



RESIDENTIAL DESIGN GUIDE



General

Reliable residential sprinklers utilize a fast response thermal element and are intended for use in wet pipe residential sprinkler systems only. Fast response and high wall wetting characteristics of residential sprinklers improve life safety by maintaining a tenable environment, providing escape time for occupants. Systems are to be designed in accordance with the following NFPA standards:

- NFPA 13D: Standard for the Installation of Sprinkler Systems for One- and Two-Family Dwellings and Manufactured Homes
- NFPA 13R: Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies
- NFPA 13: Standard for the Installation of Sprinkler Systems

This document provides design guidelines for Reliable residential sprinklers and all available models are detailed in Table A. All sprinklers are cULus listed to provide a minimum density of 0.05 gpm/ft² (2.0 mm/min), in accordance with the above-mentioned standards, manufacturer's instructions, and technical bulletins. Where documentation for residential sprinkler systems does not exist for particular applications, information based on NFPA 13 is used.

Residential fire sprinkler systems should only be designed and installed by competent individuals trained and experienced with automatic sprinkler system design and installation. Several criteria may apply to a given installation and the designer and/or installer must be familiar with the applicable codes, standards, and guidelines governing such an installation. The Reliable residential sprinklers described herein must be installed and maintained in compliance with this document, manufacturer's recommendations, with the latest published standards of the National Fire Protection Association (NFPA), and with any additional local jurisdictional requirements. Failure to comply may result in the impairment of sprinkler integrity and proper operation. Because of the various features of residential type architecture, there will be some compartment designs that cannot be fully sprinklered in accordance with the recommendations of NFPA 13, 13D, or 13R. In these instances, consult the Authority Having Jurisdiction (AHJ) for guidance and approval.

Note: This design and installation guide has been revised to incorporate information from 2022 editions of NFPA 13D, 13R, and 13.

Approvals

All Reliable residential sprinklers have been designed and tested in accordance with the latest Edition of Underwriters Laboratories UL 199, the Standard for Automatic Sprinklers for Fire-Protection Service. Typically, they are cULus listed for installation under smooth, flat ceilings of unobstructed construction, unless otherwise noted in the specific listings, with specifically approved spacing, flows, and pressures. Reliable residential sprinklers are cULus listed for installation on both horizontal ceilings with a maximum slope of 2:12 (9°) pitch, and sloped ceilings having maximum slopes of 8:12 (34°) pitch. The design criteria for residential sprinklers contained in the current NFPA 13D, 13R, and 13 Standards must be followed except as modified by the individual UL 199 listing information, the information in the Reliable residential sprinkler technical bulletins, and this design and installation guide. The AHJ must make final approval for all residential sprinkler installations for compliance with all applicable codes, standards, and jurisdictional requirements.

When establishing a minimum cULus listed flow rate, the manufacturer must use a minimum discharge rate over the specified coverage area corresponding to a 0.05 gpm/ft² (2.0 mm/min) density. In some cases, however, to successfully pass the UL 199 fire tests, the UL listed flow rate may be greater than the calculated 0.05 gpm/ft² (2.0 mm/min) density. Increased flow rates for horizontal sidewall type sprinklers, which exceed this minimum density, are common. Because this minimum density is a listing requirement, the use of residential sprinklers



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meeting this criterion applies to all editions of NFPA 13D, 13R, and 13. The design criteria for residential sprinklers contained in the current NFPA Standards must be followed except as modified by the individual cULus Listing information provided in the corresponding sprinkler's technical bulletin.

Reliable Residential Pendant Sprinkler Summary

Table A

Sprinkler Model	Sprinkler Identification Number (SIN)	Orientation	K-Factor gpm/psi ^{1/2} (L/min/bar ^{1/2})	Recessed	Conical Concealed	Flat-Plate Concealed	Low Lead	Technical Bulletin
F1Res30	R3511	Pendent	3.0 (43)	•	•			135
F1Res30 LL	RA3311	Pendent	3.0 (43)	•	•		•	033
KRes30	R3591	Pendent	3.0 (43)	•				935
RFC30	RA0611	Pendent	3.0 (43)			•		006
RFC30LL	RA3211	Pendent	3.0 (43)			•	•	006
RFC43	RA0612	Pendent	4.3 (62)			•		006
RFC43LL	RA3212	Pendent	4.3 (62)			•	•	006
F1Res49	R3516	Pendent	4.9 (71)	•	•			135
F1Res49 LL	RA3316	Pendent	4.9 (71)	•	•		•	033
KRes49	R3596	Pendent	4.9 (71)	•				935
RFC49	RA0616	Pendent	4.9 (71)			•		006
RFC49LL	RA3216	Pendent	4.9 (71)			•	•	006
RFC49plus	R401	Pendent	4.9 (71)			•		188
RFC49LLplus	R402	Pendent	4.9 (71)			•	•	188
F1Res58	R3513	Pendent	5.8 (84)	•	•			135
F1Res58 LL	RA3313	Pendent	5.8 (84)	•	•		•	003
KRes58	R3591	Pendent	5.8 (84)	•				935
RFC58	RA0613	Pendent	5.8 (84)			•		006
F1Res76	R7618	Pendent	7.6 (109)	•	•			135
RFC76	RA0618	Pendent	7.6 (109)			•		006
RFS42	RA4835	Sidewall	4.2 (60)			•		048
F1Res44 HSW	R3531	Sidewall	4.4 (63)	•	•			135
F1Res44 LL HSW	RA3331	Sidewall	4.4 (63)	•			•	033
F1Res44 Dry HSW	RA5231	Sidewall	4.4 (63)	•				052
KRes44 HSW	RA3591	Sidewall	4.4 (63)	•				935
F1Res58 HSW	R3533	Sidewall	5.8 (84)	•				135
F1Res58 LL HSW	RA3333	Sidewall	5.8 (84)	•			•	033
F1Res58 HSWX	RA3533	Sidewall	5.8 (84)	•				135
KRes58 HSWX	RA3593	Sidewall	5.8 (84)	•				935

Definitions

The following terms are defined in NFPA Standards, explained in greater detail in annex material, and are applicable when used in this design and installation guide. Refer to the applicable Standard and adopted edition of NFPA 13D, NFPA 13R, and NFPA 13 for official definitions of these terms, and for terms not found in this guide.

Approved. Acceptable to the authority having jurisdiction.

Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

Compartment. A compartment is a space completely enclosed by walls and a ceiling. The compartment enclosure is permitted to have openings (in walls) to an adjoining space, provided that soffits or lintels along the ceiling over the compartment opening have a minimum depth of 8 in. (200 mm) from the ceiling. In other words, areas such as hallways, stairwells, and rooms must be separated by beams, lintels, or soffits 8 in. (200 mm) or more inches in depth to be considered single compartments.

Dwelling. Any building that contains not more than one or two dwelling units intended to be used, rented, leased, let, or hired out to be occupied or that are occupied for habitation purposes.

Dwelling Unit. One or more rooms, arranged for the use of one or more individuals living together, as in a single housekeeping unit, that normally has cooking, living, sanitary, and sleeping facilities. Dwelling units include hotel rooms, dormitory rooms, condominiums, apartments, and similar living units.

Flat Ceiling. A continuous ceiling in a single plane.

Horizontal Ceiling. A ceiling that does not exceed a slope of 2:12 pitch (slope of 9°).

Listed. Equipment, materials or services included in a list published by an organization that is acceptable to the authority having jurisdiction.

Obstructed Construction. Panel construction and other construction where beams, trusses, or other members impede heat flow or water distribution in a manner that materially affects the ability of sprinklers to control or suppress a fire.

Residential Sprinkler. A type of fast-response sprinkler that has a thermal element with an RTI of 50 (m-s)^{1/2} or less that has been specifically tested for its ability to enhance survivability in the room of fire origin and that is listed for use in the protection of dwelling units. Residential sprinklers possess a fast response thermal element and produce a spray pattern that discharges water higher on the wall than a standard spray sprinkler.

Sloped Ceiling. A ceiling exceeding a maximum slope of 2:12 pitch (slope of 9°).

Smooth Ceiling. A continuous ceiling free from significant irregularities, lumps, or indentations.

Unobstructed Construction. Construction where beams, trusses, or other members do not impede heat flow or water distribution in a manner that materially affects the ability of sprinklers to control or suppress a fire. This type of construction has the following features:

1. Horizontal structural members that are not solid.
2. Openings of the structural members are at least 70% of the cross-sectional area.
3. Depth of the structural members do not exceed the least dimension of the openings.
4. The spacing of structural members exceeds 7 ft 6 in. (2.3 m) on center.

Installation Considerations

Residential sprinklers use either a fusible solder link or a glass bulb thermal element. Glass bulb type sprinklers have orange protective caps and straps to provide temporary protection to the frangible glass bulb during shipping and installation. Fusible link sprinklers, not of the flat concealed type, do not have orange protective caps and straps. Flat-plate concealed pendent and sidewall sprinklers utilize caps that allow installation to occur with them on the sprinkler when using the correct wrench.

