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# A Technical Analysis:

## Listings and Applications of Residential Sprinklers

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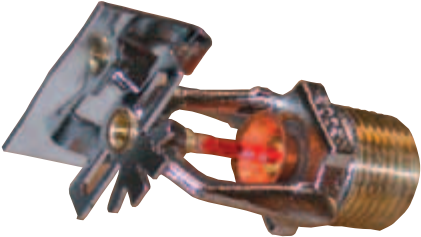
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## BACKGROUND

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Recent changes to the National Fire Protection Association (NFPA) Standard 13D - Installation of Sprinkler Systems One and Two Family Dwellings and Manufactured Homes, Standard 13R - Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height, and revisions to Underwriters Laboratory (UL) Standard 1626 - Standard for Residential Sprinklers - have prompted the largest revision to residential sprinklers since the early 1980's. Until these recent changes, manufacturers have held a wide variety of listings with applications of residential sprinklers from sprinkler spacings of 12' X 12' to 20' X 20'; and horizontal ceiling heights of 8 ft, to sloped ceilings with a pitch of 8/12 (rise over run) with unlimited ceiling heights. Additionally, discharge densities that had no specified minimums in the UL or NFPA standards resulted in Listings as low as .03-gpm/sq ft. This reduction is significant compared to the minimum density of .09-gpm/sq ft. density referenced in NFPA 13D in the 1980 to 1999 editions. In 2002, the UL Directory listed 110 Models of residential sprinklers with over 600 different applications. Both the NFPA 13D-2002 & NFPA 13R-2002 edition, with an effective date of August 8, 2002 contain a new minimum discharge density of .05-gpm/sq ft for all residential sprinkler coverage areas. Although this is a reduction to the minimum densities specified by NFPA 13D and NFPA 13R, it is an increase in flow rates from the special Listings manufacturers have obtained from UL over the past 20 years.

## HISTORY

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The first residential sprinkler Listing was granted to Grinnell's Model F954 in 1981. The Listing was based on a maximum coverage area of 144 sq ft (12 ft x 12 ft maximum spacing). The minimum flow for the F954 was based on the NFPA 13D minimum of 18 gpm for a single sprinkler flow rate and 13 gpm for the multiple (two sprinklers) sprinkler flow rate. These minimum flow rates translate to equivalent .125-gpm/sq ft and .09gpm/sq ft densities. All residential sprinklers were required to meet these requirements unless they were Listed as equivalent. Beginning in the early 1980's, Central Sprinkler utilized the Listing process to provide equivalent protection with lower flow rates combined with greater sprinkler spacing. Soon coverage areas up to 400 sq ft (20 ft x 20 ft) existed at densities as low as .03-gpm/sq ft. Extended coverage Listings, combined with lower flows, provided the industry with exactly what NFPA 13D was created for - a low cost life safety sprinkler system that allows the evacuation of occupants in the event of a fire in one and two family dwellings.

NFPA 13 - Installation of Sprinkler Systems recognized the use of residential sprinklers in residential portions of NFPA 13 occupancies in 1983. Additionally, NFPA 13R - Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height, first published in 1989 recognized the use of residential sprinklers in multiple (more than two) family residences in buildings up to four stories in height. More and more dependence on the performance of residential sprinklers was expected, including the protection of property rather than just their life safety feature.

In 1999, Factory Mutual (FM) conducted a residential fire test using a UL listed residential sprinkler as manufactured by the Viking Corporation. According to the FM report, the Listed flows and pressures were inadequate for the FM residential test series, sparking a debate on the adequacy of the current test and installation standards.

## WHY DID CHANGES OCCUR?

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This is a frequently asked question since these residential sprinklers were Listed by UL, a nationally recognized laboratory. While residential sprinklers have an impeccably successful field record since their origin, it was also recognized that a level of variability exists in residential type fire testing that cannot be practically eliminated, as well as fire challenges that are expected to occur in field installations. Discussions ensued, referencing the original Los Angeles residential fire tests and the fuel load used to simulate typical living room residential fires. Underwriters Laboratories and Factory Mutual ran hundreds of simulated residential fire tests. When the dust settled after two years of research, a recommendation to establish a minimum density of .05-gpm/sq ft for both the single and multiple sprinkler designs for residential sprinklers was accepted by Underwriters Laboratories, Factory Mutual and the NFPA 13D technical committee. With the acceptance of the higher flow rates, changes to the fire test protocol were also made. The changes provide enhanced consistency in the fire growth and challenge to residential sprinklers that is similar to the burning characteristics in the Los Angeles fire tests. Changes were made to the type of wall paneling, simulated furniture foam, dimensions for the simulated furniture, ignition type, and ignition location, as well as dimensional locations for the simulated furniture (see Figure 1). The test revisions provide a much more consistent laboratory fire test, and the new minimum density provides consistent results (see Figure 2 for a laboratory fire test).

