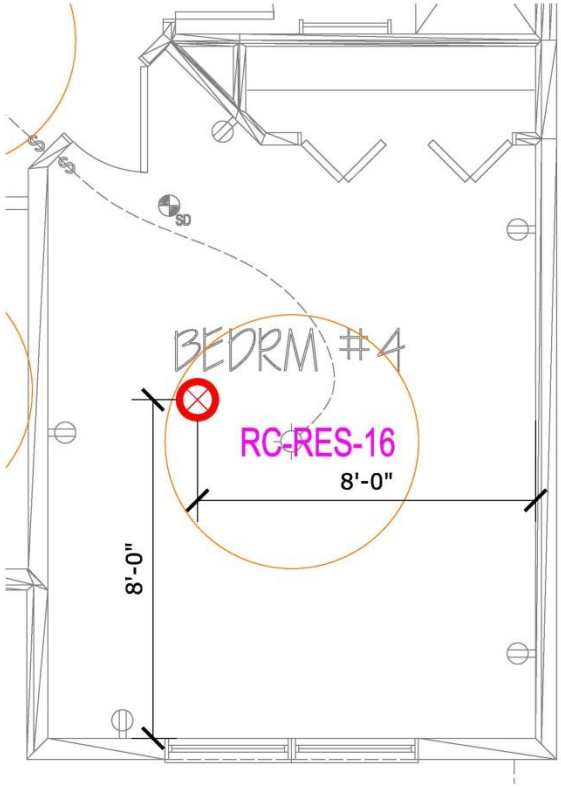
(a) For coverage area dimensions less than the above mentioned, it needs to use the minimum required flow for the Next Higher Coverage Area listed.

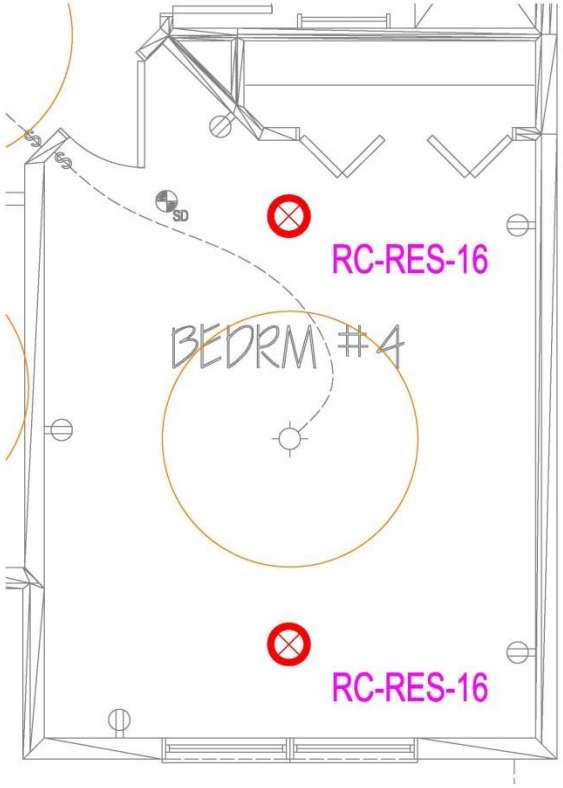
(b) Requirement is based on minimum flow in GPM/LPM from each sprinkler. The associated residual pressures are calculated using the nominal K-Factor. Refer to Hydraulic Design Criteria Section for details.

(c) For systems with ceiling types smooth flat horizontal, or beamed, or sloped, in accordance with the 2013 Edition of NFPA 13D, 13R or 13 as applicable.

Design Techniques to Limit Pressure

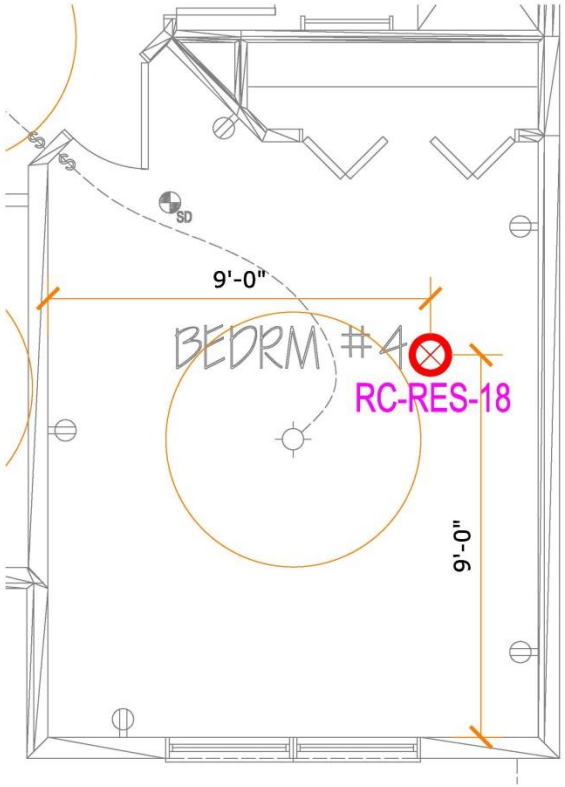
- Make good use of sprinklers spaced beyond 16'x16' in areas it won’t negatively impact total flow for the system.





Design Techniques to Limit Pressure

- Make good use of sprinklers spaced beyond 16'x16' in areas it won’t negatively impact total flow for the system.



Thank you!

Melisa Rodriguez, P.E., NICET IV
Design Services Supervisor, Fire Safety
800.321.4739 ext. 5330
melisa.rodriguez@uponor.com