- a. Do not install any bulb-type sprinkler if the bulb is cracked or there is liquid missing from the bulb. While holding the sprinkler in the horizontal position, a small air bubble having an approximate diameter of 1/16 in. (1.6 mm) should be visible.
- b. The bulb-type sprinkler is designed for installation with the protective strap in place using the appropriate sprinkler wrench.
- c. Sprinklers that are dropped during the installation process or that are installed on piping other than that in accordance with item "a" shall be replaced, including sprinklers with protective caps or straps.
- d. Protective caps and straps shall be removed only using means in accordance with the manufacturer's installation instructions. They are not to be left on the sprinkler after the sprinkler system is placed in service.
- e. Protective caps and straps may be removed immediately after installation from sprinklers when installed more than 10 ft. (3.0 m) above the floor. All other sprinkler protective caps and straps shall be removed only when the sprinkler system is placed in service.
- f. When installing sprinklers in a national pipe thread (NPT) joint, high levels of torque may distort the sprinkler inlet or bend the frame, causing leakage or impairment of the sprinkler. A leak-tight sprinkler joint can be obtained with the following torque:
 - 1/2 in. NPT and ISO7-1R1/2: 8-18 lbs-ft (11-24 N·m)
 - 3/4 in. NPT and ISO7-1R3/4: 14-20 lbs-ft (19-27 N·m)
- g. When installing sprinklers in a CPVC sprinkler adapter fitting that incorporates a gasket, follow the CPVC fitting manufacturer's instructions on how to achieve a leak-free installation.

Where applicable, metallic escutcheons, listed recessed escutcheons, and listed concealed cover plates must be used with corresponding residential sprinklers. The absence of an escutcheon or concealed cover plate, where there is an annular space between the ceiling and the sprinkler, may delay sprinkler operation in the event of a fire.

Never introduce any leak-stopping additives to any fire sprinkler system.

Residential sprinklers must be installed with the manufacturer's specified sprinkler wrench. Tongue and groove pliers, crescent wrenches, adjustable spanner wrenches, or anything other than the proper sprinkler wrench shall not be used.

Installing sprinklers in CPVC and copper piping systems requires special considerations. Never install the sprinkler into the sprinkler adapter fitting prior to attaching the sprinkler adapter fitting to the system piping. When installing residential sprinklers or commercial sprinklers in a CPVC piping system, sprinklers must be installed only after the sprinkler adapter fitting has been installed and the CPVC manufacturer's cure time for the solvent cement has passed. This is to ensure that the solvent cement does not accumulate within the sprinkler.

In copper piping systems, sprinklers must be installed only after the inside of the sprinkler drop and associated fittings have been wire brushed to remove any residual flux. Residual flux can cause corrosion. Both of these conditions can impair and prevent proper sprinkler operation.

System Design Criteria

Permitted Sprinklers for Residential Sprinkler Systems

For NFPA 13D and 13R sprinkler systems, only listed residential sprinklers shall be used, with the following exceptions:

1. Listed standard dry-pendent or dry sidewall sprinklers shall be permitted to be extended into unheated areas not intended for living purposes.
2. Quick-response sprinklers shall be permitted to be used in mechanical closets.
3. For NFPA 13R systems, listed quick-response sprinklers shall be permitted to be installed in dwelling units meeting the definition of a compartment where no more than four (4) sprinklers are located within the dwelling unit.

Non-residential sprinklers are to be installed in accordance with the criteria specified by NFPA 13.

Residential Sprinkler Positioning and Spacing Requirements

When locating residential sprinklers, consideration must be given to sensitivity, sprinkler spacing, obstructions to discharge, temperature rating, and proximity to heat sources.

Sprinkler Sensitivity - Deflector Positioning

Residential pendent sprinklers not listed with specific positioning criteria must be positioned so that the deflectors are within 1 in. to 4 in. (25 mm to 100 mm) from the ceiling. Reliable Model F1Res49 pendent sprinklers may also be positioned with the deflector 1 in. to 8 in. (25 mm to 200 mm) from the ceiling, in accordance with the listed flows and pressures shown in Bulletin 135. Reliable residential horizontal sidewall sprinklers have been listed with specific positioning criteria so that the deflectors may be positioned within 4 in. to 12 in. (100 mm to 300 mm) from the ceiling. Under both horizontal and sloped ceilings, always align sprinkler deflectors so that the deflector is parallel with the plane of the ceiling surface.

Sprinkler Spacing Under Horizontal Ceilings

Several maximum coverage areas are used for residential sprinklers in accordance with minimum listed flows and pressures. The area of coverage must be equal to or greater than both the length and width of the hazard area. Residential sprinklers must be located not more than half the listed spacing nor less than 4 in. (100 mm) from walls. Adjacent sprinklers must be located no farther apart than the listed spacing; the minimum distance to prevent cold soldering, unless otherwise specified, is 8 ft (2.4 m).

When selecting an area of coverage, the suggested practice is to select one that can be adequately supplied by the available water supply, allowing for the installation of as few sprinklers as possible while observing all guidelines pertaining to obstructions and spacing. Listed coverage areas for residential sprinklers are to be measured perpendicular from the sprinkler to the wall. After selection of an area of coverage, sprinklers must be spaced according to the criteria set forth in the NFPA standards and this document.

Sprinkler Spacing Under Sloped Ceilings

The spacing of sprinklers is measured along the slope when determining the distance off of walls and between sprinklers. Residential sprinklers may be located no more than one-half (0.5) the listed spacing nor less than 4 in. (100 mm) from the peak of the sloped ceiling. Residential sprinklers located at the highest elevation must not be located more than 3 ft (900 mm) measured vertically down from the peak. Listed areas of coverage are applicable for sloped ceilings up to an 8:12 pitch (34°).

Table B provides a conversion of "Rise Over Run" that is often used as a way of defining slope in architectural drawings to "Degrees of Slope" which is also referenced in this document.

Rise Over Run Conversion to Degrees of Slope

Table B

Rise, Inches	12							60°	56°	53°	50°	46°	45°
	11							58°	54°	51°	48°	45°	42°
	10						58°	54°	51°	48°	45°	42°	40°
	9						56°	52°	48°	45°	42°	39°	37°
	8					58°	53°	49°	45°	42°	39°	36°	34°
	7				60°	54°	49°	45°	41°	38°	35°	32°	30°
	6				56°	50°	45°	41°	37°	34°	31°	29°	27°
	5			59°	51°	45°	40°	36°	32°	29°	27°	24°	23°
	4			53°	45°	39°	34°	30°	27°	24°	22°	20°	18°
	3		56°	45°	37°	31°	27°	23°	21°	18°	17°	15°	14°
	2		45°	34°	27°	22°	18°	16°	14°	13°	11°	10°	9°
	1	45°	27°	18°	14°	11°	9°	8°	7°	6°	6°	5°	5°
		1	2	3	4	5	6	7	8	9	10	11	12
		Run, Inches											

Obstruction to Water Distribution

Refer to Figures 8 through 15 for the location of sprinklers relative to obstructions. The discharge from residential sprinklers is directed radially outward and downward from the sprinkler. Sprinklers must be located such that there will not be any spaces shielded from distribution by walls, dividing partitions, or other dwelling construction features. If the sprinkler water distribution pattern is obstructed, the obstruction is to be considered the maximum distance of coverage for a given sprinkler. Additional sprinklers beyond the obstruction may be necessary unless the obstruction criteria contained herein can be met. Consult the appropriate NFPA standard and/or the AHJ for guidance regarding these situations.

Reliable flat cover plate concealed pendent sprinklers utilize a drop-down style deflector. The distance the deflector drops below the ceiling is needed when determining the position of the deflector above the bottom of an obstruction. This information can be found in the corresponding Technical Bulletin for the sprinkler.

Continuous and Noncontinuous Obstructions

A minimum distance is required to be maintained between sprinklers and continuous obstructions, such as beams, soffits, and long horizontal light fixtures. See Figures 8 through 15 for guidance, along with additional information published in NFPA 13D, 13R, and 13.

A minimum distance is also required to be maintained between sprinklers and noncontinuous obstructions, such as ceiling fans and certain light fixtures. The ceiling fan motor housing is the primary element that can obstruct the sprinkler discharge pattern. Testing has demonstrated that no adverse effects occur as a result of the ceiling fan’s blade rotation in either direction, so long as the fan blades are 50% open when from the plan view.

With regards to the location of sprinklers near light fixtures, there are two considerations; the amount of heat the light gives off and the light fixture as an obstruction. The minimum distance of a sprinkler relative to the light as a heat source is given in Table C. If the light is also an obstruction, then the obstruction criteria must be applied, relative to the minimum distance required from Table C.

For noncontinuous obstructions, apply the “four times rule” as provided in NFPA 13 where it is determined that the sprinkler can spray to at least two sides of the obstruction, either over and under or around the obstruction on

both sides. Sprinklers shall be positioned away from the obstruction a minimum distance of four times the maximum dimension of the obstruction. When the obstruction is in the horizontal orientation, the maximum clear distance required shall be 36 in. (900 mm).