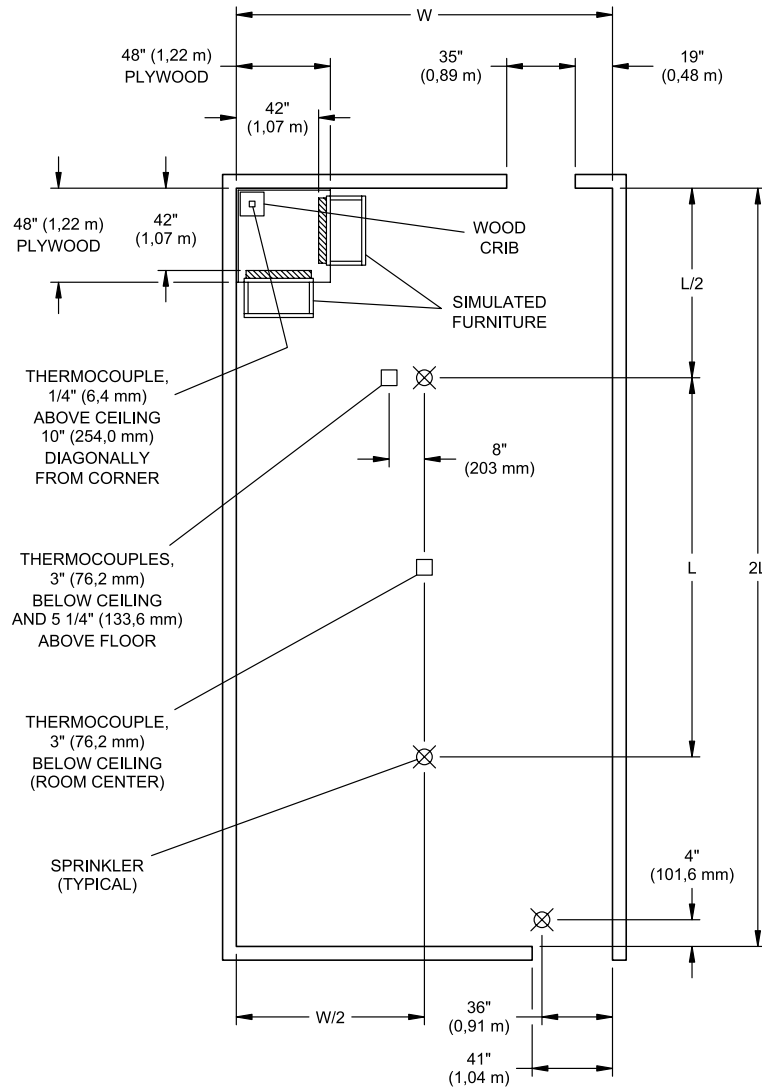


Figure 1 - Revised UL residential fire test setup.

The max. temp. 3" (76 mm) below the ceiling shall not exceed 600°F (316°C).

The max. temp 5'-3" (1.6 m) above the floor shall not exceed 200°F (93°C) & the temp. shall not exceed 130°F (54°C) for more than any continuous 2-min. period.

The max. ceiling material temp. 1/4" (6.4 mm) behind the finished ceiling surface shall not exceed 500°F (260°C).