Temperature Ratings

Changes to current NFPA 13D, 13R, and 13 Standards permit the use of Ordinary or Intermediate temperature residential sprinklers throughout residential buildings and dwellings. Standardizing on Intermediate temperature sprinklers, when such sprinklers are available, will provide greater sprinkler placement flexibility concerning distances from heat sources and eliminate the guesswork of whether sprinklers will experience ambient temperatures greater than permitted with Ordinary temperature residential sprinklers.

Ordinary temperature rated sprinklers, manufactured within the range of 135°F - 170°F (57°C - 77°C), are only permitted for installations where the maximum ambient ceiling temperature will not exceed 100°F (38°C). Intermediate temperature-rated residential sprinklers, which are manufactured within the range of 175°F - 225°F (79°C - 107°C), can be exposed to a maximum ambient temperature of 150°F (66°C). The following practices apply unless higher expected ambient temperatures require a higher temperature rated sprinkler:

1. Sprinklers under glass or plastic skylights exposed to direct rays of the sun shall be of the intermediate temperature classification.
2. Sprinklers in an unventilated concealed space under an insulated roof or in an unventilated attic shall be of the intermediate temperature classification.
3. Sprinklers installed in saunas and steam rooms where the maximum ambient ceiling temperatures are between 151°F and 225°F (66°C to 107°C) shall be high temperature-rated spray sprinklers.
4. Sprinklers in closets containing ventless clothes dryers shall be of the intermediate temperature classification or higher.
5. Residential sprinklers must be located to prevent inadvertent operation due to exposure to normal heat sources. Sprinklers must be positioned a sufficient distance away from heat sources such as fireplaces, ovens, kitchen ranges, hot water pipes, water heaters, furnaces and associated ductwork, and light fixtures. The minimum distances in accordance with NFPA 13D, 13R and 13 must be maintained as indicated in Table C.

Minimum Distances for Residential Sprinklers Relative to Specific Heat Sources

Table C

Heat Source	Ordinary Temperature Sprinkler Minimum Distance from Edge of Heat Source	Intermediate Temperature Sprinkler Minimum Distance from Edge of Heat Source
Side of open or recessed fireplace	36 in. (900 mm)	12 in. (300 mm)
Front of recessed fireplace	60 in. (1500 mm)	36 in. (900 mm)
Coal- or wood-burning stove	42 in. (1050 mm)	12 in. (300 mm)
Kitchen range	18 in. (450 mm)	9 in. (225 mm)
Wall oven	18 in. (450 mm)	9 in. (225 mm)
Hot air flues	18 in. (450 mm)	9 in. (225 mm)
Uninsulated heat ducts	18 in. (450 mm)	9 in. (225 mm)
Uninsulated hot water pipes	12 in. (300 mm)	6 in. (150 mm)
Side of ceiling- or wall-mounted hot air diffusers	24 in. (600 mm)	12 in. (300 mm)
Front of wall-mounted hot air diffusers	36 in. (900 mm)	18 in. (450 mm)
Hot water heater or furnace	6 in. (150 mm)	3 in. (75 mm)
Light fixture, 0 W – 250 W	6 in. (150 mm)	3 in. (75 mm)
Light fixture, 250 W – 499 W	12 in. (300 mm)	6 in. (150 mm)

Hydraulic Design Requirements

Reliable residential sprinkler listings indicate minimum flow rates for each specified coverage area. Hydraulic calculations are required to verify adequate water supply at the hydraulically most remote single sprinkler operating at the minimum flow and pressure listing of that sprinkler. When multiple residential sprinklers are required to be calculated, each sprinkler within the design area must be calculated using the listed minimum flow rates corresponding to its area of coverage. No reduction in minimum flow requirements is provided for flowing multiple sprinklers. More design sprinklers may need to be calculated than the minimum stated by the applicable NFPA standards where unusual conditions may result in more sprinklers operating. These conditions include:

- Sloped ceilings having a pitch greater than 8:12 (34°).
- Ceiling heights over 24 ft (2.3 m).
- Beamed ceilings in rooms or compartments greater than 600 ft² (56 m²).

Consult with the AHJ regarding the number of sprinklers to include in the design for these types of applications.

NFPA 13D

The number of design sprinklers under flat, smooth, horizontal ceilings shall include all sprinklers within a compartment, up to a maximum of two (2) sprinklers, that requires the greatest hydraulic demand. The cULus listed specific coverage criteria for systems designed to NFPA 13R are given in the corresponding sprinkler's technical bulletin referenced in Table A, as a function of the maximum allowable coverage area and temperature rating. For actual coverage areas less than or between those indicated in the respective technical bulletin, it is necessary to use the minimum required flow for the next largest area.

For example, assuming the use of a pendent sprinkler, for an actual coverage area of 12 ft x 14 ft (3.7 m x 4.3 m), the specific coverage criteria for a 14 ft x 14 ft (4.3 m x 4.3 m) coverage area must be used. For an actual coverage area of 17 ft x 17 ft (5.2 m x 5.2 m), the specific coverage criteria for an 18 ft x 18 ft (5.5 m x 5.5 m) coverage area must be used.

NFPA 13R

The number of design sprinklers under flat, smooth, horizontal ceilings shall include all sprinklers within a compartment, up to a maximum of four (4) sprinklers, that requires the greatest hydraulic demand. The cULus listed specific coverage criteria for systems designed to NFPA 13R are given in the technical bulletins referenced in Table A, as a function of the maximum allowable coverage area and temperature rating. For actual coverage areas less than or between those indicated in the respective technical bulletin, it is necessary to use the minimum required flow for the next largest area, as shown in the examples above.

NFPA 13

For residential sprinkler systems designed to NFPA 13, the design area will include the four (4) hydraulically most demanding sprinklers. Unlike NFPA 13R the four-sprinkler design area in NFPA 13 must be determined without regard to compartment boundaries. In certain types of construction, additional sprinklers may need to be calculated, review the adopted version of NFPA 13 for definitive determination on the number of sprinklers to be calculated. For the sprinklers to be calculated in the design area, the minimum required discharge from each sprinkler shall be the greater of the following conditions:

1. Using the listed flows and pressures found in the sprinkler's technical bulletin.
2. Based on delivering a minimum 0.1 gpm/ft² (4.1 mm/min) density from each sprinkler in rooms or compartments that are greater than 800 ft² (74 m²).
3. If the room or compartment is 800 ft² (74 m²) or less, calculate based on delivering a minimum 0.1 gpm/ft² (4.1 mm/min) density over the design area by dividing the room or compartment area by the number of sprinklers in the room.

Using the $A_s = S \times L$ method to determine the sprinkler protection area of coverage in accordance with NFPA 13, apply the 0.1 gpm/ft² (4.1 mm/min) density to this area to determine the minimum required flow. Compare this flow to the minimum 0.05 gpm/ft² (2.0 mm/min) cULus listed flow for the appropriate coverage area in the technical bulletin for the specific residential sprinkler. If the flow stated in the technical bulletin is less than the calculated 0.1 gpm/ft² (4.1 mm/min) density flow required, the 0.1 gpm/ft² (4.1 mm/min) density flow must then be used in the equation $P=(Q/K)^2$, where Q is the flow in gpm or L/min and K is the K-factor of the sprinkler, to establish the minimum required pressure.

In many cases, the listed flow of individual residential sprinklers may exceed the required minimum 0.05 gpm/ft² (2.0 mm/min) density. Reliable has available residential sprinklers with larger K-factors (K=5.8 and K=7.6) that will provide lower pressure demands for 0.1 gpm/ft² (4.1 mm/min) densities in NFPA 13 residential applications.

Example No. 1

If a room is 12 ft wide x 20 ft long (3.7 m x 6.1 m), the coverage area being considered would be 240 ft² (22.3 m²). Using an F1Res49 pendent sprinkler with a 1 in. - 4 in. (300 mm – 1200 mm) ceiling-to-deflector distance, the flow for a 20 ft x 20 ft (6.1 m x 6.1 m) coverage area is 20 gpm at 16.7 psi (75.7 L/min @ 1.15 bar). However, based on a discharge density of 0.1 gpm/ft² (4.1 mm/min), the flow rate required would be 24 gpm (90.8 L/min). Therefore, 24 gpm (90.8 L/min) would be the minimum flow required for each design sprinkler. The corresponding pressure would be 24 psi (1.65 bar).

Example No. 2

If a room is 10 ft wide x 20 ft long (3.0 m x 6.1 m), the coverage area being considered would be 200 ft² (18.6 m²). Using an F1Res58 pendent sprinkler with a 1 in. to 4 in. (300 mm to 1200 mm) ceiling-to-deflector distance, the flow for a 20 ft x 20 ft (6.1 m x 6.1 m) coverage area is 22 gpm at 14.4 psi (83.3 L/min at 0.99 bar). Based on a discharge density of 0.1 gpm/ft² (4.1 mm/min), the flow rate required would only be 20 gpm (75.7 L/min). However, the flow of 22 gpm (83.3 L/min) must still be used as the minimum flow for each design sprinkler, since this is the minimum cULus listed flow for this sprinkler at the 20 ft x 20 ft (6.1 m x 6.1 m) coverage area.

Example No. 3

Where the coverage area per sprinkler is 16 ft x 8 ft (4.9 m x 2.4 m), or 128 ft² (11.9 m²), the F1Res44 HSW, having a temperature rating of 155°F (68°C) and positioned 4 in. to 6 in. (100 mm to 150 mm) below the ceiling, requires a minimum flow of 16 gpm at 13.3 psi (60.6 L/min at .92 bar) for a 16 ft x 16 ft (4.9 m x 4.9 m) coverage area. Based on a minimum discharge of 0.1 gpm/ft² (4.1 mm/min), the flow rate needed would only be 12.8 gpm at 10.2 psi (48.4 L/min at 0.7 bar). However, the flow rate of 16 gpm (60.6 L/min) must still be used for each design sprinkler.

Unusual Conditions

Consult with the AHJ regarding the number of sprinklers in the design area for any or all the types of applications bulleted below as listed flows and pressures are not applicable.

- Sloped ceilings having a pitch greater than 8:12 (34°).
- Ceiling heights over 24 ft (7.3 m).
- Rooms over 600 ft² having beamed ceilings.



Care and Maintenance

It is recommended that residential sprinkler systems should be inspected and maintained in accordance with the criteria set forth in NFPA 25, Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems as well as the requirements of any Authorities Having Jurisdiction.

Wet-pipe sprinkler systems must be maintained at a minimum temperature of 40°F (4°C). Exposure to freezing temperatures can damage system piping and residential sprinklers.

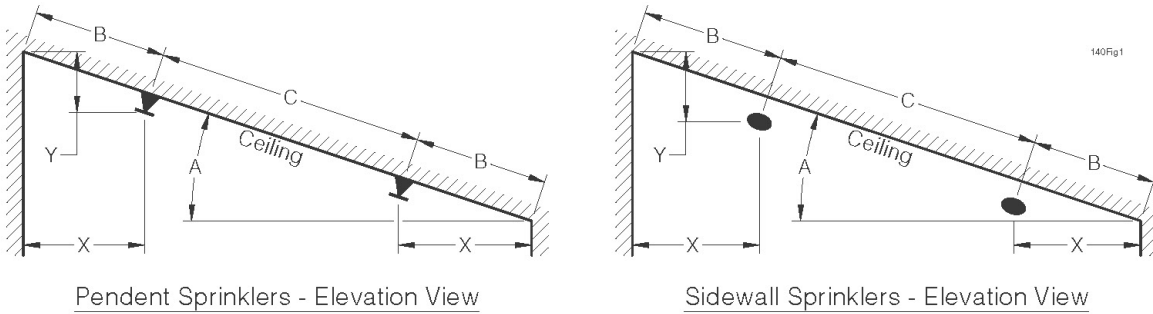
Do not clean the sprinklers with soap and water, detergents, ammonia, or any other cleaning fluid. Remove dust by gentle vacuuming without touching the sprinkler. Replace any sprinkler which has been painted (other than factory-applied).

Replace any sprinkler which has been damaged. Where cracks are observed in the glass bulb, or when the liquid has been lost from the glass bulb. The new sprinkler shall have the same performance characteristics as the original sprinkler; that is the same temperature rating, nominal K-factor, coverage area, and the same or lower flow rate requirements.

Do not hang anything from sprinklers or sprinkler piping. Do not put curtains, drapes, or valences around sprinklers. Doing so will obstruct the discharge pattern of the sprinkler.

Residential Sprinkler Spacing Locations Under Single Slope

Figure 1

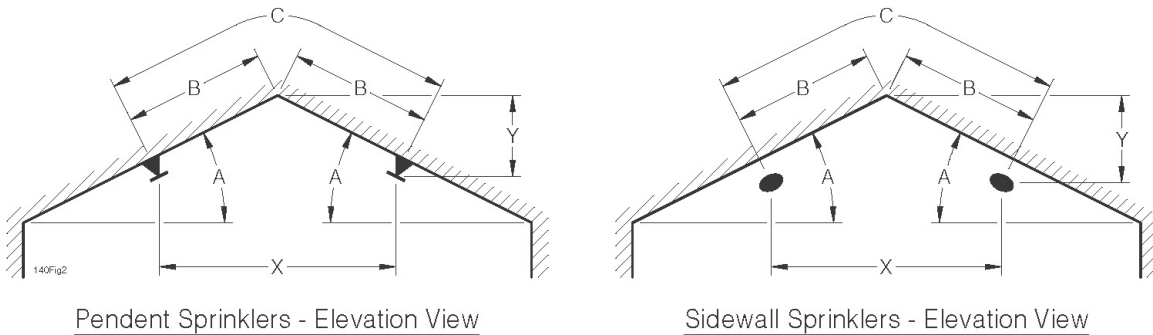


- A - Range: 10° - 34° Ceiling angle (greater than 2:12 up to and including 8:12).
- B - Maximum: One-half (0.5) of the max sprinkler spacing for the coverage area being hydraulically calculated.
- C - Maximum: The maximum sprinkler spacing for the coverage area being hydraulically calculated.
Minimum: 8 ft 0 in. (2400 mm)
- X - Minimum: 4 in. (100 mm)
- Y - Maximum: 3 ft 0 in. (900 mm)

Applicable NFPA Standard: 13D / 13R / 13

Residential Sprinkler Spacing Locations Under Opposing Slopes

Figure 2

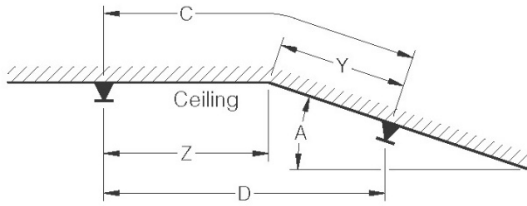


- A - Range: 10° - 34° ceiling angle (greater than 2:12 up to and including 8:12).
- B - Maximum: One-half (0.5) of the max sprinkler spacing for the coverage area being hydraulically calculated.
- C - Maximum: The maximum sprinkler spacing for the coverage area being hydraulically calculated.
Minimum: 8 ft 0 in. (2400 mm)
- X - Minimum: 8 ft 0 in. (2400 mm)
- Y - Maximum: 3 ft 0 in. (900 mm)

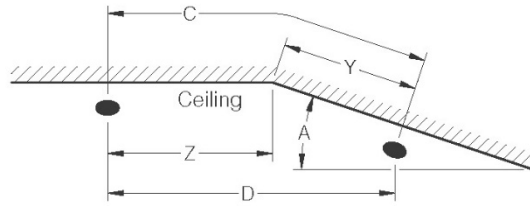
Applicable NFPA Standard: 13D / 13R / 13

Residential Sprinkler Spacing With Horizontal to Slope Transitions

Figure 3

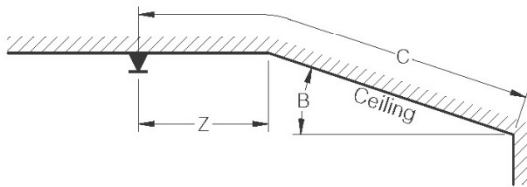


Pendent Sprinklers - Elevation View

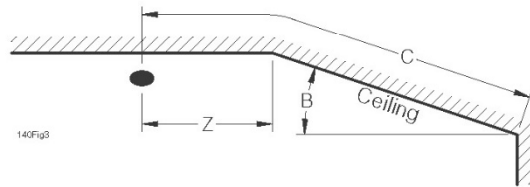


Sidewall Sprinklers - Elevation View

Sprinklers Installed on Horizontal and Sloped Ceilings



Pendent Sprinkler - Elevation View



Sidewall Sprinkler - Elevation View

Sprinklers Installed on Horizontal Ceilings Only

- A - Range: 10° - 34° ceiling angle (greater than 2:12 up to and including 8:12).
- B - Range: 10° - 60° ceiling angle (greater than 2:12 up to and including 12:7).
- C - Maximum: The maximum listed sprinkler spacing measured along the slope and horizontal ceiling.
- D - Minimum: 8 ft 0 in. (2400 mm)
- Y - Minimum: The minimum distance to the intersecting horizontal ceiling, to be permitted per chart below.
- Z - Minimum: The minimum distance to the intersecting sloped ceiling, to be permitted per chart below.

Y Value - Sprinklers on Slope

Ceiling Angle (A)*	Minimum Permitted Horizontal Distance (Y)
10° (>2:12)	1 ft 0 in. (300 mm)
14° (3:12)	1 ft 0 in. (300 mm)
18° (4:12)	1 ft 0 in. (300 mm)
23° (5:12)	1 ft 0 in. (300 mm)
27° (6:12)	1 ft 0 in. (300 mm)
30° (7:12)	1 ft 6 in. (450 mm)
34° (8:12)	1 ft 6 in. (450 mm)

*Interpolation between values permitted.