*Figure 2 - UL Residential Fire Test*

## ARE ALL LISTINGS THE SAME?

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Absolutely not - understanding the definition of terms used in the Listing applications is critical to proper design and installation of residential sprinklers. Currently, the basic Listing of a residential sprinkler follows the minimum .05-gpm/sq ft density is for smooth flat horizontal (pitch not exceeding 2 units rise over 12 units run) ceilings. Any uses beyond these basic minimums require a special Listing or the acceptance of the design criteria by the contractor and the Authority Having Jurisdiction (AHJ). Other than the Listing protocol, the design criteria usually proposed by designers includes an increase in the minimum flow/pressure or an increase in the number of sprinklers being hydraulically calculated. At the end of the day, if the Listing of the residential sprinkler does not cover the application, the designer and the AHJ become the responsible parties. Manufacturers are frequently asked about installation conditions and often render common sense solutions subject to the approval of the AHJ. Manufacturers rarely want to become the system designer.

Tyco Fire Products has gone to great lengths to identify and qualify Listings for common construction features used in residential occupancies. The greater the amount of Listed applications, the less the AHJ or contractors have to become the responsible design parties. Listings follow some common terms used by most manufacturers, but many listings vary by manufacturer. The following list defines these terms used in the Listing protocol.

**Deflector distance** - This is the dimensional range that the deflector can be located below a ceiling or away from a wall (sidewall). Currently, only pendent and horizontal sidewall sprinklers are in the residential category. NFPA 13D, 2002 allows pendent sprinklers to have a deflector distance of 1 to 4 inches below the ceiling with an allowance of up to 12 inches for closets (to avoid obstructions). Sidewalls are specified at 4 to 6 inches below the ceiling. Most important about these requirements is the allowance for “listed with specific positioning criteria”, this allows manufactures to design and obtain Listings for deflector distances that vary from the specified minimum and maximums set in 13D such as flush or concealed designs. The following definition of categories cover the current applications of residential sprinklers, keep in mind that only some of (a.) and (e.) comply with the deflector distances specified in 13D. The remaining categories are “listed with specific positioning criteria”. The categories are:

- a. **Pendent** - the entire sprinkler (from the discharge orifice to the deflector) is located below the ceiling. The manufacturer will identify variances to the standard Listing of deflector distances of 1 to 4 inches from the ceiling. Some manufactures choose to have their pendent sprinklers listed with deflector distances greater than 4 inches from the ceiling. The most common modification is 4 to 8 inches below a smooth flat ceiling. Most pendants are Listed as recessed pendants as well (see recessed pendent).
- b. **Recessed Pendent** - An exposed pendent sprinkler having its discharge orifice above the ceiling line using an escutcheon assembly. The amount of recess (distance above the ceiling) is controlled by the manufacturer’s escutcheon selection and the subsequent testing. It is important that the escutcheon referenced and supplied by the manufacturer be used. Escutcheons are referenced in combination with the pendent sprinklers, and many after-market escutcheons violate the Listing by allowing non-Listed recessed dimensions.
- c. **Flush Pendent** - A pendent sprinkler whose body is generally located above the ceiling line and whose operating (thermal) element is below the ceiling line.
- d. **Concealed Pendent** - A pendent sprinkler that is covered from view with a plate or cup. Earlier versions of concealed pendent sprinklers had flat, circular plates that covered the holes in the ceiling. These were required as the sprinklers were located almost entirely above the ceiling line. Some currently Listed concealed designs (domed) employ cover plates that protrude from the ceiling and cover a recessed sprinkler from view.
- e. **Horizontal Sidewall** - the entire sprinkler from the discharge orifice to the deflector is located below a ceiling, outside a wall, in the horizontal position. The most common reference for the horizontal sidewall is to have its deflector 4 to 6 inches below the ceiling and away from the wall. Some manufactures will qualify their sidewalls with an additional application of 6 to 12 inches below the ceiling. Most manufacturers qualify horizontal sidewalls as recessed horizontal sidewalls, as well.
- f. **Recessed Horizontal Sidewall** - An exposed sidewall sprinkler whose discharge orifice is inside the wall surface. The escutcheon chosen by the manufacturer and the testing control the amount of recess. It is important that the escutcheon referenced and supplied by the manufacturer be used. Escutcheons are referenced in combination with the sprinklers in the listings and many after-market escutcheons violate the Listing by allowing non-Listed recessed dimensions.



- g. **Flush Horizontal Sidewall** - A horizontal sidewall sprinkler whose body is generally located outside the room (within the vertical plane of a wall), and whose operating element is inside the room (outside the vertical plane of a wall).
- h. **Concealed Horizontal Sidewall** - A horizontal sidewall sprinkler that is covered from view using a plate or cup. Cups that cover a recessed sprinkler from view are being used to conceal some sprinkler types.
- i. **Special** - Every category has a special area in which a manufacturer can specify styles or types that do not exist in the standard descriptions.