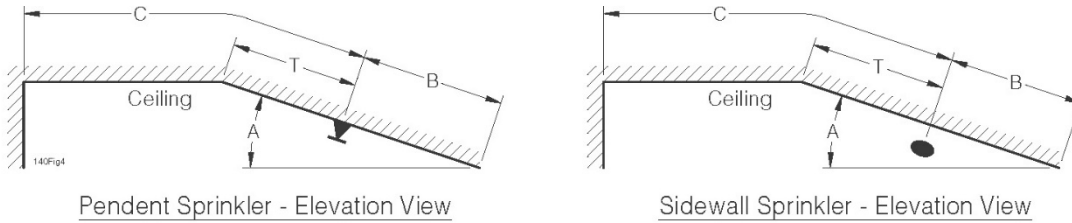
Z Value - Sprinklers on Horizontal

Ceiling Angle (B)*	Minimum Permitted Horizontal Distance (Z)
10° (>2:12)	1 ft 0 in. (300 mm)
14° (3:12)	1 ft 0 in. (300 mm)
18° (4:12)	1 ft 0 in. (300 mm)
23° (5:12)	1 ft 0 in. (300 mm)
27° (6:12)	1 ft 0 in. (300 mm)
30° (7:12)	1 ft 6 in. (450 mm)
34° (8:12)	1 ft 6 in. (450 mm)
37° (9:12)	1 ft 6 in. (450 mm)
40° (10:12)	1 ft 8 in. (500 mm)
42° (11:12)	1 ft 8 in. (500 mm)
45° (12:12)	2 ft 0 in. (600 mm)
50° (12:10)	2 ft 0 in. (600 mm)
60° (12:7)	2 ft 0 in. (600 mm)

*Interpolation between values permitted.

Residential Sprinkler Spacing With Horizontal to Slope Transitions

Figure 4



- A - Range: 10° - 34° ceiling angle (greater than 2:12 up to and including 8:12).
- B - Maximum: One-half (0.5) of the max sprinkler spacing for the coverage area being hydraulically calculated.
- C - Maximum: One-half (0.5) of the max sprinkler spacing for the coverage area being hydraulically calculated.
- T - Minimum: Unobstructed minimum distance to intersecting horizontal ceiling as permitted by Table D. If the minimum distance cannot be met, additional sprinklers will be required on the horizontal ceiling.

Applicable NFPA Standard: 13D / 13R / 13

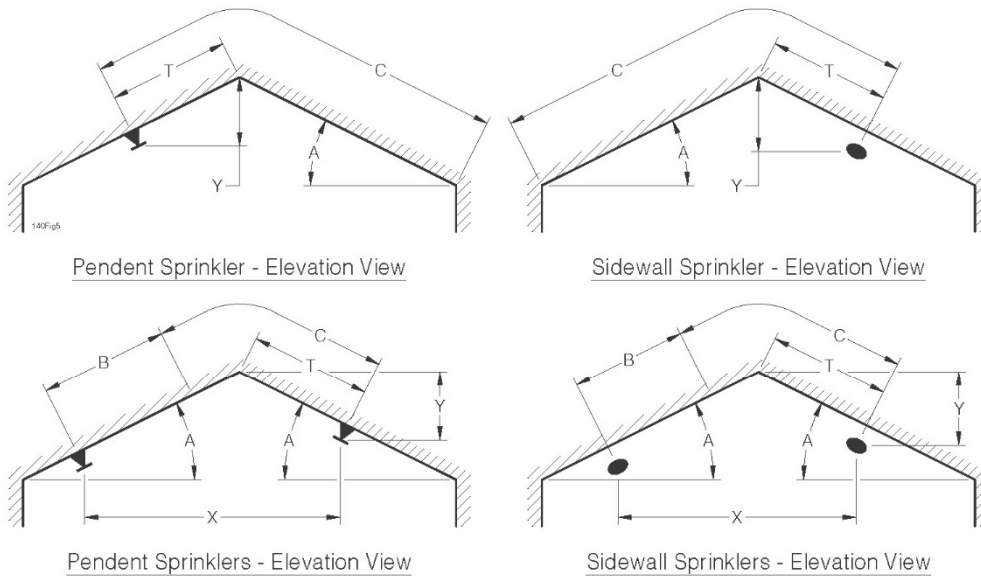
Minimum Distance to Intersecting Horizontal Ceiling

Table D

Ceiling Angle (A)	Sprinkler Spacing (T)				
	12 ft (3.7 m)	14 ft (4.2 m)	16 ft (4.9 m)	18 ft (5.5 m)	20 ft (6.1 m)
10° (>2:12)	0 ft 6 in. (150 mm)	0 ft 6 in. (150 mm)	0 ft 6 in. (150 mm)	0 ft 10 in. (250 mm)	1 ft 0 in. (300 mm)
14° (3:12)	0 ft 6 in. (150 mm)	0 ft 6 in. (150 mm)	0 ft 6 in. (150 mm)	1 ft 4 in. (400 mm)	2 ft 2 in. (650 mm)
18° (4:12)	0 ft 6 in. (150 mm)	0 ft 6 in. (150 mm)	0 ft 6 in. (150 mm)	2 ft 0 in. (600 mm)	3 ft 0 in. (900 mm)
23° (4:12)	0 ft 6 in. (150 mm)	0 ft 6 in. (150 mm)	0 ft 6 in. (150 mm)	2 ft 8 in. (800 mm)	3 ft 8 in. (1100 mm)
27° (5:12)	0 ft 6 in. (150 mm)	0 ft 6 in. (150 mm)	0 ft 6 in. (150 mm)	3 ft 6 in. (1050 mm)	4 ft 6 in. (1400 mm)
30° (7:12)	0 ft 6 in. (150 mm)	0 ft 6 in. (150 mm)	0 ft 10 in. (250 mm)	4 ft 0 in. (1200 mm)	4 ft 10 in. (1450 mm)
34° (8:12)	0 ft 8 in. (200 mm)	0 ft 8 in. (200 mm)	1 ft 2 in. (350 mm)	4 ft 4 in. (1300 mm)	5 ft 0 in. (1500 mm)

Non-Symmetrical Residential Sprinkler Spacing on Sloped Ceilings

Figure 5



- A - Range: 10° - 34° ceiling angle (greater than 2:12 up to and including 8:12).
- B - Maximum: One-half (0.5) of the max sprinkler spacing for the coverage area being hydraulically calculated.
- C - Maximum: One-half (0.5) of the max sprinkler spacing for the coverage area being hydraulically calculated.
- T - Minimum: Unobstructed minimum distance to opposed slope as permitted by Table E.
- X - Minimum: 8 ft. 0 in. (2400 mm)
- Y - Maximum: 3 ft 0 in. (900 mm)

Applicable NFPA Standard 13D/13R/13

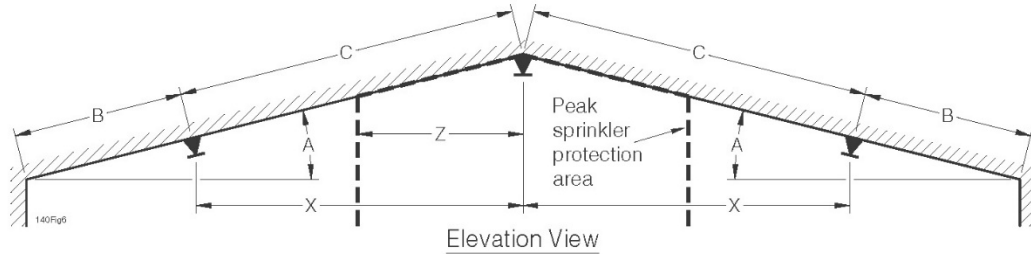
Minimum Distance to Opposed Slope

Table E

Ceiling Angle (A)	Sprinkler Spacing (T)				
	12 ft (3.7 m)	14 ft (4.2 m)	16 ft (4.9 m)	18 ft (5.5 m)	20 ft (6.1 m)
10° (>2:12)	1 ft 0 in. (300 mm)	1 ft 0 in. (300 mm)	1 ft 0 in. (300 mm)	1 ft 0 in. (300 mm)	1 ft 0 in. (300 mm)
14° (3:12)	1 ft 0 in. (300 mm)	1 ft 0 in. (300 mm)	1 ft 0 in. (300 mm)	1 ft 0 in. (300 mm)	2 ft 0 in. (600 mm)
18° (4:12)	1 ft 0 in. (300 mm)	1 ft 0 in. (300 mm)	1 ft 0 in. (300 mm)	1 ft 0 in. (300 mm)	2 ft 0 in. (600 mm)
23° (4:12)	1 ft 0 in. (300 mm)	1 ft 0 in. (300 mm)	1 ft 0 in. (300 mm)	1 ft 0 in. (300 mm)	3 ft 0 in. (900 mm)
27° (5:12)	1 ft 0 in. (300 mm)	1 ft 0 in. (300 mm)	1 ft 0 in. (300 mm)	2 ft 4 in. (700 mm)	3 ft 10 in. (1150 mm)
30° (7:12)	1 ft 0 in. (300 mm)	1 ft 0 in. (300 mm)	2 ft 0 in. (600 mm)	3 ft 2 in. (950 mm)	4 ft 4 in. (1300 mm)
34° (8:12)	1 ft 0 in. (300 mm)	1 ft 6 in. (450 mm)	2 ft 8 in. (800 mm)	3 ft 8 in. (1100 mm)	4 ft 8 in. (1400 mm)
	12 ft (3.7 m)	14 ft (4.2 m)	16 ft (4.9 m)	18 ft (5.5 m)	20 ft (6.1 m)

Sprinkler Spacing Under Sloped Ceilings - Pendent Sprinklers Located at Peak

Figure 6



- A - Range: 10° - 34° ceiling angle (greater than 2:12 up to and including 8:12).
- B - Maximum: One-half (0.5) of the max sprinkler spacing for the coverage area being hydraulically calculated.
Minimum: 4 in. (100 mm)
- C - Maximum: Listed spacing of sprinkler, or as restricted by dimension Z.
- X - Minimum: 8 ft. 0 in. (2400 mm)
- Z - Maximum: Peak sprinkler coverage area restricted by maximum horizontal dimension as follows:

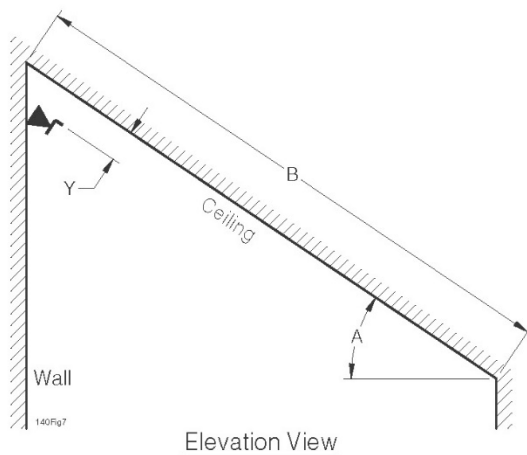
Ceiling Angle (A)*	Maximum Permitted Horizontal Distance (Z)
10° (>2:12)	10 ft 0 in. (3000 mm)
14° (3:12)	9 ft 7 in. (2875 mm)
18° (4:12)	9 ft 2 in. (2750 mm)
23° (5:12)	8 ft 11 in. (2675 mm)
27° (6:12)	7 ft 8 in. (2300 mm)
30° (7:12)	7 ft 0 in. (2100 mm)
34° (8:12)	6 ft 2 in. (1850 mm)

*Interpolation between values permitted.

Applicable NFPA Standard / 13D / 13R / 13

Sprinkler Spacing Under Sloped Ceilings - Sidewall Sprinklers Located at Peak

Figure 7

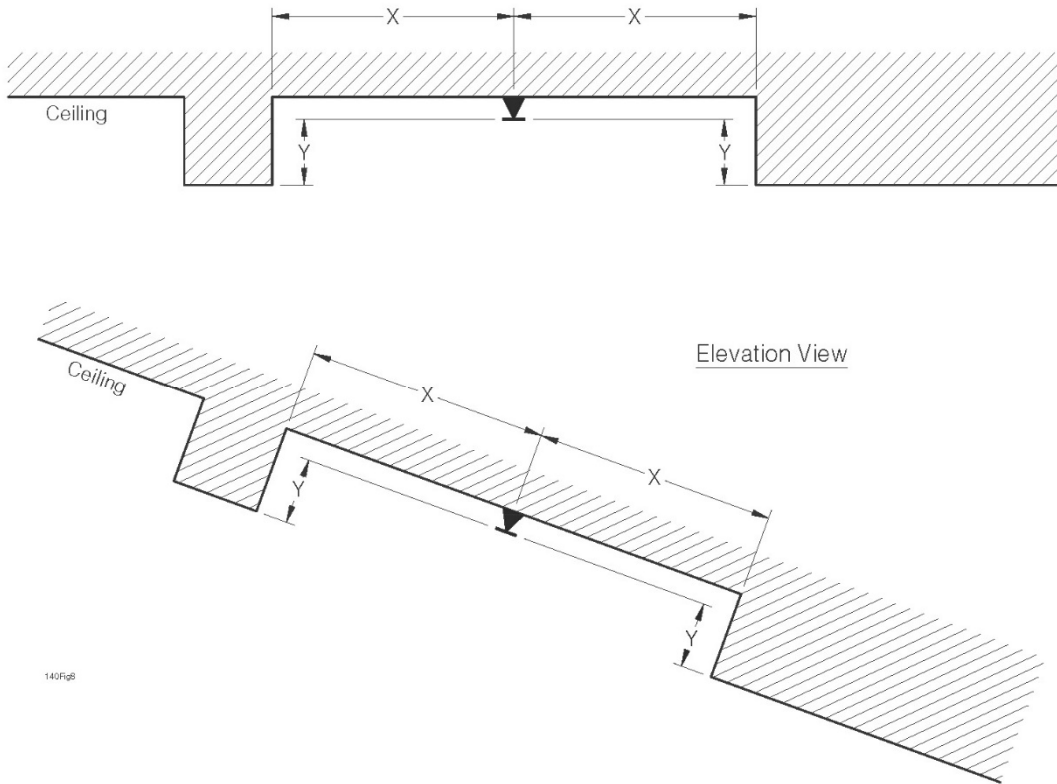


- A - Range: 10° - 34° ceiling angle (greater than 2:12 up to and including 8:12).
- B - Maximum: Up to the max sprinkler spacing for the coverage area being hydraulically calculated.
- Y - Minimum: 4 in. (100 mm)
Maximum: Per the listed deflector to ceiling distance found in the technical bulletin.

Applicable NFPA Standard / 13D / 13R / 13

Positioning of Residential Pendent Sprinklers to Avoid Obstructions to Discharge

Figure 8

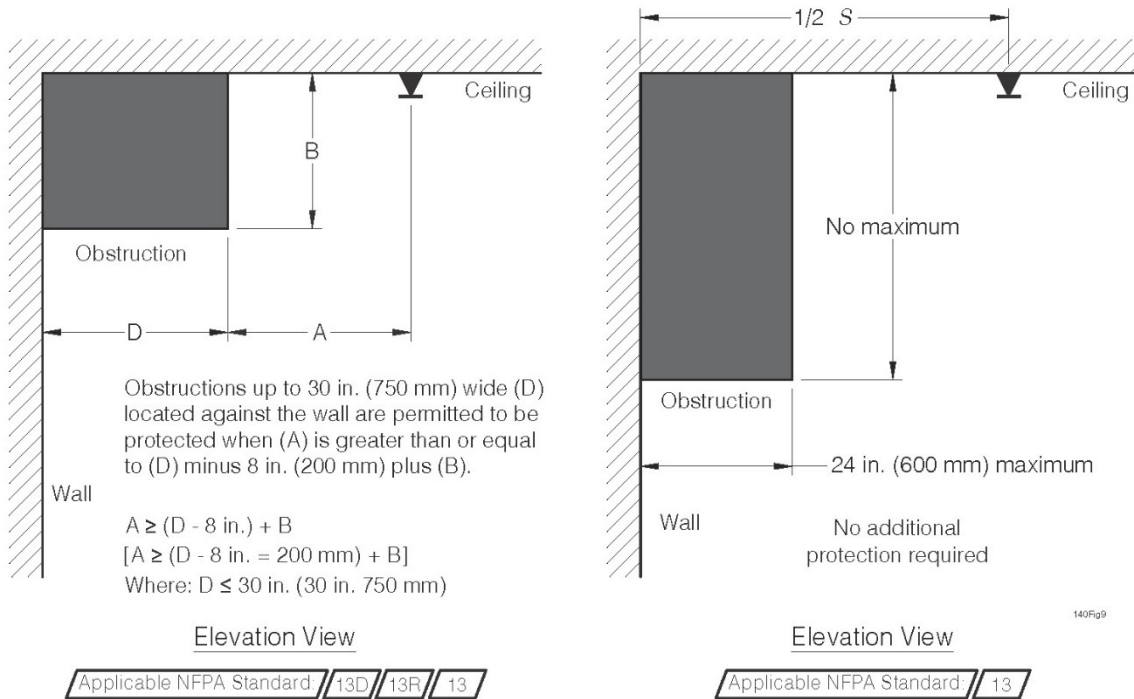


140Fig8

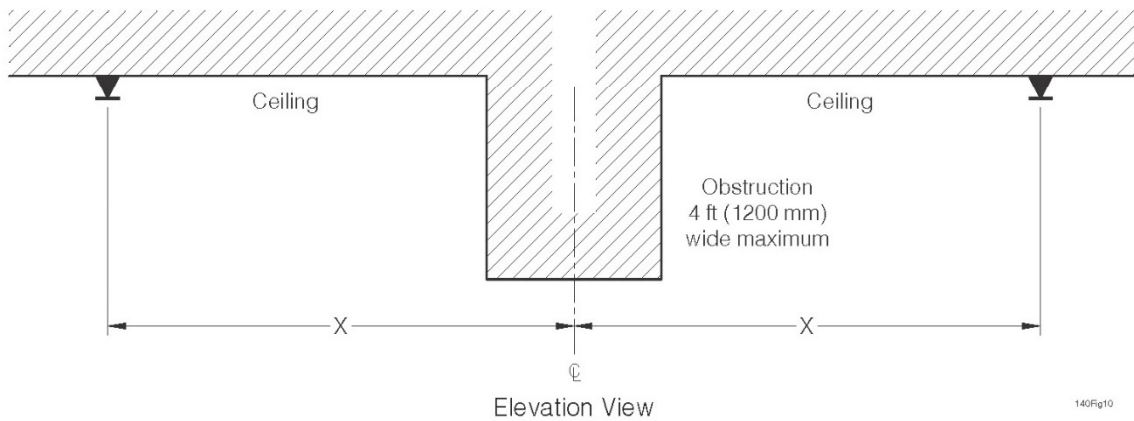
Distance from Sprinklers to Side of Obstruction (X) to Discharge	Maximum Allowable Distance of Deflector Above Bottom of Obstruction (Y)
Less than 1 ft 6 in. (450 mm)	0 in. (0 mm) or less
1 ft 6 in. (450 mm) or more	1 in. (25 mm) or less
3 ft (900 mm) or more	3 in. (75 mm) or less
4 ft (1200 mm) or more	5 in. (125 mm) or less
4 ft 6 in. (1400 mm) or more	7 in. (175 mm) or less
6 ft (1800 mm) or more	9 in. (225 mm) or less
6 ft 6 in. (2000 mm) or more	11 in. (275 mm) or less
7 ft (2100 mm) or more	14 in. (350 mm) or less
8 ft (2400 mm) or more	15 in. (375 mm) or less
8 ft 6 in. (2600 mm) or more	16 in. (425 mm) or less
9 ft (2700 mm) or more	17 in. (475 mm) or less