**Ceiling Configuration** - The most common ceiling type is a flat, smooth, horizontal ceiling with a pitch not exceeding 2 units of rise over 12 units of run (2/12). Additional ceiling types include sloped ceilings with ceiling pitch in excess of 2/12, from 2/12 to 4/12 and from 2/12 to 8/12. Additional listings are also now available for beamed ceilings.

- a. **Flat Smooth Horizontal Ceiling** - The first Listing that residential sprinklers obtain. Currently, it is understood that the new Listings for the .05-gpm/sq ft designs apply to ceilings from horizontal to a pitch of 2/12. This is consistent with other NFPA standards defining horizontal vs. pitched ceilings. There are no obstructions such as ceiling offsets or beams tested in this basic residential application. It is clearly understood that the application is for "smooth ceiling" designs.
- b. **Sloped Ceilings** - A smooth ceiling with a pitch exceeding 2/12. NFPA 13 D allows Listed sprinklers for "flat smooth" to be used in sloped applications; however, the AHJ is responsible for specifying or accepting the proposed design criteria, such as the number of sprinklers calculated beyond the Listed minimums, or increases in the minimum Listed flow rates. Tyco Fire Products has chosen to qualify its residential line by Listing sloped ceiling applications from above 2/12 to 4/12 and above 2/12 to 8/12. This relieves the contractor and the AHJ of the burden of accepting theoretical designs or performance.
- c. **Beamed Ceilings** - A new application for residential sprinklers in which the sprinklers are located at the bottom of the beam. Traditionally, if the sprinkler could not be located below the beam due to the maximum deflector distance limitations below the ceiling, residential sprinklers were located in each pocket formed by beams. This could require as many as 10 to 12 sprinklers in one room, creating its own set of problems such as operating additional sprinklers that tax the water supply. To obtain a specific Listing for beamed type ceilings, testing must be performed with beams and the listing is specific to the application. Tyco Fire Products has recently tested to expand Listings of three of our residential sprinklers that allow them to be located on the bottom of ceiling beams up to 14 inches deep (see details below). Without this application listing, an AHJ would again be responsible for determining the minimum number of operating sprinklers, as well as their required design flow rates. It should be noted that the concealed pendent sprinkler failed to pass the test program for the beam ceiling application; therefore, it may not be assumed that all residential sprinklers will perform under beams.
- d. **Special** - Again, never say never. It is important that new residential sprinkler products be developed to provide for cost effective fire protection, particularly as it relates to NFPA 13D occupancies.

## WHAT HAS THE INDUSTRY DONE?

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The fire sprinkler manufacturers have complied with the new industry standards. Understanding these new products, their Listings, and applications is critical to proper residential design and installations. Most manufacturers have abandoned the use of old residential sprinklers and listings in favor of optimizing new lines of residential sprinklers.

Tyco Fire Products (Central, Gem and Star), maintaining a leadership role, has worked with AHJs, contractors and industry association members to identify the most common room sizes, ceiling configurations, and water supplies to develop a line of residential sprinklers and applications that meet the needs of the industry. We have optimized for both flow and pressure based on the most common uses. The following tables and figures detail the minimum flows and pressures required for TFP's new line of residential sprinklers.

Additionally, a competitive analysis for each application is included in the tables. The flows and pressures for the TFP products are accurate, and are as Listed. The competitors' flows and pressures were accumulated from many sources as of February 13, 2003 (6 months after compliance date). Some of these may have changed, and we make no representation to their Listings. The reader should verify the actual current data with each manufacturer.

## FLAT SMOOTH CEILINGS AND SLOPED CEILINGS

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Figures 3 through 8 show the flows and pressures for flat smooth ceilings in the "Flat" column, sloped ceilings in the "4/12 Slope" and the "8/12 Slope" columns respectively. Sloped ceilings Listings are optional for the manufacturer to obtain. For the reasons stated above in the definition section, Tyco Fire Products obtained sloped ceiling Listings for its entire residential line to relieve the burden of design "equivalent methods" from the contractor and AHJ. For flat and sloped ceilings, the most competitive flows available match the minimum .05-gpm/sq ft for the area of protection. An example of the minimum flow allowed for common spacings of 16ft x 16ft (256 sq ft) is 13 gpm, 18ft x 18ft (324 sq ft) is a minimum of 17 gpm and 20ft x 20ft (400 sq ft) is 20 gpm. All Listings other than "Flat" are special applications that the manufacturer chooses to have tested and Listed.