Applicable NFPA Standard / 13D / 13R / 13

Positioning of Residential Pendent Sprinklers Relative to Obstructions Against Walls Figure 9



Positioning of Residential Pendent Sprinklers Relative to Continuous Obstructions Figure 10

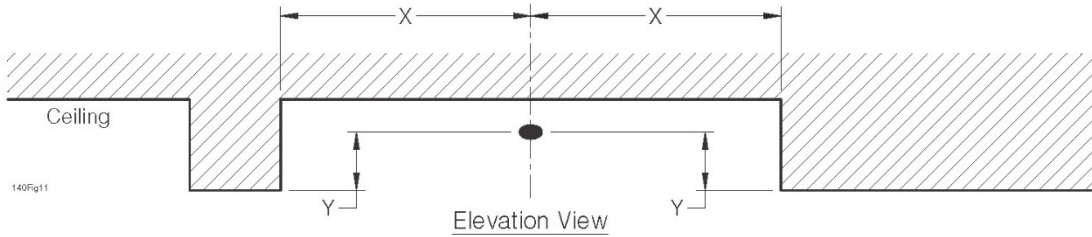


Sprinklers shall be permitted to be spaced on opposite sides of continuous obstructions located at the ceiling not exceeding 4 ft (1200 mm) in width, provided that the distance from the centerline of the obstruction to the sprinklers (X) does not exceed one-half (0.5) of the maximum allowable spacing.

Applicable NFPA Standard: 13D / 13R / 13

Positioning of Residential Sidewall Sprinklers to Avoid Obstructions to Discharge

Figure 11



Distance from Sprinklers to Side of Obstruction (X) to Discharge

Maximum Allowable Distance of Deflector Above Bottom of Obstruction (Y)

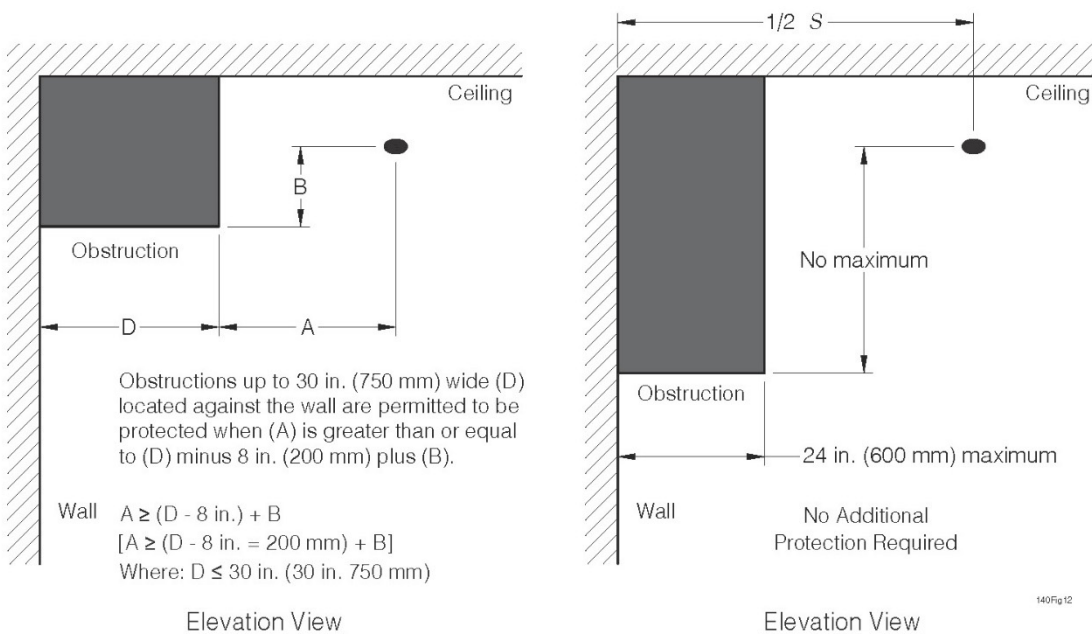
Less than 1 ft 6 in. (450 mm)
 1 ft 6 in. (450 mm) or more
 3 ft (900 mm) or more
 4 ft (1200 mm) or more
 4 ft 6 in. (1400 mm) or more
 6 ft (1800 mm) or more
 6 ft 6 in. (2000 mm) or more
 7 ft (2100 mm) or more

0 in. (0 mm)
 1 in. (25 mm) or less
 3 in. (75 mm) or less
 5 in. (125 mm) or less
 7 in. (175 mm) or less
 9 in. (225 mm) or less
 11 in. (275 mm) or less
 14 in. (350 mm) or less

Applicable NFPA Standard / 13D / 13R / 13

Positioning of Residential Sidewall Sprinklers Relative to Obstructions Against Walls

Figure 12



Elevation View

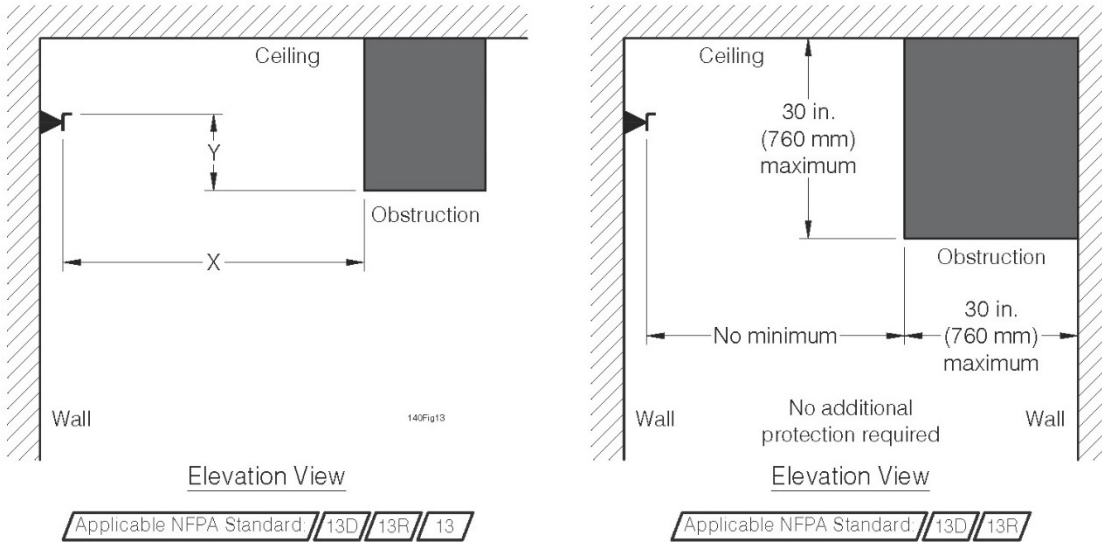
Elevation View

Applicable NFPA Standard / 13D / 13R / 13

Applicable NFPA Standard / 13

Positioning of Residential Sidewall Sprinklers Relative to Obstructions

Figure 13



Distance from Sprinklers to Side of Obstruction (X) to Discharge

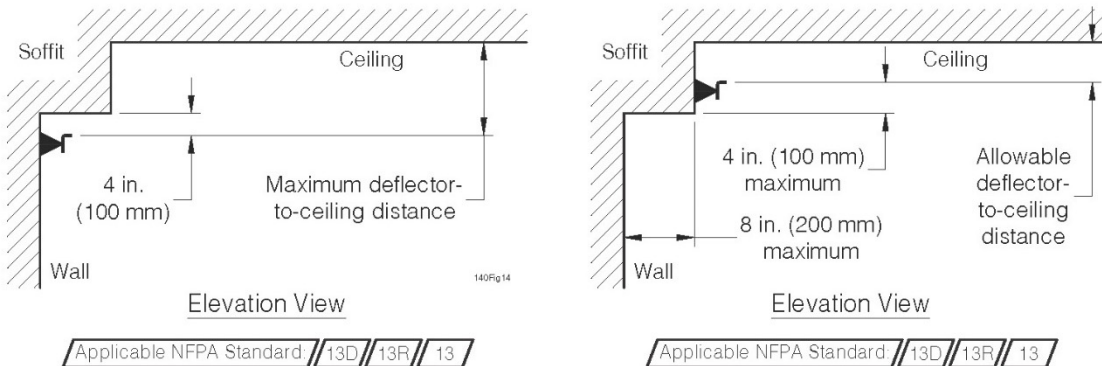
Maximum Allowable Distance of Deflector Above Bottom of Obstruction (Y)