Each category of Pendent and Recessed Pendent, Horizontal Sidewall and Recessed Horizontal Sidewall, Flush Pendent, Flat Plate Concealed, and Domed Concealed are shown in Tables 3 through 8 respectively. Again, as of February 13th, 2003 the information for all manufactures is current based on a variety of sources such as websites, data sheets and UL Listings. Verification of these flows with each manufacturer is necessary prior to actual design.

**Pendent,  
Recessed Pendent**



**Flow (GPM)**

Room Size ft. X ft.	Rating (F)	Central, Gem and Star			Viking			Reliable		Victaulic		Globe				Automatic			
		4.9 TY2234			5.5	4.3	3.1	4.9		4.9/4.9		4.1		4.7		4.3/5.6			
		Flat	4/12 Slope	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	
12 X 12	155	13	13	13	16	21	12	18	9	13/15*	20	13/13	na	11	na	13	na	13/na	na
12 X 12	175	13	17	18	16	21	12	18	9	13	na	13/13	na	11	na	13	na	na	na
14 X 14	155	13	13	13	19	21	13	18	13	13/16*	20	13/17	na	12	na	18	na	13/na	na
14 X 14	175	13	17	18	19	21	13	18	13	13	na	15/17	na	na	na	na	na	na	na
16 X 16	155	13	13	13	19	21	13	18	13	13/17*	20	13/17	na	14	na	18	na	13/na	na
16 X 16	175	13	17	18	19	21	13	18	13	13	na	15/17	na	na	na	na	na	na	na
18 X 18	155	17	17	17	21	22	17	na	na	17/19*	20	na/17	na	na	na	18	na	na/21	na
18 X 18	175	17	17	23	21	22	17	na	na	17	na	na/17	na	na	na	na	na	na	na
20 X 20	155	20	20	21	24	28	21	na	na	20/22*	25	na/20	na	na	na	20	na	na/23	na
20 X 20	175	20	20	na	24	28	21	na	na	20	na	na/20	na	na	na	na	na	na	na

\* = Deflector to smooth ceiling between 4" and 8"

**Pressure (PSI)**

Room Size ft. X ft.	Rating (F)	Central, Gem and Star			Viking			Reliable		Victaulic		Globe				Automatic			
		4.9 TY2234			5.5	4.3	3.1	4.9		4.9/4.9		4.1		4.7		4.3/5.6			
		Flat	4/12 Slope	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	
12 X 12	155	7.0	7.0	7.0	8.5	14.6	7.8	17.5	8.4	7.0/9.4*	16.7	7.0/7.0	na	7.2	na	7.7	na	9.2/na	na
12 X 12	175	7.0	12.0	13.5	8.5	14.6	7.8	17.5	8.4	7.0	na	7.0/7.0	na	7.2	na	7.7	na	na	na
14 X 14	155	7.0	7.0	7.0	11.9	14.6	9.1	17.5	17.6	7.0/10.6*	16.7	7.0/7.0	na	8.6	na	14.7	na	9.2/na	na
14 X 14	175	7.0	12.0	13.5	11.9	14.6	9.1	17.5	17.6	7.0	na	9.4/7.0	na	na	na	na	na	na	na
16 X 16	155	7.0	7.0	7.0	11.9	14.6	9.1	17.5	17.6	7.0/12.0*	16.7	7.0/12.0	na	11.7	na	14.7	na	9.2/na	na
16 X 16	175	7.0	12.0	13.5	11.9	14.6	9.1	17.5	17.6	7.0	na	9.4/12.0	na	na	na	na	na	na	na
18 X 18	155	12.0	12.0	12.0	14.6	16.0	15.6	na	na	12.0/15.0*	16.7	na/12.0	na	na	na	14.7	na	na/14.0	na
18 X 18	175	12.0	12.0	22.0	14.6	16.0	15.6	na	na	12.0	na	na/12.0	na	na	na	na	na	na	na
20 X 20	155	16.7	16.7	18.4	19.0	25.9	23.9	na	na	16.7/20.2*	26.0	na/16.7	na	na	na	18.1	na	na/17.0	na
20 X 20	175	16.7	16.7	na	19.0	25.9	23.9	na	na	16.7	na	na/16.7	na	na	na	na	na	na	na

\* = Deflector to smooth ceiling between 4" and 8"

Figure 3 - Flows and Pressures for Pendent and Recessed Pendent

# Horizontal Sidewall, Recessed Horizontal Sidewall



**Flow (GPM)**

Room Size (ft. x ft.)	Rating (F)	Central, Gem and Star 4.2 TY1334						Viking				Reliable			Victaulic		Globe		Automatic		Deflector to ceiling (in.)
		Flat		4/12 Slope		8/12 Slope		5.5 VK442		4.3 VK440		4.3 VK448		4.0 - F1 RES40			4.2		4.2		
		At Peak	Across Slope	At Peak	Across Slope	At Peak	Across Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Across Slope	Flat	8/12 Slope	At Peak	8/12 Slope	Flat	8/12 Slope	
12 X 12	155	12	12	16	12	16*	na	21	na	19	na	na	13	13	17*	13	13	na	20	na	4-6
12 X 12	155	13	13	18	13	na	21	na	19	na	na	na	13	13	na	na	na	na	na	na	6-12
12 X 12	175	12	12	16	12	16*	na	21	na	19	na	na	13	13	na	na	na	13	na	na	4-6
12 X 12	175	13	13	18	13	na	21	na	19	na	na	na	13	13	na	na	na	na	na	na	6-12
14 X 14	155	14	14	16	14	16*	na	22	na	na	na	na	16	16	17*	16	20	15	na	20	4-6
14 X 14	155	17	17	18	17	na	22	na	21	na	na	na	17	17	na	na	na	na	na	na	6-12
14 X 14	175	16	14	16	14	16*	na	22	na	na	na	na	16	16	na	na	na	15	na	na	4-6
14 X 14	175	18	17	18	17	na	22	na	21	na	na	na	17	17	na	na	na	na	na	na	6-12
16 X 16	155	16	16	16	16	16*	na	24	na	na	na	na	17	17	17*	20	na	16	na	25	4-6
16 X 16	155	18	18	18	18	na	24	na	na	na	na	na	20	20	na	na	na	na	na	na	6-12
16 X 16	175	16	16	16	16	16*	na	24	na	na	na	na	18	17	na	na	na	16	na	na	4-6
16 X 16	175	18	18	18	18	na	24	na	na	na	na	na	20	20	na	na	na	na	na	na	6-12
16 X 18	155	19	19	22	19	na	na	28	na	na	23	na	20	20	na	23	na	19	na	na	4-6
16 X 18	155	21	21	22	21	na	27	na	na	na	24	na	na	20	na	na	na	na	na	na	6-12
16 X 18	175	19	19	22	19	na	na	28	na	na	23	na	20	21	na	na	na	19	na	na	4-6
16 X 18	175	21	21	22	21	na	27	na	na	na	24	na	na	20	na	na	na	na	na	na	6-12
18 X 18	155,175	na	na	na	na	na	na	na	na	na	na	na	22	na	na	na	na	na	na	na	4-6
16 X 20	155	23	24	23*	24	na	na	na	na	na	25	na	23	23	na	23	na	23	na	na	4-6
16 X 20	155	26	26	26*	26	na	na	na	na	na	26	na	na	na	na	na	na	na	na	na	6-12
16 X 20	175	23	24	23*	24	na	na	na	na	na	25	na	23	23	na	na	na	23	na	na	4-6
16 X 20	175	26	26	26*	26	na	na	na	na	na	26	na	na	na	na	na	na	na	na	na	6-12