- Less than 8 ft (2400 mm)
- 8 ft (2400 mm) or more
- 10 ft (3000 mm) or more
- 11 ft (3300 mm) or more
- 12 ft (3700 mm) or more
- 13 ft (4000 mm) or more
- 14 ft (4300 mm) or more
- 15 ft (4600 mm) or more
- 16 ft (4900 mm) or more
- 17 ft (5200 mm) or more

- 0
- 1 in. (25 mm) or less
- 2 in. (50 mm) or less
- 3 in. (75 mm) or less
- 4 in. (100 mm) or less
- 6 in. (150 mm) or less
- 7 in. (175 mm) or less
- 9 in. (225 mm) or less
- 11 in. (275 mm) or less
- 14 in. (350 mm) or less

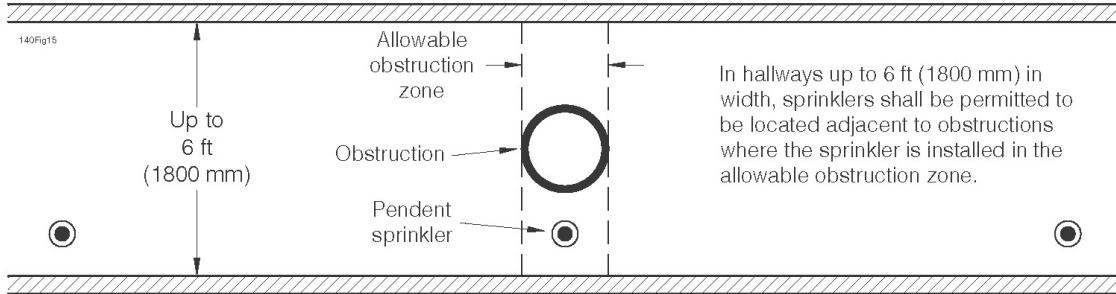
Positioning of Residential Sidewall Sprinklers With Soffits

Figure 14



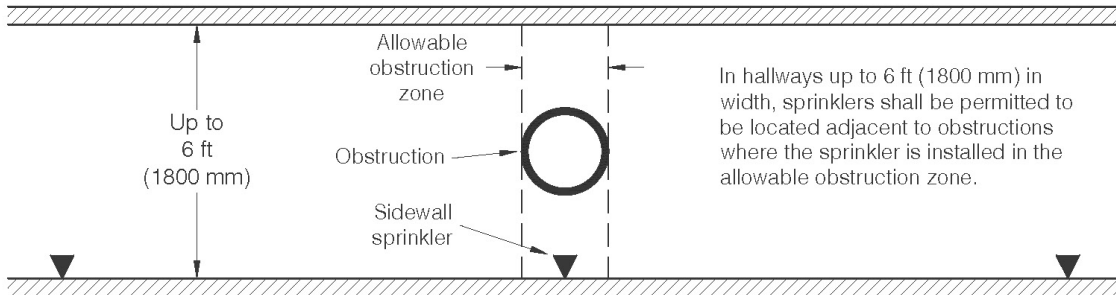
Obstructions in Hallway

Figure 15



Plan View

Applicable NFPA Standard: 13D 13R 13

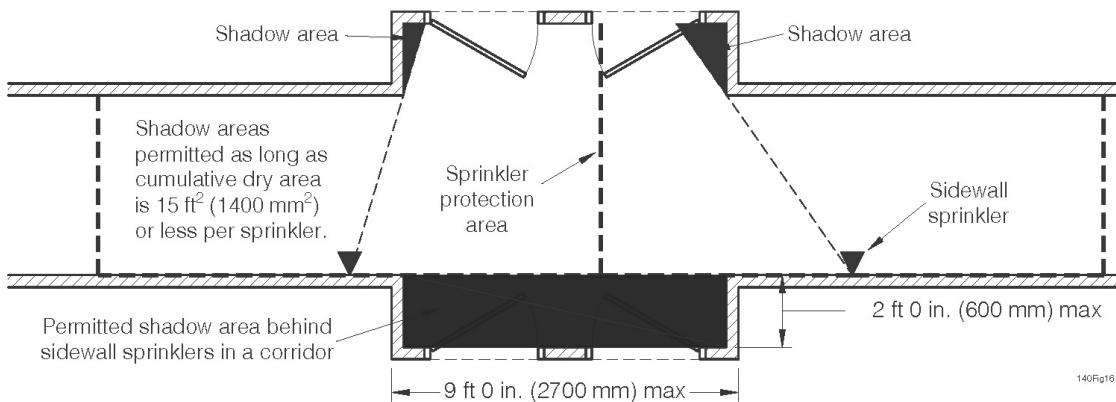


Plan View

Applicable NFPA Standard: 13D 13R 13

Shadow Areas

Figure 16

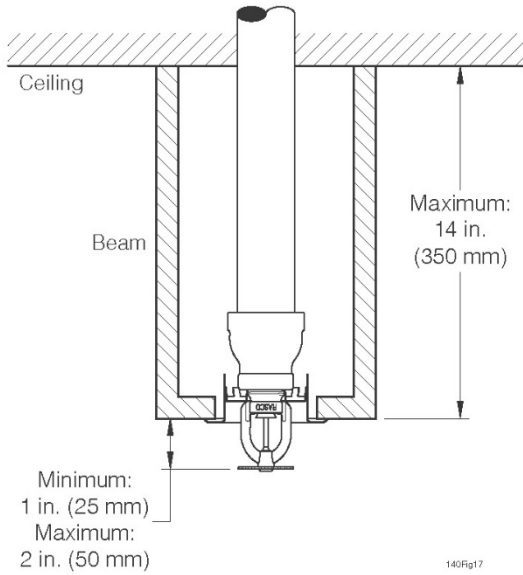


Plan View

Applicable NFPA Standard: 13D 13R 13

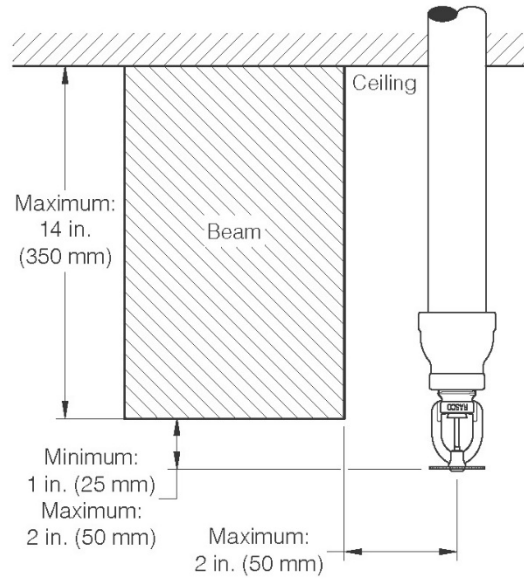
Residential Pendant Sprinklers in Beamed or Beamed and Sloped Ceilings

Figure 17



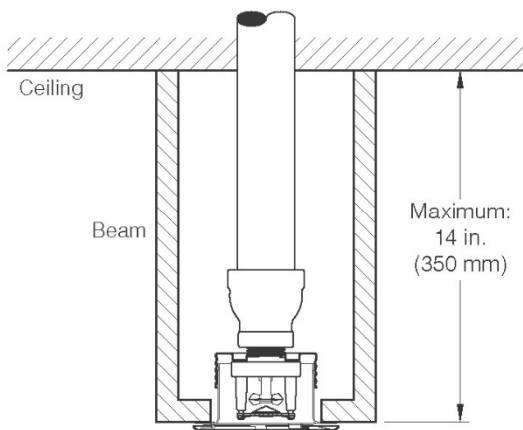
Elevation View

Applicable NFPA Standard: 13D 13R 13



Elevation View

Applicable NFPA Standard: 13D 13R 13



Elevation View

Applicable NFPA Standard: 13D 13R 13

Model RFC Series concealed sprinklers are not to be installed in structural beams or "false" beams that impede the flow of air through the vent holes in the cup assembly into the space above.

Beamed Ceiling Notes:

The following conditions apply when using residential sprinklers in beamed or beamed and sloped ceilings:

1. Maximum beam depth of 14 in. (350 mm)
2. Maximum ceiling height of 24 ft (7300 mm)
3. Maximum ceiling slope of 8:12 (34°)
4. Maximum compartment size of 600 ft² (56 m²)

Important Note:

Core drilling of structural or load bearing beams to allow the installation of sprinkler drops requires approval of a structural engineer.