\* = 3 head design across slope

Figure 4 - Flows for Horizontal Sidewalls and Recessed Horizontal Sidewalls

**Horizontal Sidewall,  
Recessed Horizontal  
Sidewall**



**Pressure (PSI)**

Room Size (ft. x ft.)	Rating (F)	Central, Gem and Star						Viking				Reliable			Victaulic		Globe		Automatic		Deflector to ceiling (in.)	
		4.2 TY1334						5.5 VK442		4.3 VK440		4.3 VK448		4.0 - F1 RES40			4.2		4.2			
		Flat		4/12 Slope		8/12 Slope		Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	At Peak	8/12 Slope	Flat	8/12 Slope	Flat		8/12 Slope
		At Peak	Across Slope	At Peak	Across Slope	At Peak	At Peak	At Peak	At Peak	At Peak	Across Slope	At Peak	Across Slope	At Peak	At Peak	At Peak	At Peak	At Peak	At Peak			
12 X 12	155	8.2	8.2	14.5	8.2	14.5*	na	14.6	na	19.5	na	na	10.6	10.6	18.1	9.6	9.6	9.6	na	23.0	na	4-6
12 X 12	155	9.6	9.6	18.4	9.6	na	14.6	na	19.5	na	na	na	10.6	10.6	na	na	na	na	na	na	na	6-12
12 X 12	175	8.2	8.2	14.5	8.2	14.5*	na	14.6	na	19.5	na	na	10.6	10.6	na	na	na	9.6	na	na	na	4-6
12 X 12	175	9.6	9.6	18.4	9.6	na	14.6	na	19.5	na	na	na	10.6	10.6	na	na	na	na	na	na	na	6-12
14 X 14	155	11.1	11.1	14.5	11.1	14.5*	na	16.0	na	na	na	na	16.0	16.0	18.1	14.5	22.7	12.8	na	23.0	na	4-6
14 X 14	155	16.4	16.4	18.4	16.4	na	16.0	na	23.9	na	na	na	18.1	18.1	na	na	na	na	na	na	na	6-12
14 X 14	175	14.5	11.1	14.5	11.1	14.5*	na	16.0	na	na	na	na	16.0	16.0	na	na	na	12.8	na	na	na	4-6
14 X 14	175	18.4	16.4	18.4	16.4	na	16.0	na	23.9	na	na	na	18.1	18.1	na	na	na	na	na	na	na	6-12
16 X 16	155	14.5	14.5	14.5	14.5	14.5*	na	19.0	na	na	na	na	18.1	18.1	18.1	22.7	na	14.5	na	35.0	na	4-6
16 X 16	155	18.4	18.4	18.4	18.4	na	19.0	na	na	na	na	na	25.0	25.0	na	na	na	na	na	na	na	6-12
16 X 16	175	14.5	14.5	14.5	14.5	14.5*	na	19.0	na	na	na	na	20.2	18.1	na	na	na	14.5	na	na	na	4-6
16 X 16	175	18.4	18.4	18.4	18.4	na	19.0	na	na	na	na	na	25.0	25.0	na	na	na	na	na	na	na	6-12
16 X 18	155	20.5	20.5	27.4	20.5	na	na	25.9	na	na	28.6	na	25.0	25.0	na	30.0	na	20.5	na	na	na	4-6
16 X 18	155	25.0	25.0	27.4	25.0	na	24.1	na	na	na	31.2	na	na	na	na	na	na	na	na	na	na	6-12
16 X 18	175	20.5	20.5	27.4	20.5	na	na	25.9	na	na	28.6	na	25.0	27.6	na	na	na	20.5	na	na	na	4-6
16 X 18	175	25.0	25.0	27.4	25.0	na	24.1	na	na	na	31.2	na	na	na	na	na	na	na	na	na	na	6-12
18 X 18	155,175	na	na	na	na	na	na	na	na	na	na	na	30.2	na	na	na	na	na	na	na	na	4-6
16 X 20	155	30.0	32.7	30.0*	32.7	na	na	na	na	na	33.8	na	33.1	33.1	na	30.0	na	30.0	na	na	na	4-6
16 X 20	155	38.3	38.3	38.3*	38.3	na	na	na	na	na	36.6	na	na	na	na	na	na	na	na	na	na	6-12
16 X 20	175	30.0	32.7	30.0*	32.7	na	na	na	na	na	33.8	na	33.1	33.1	na	na	na	30.0	na	na	na	4-6
16 X 20	175	38.3	38.3	38.3*	38.3	na	na	na	na	na	36.6	na	na	na	na	na	na	na	na	na	na	6-12

\* = 3 head design across slope

Figure 5 - Pressures for Horizontal Sidewalls and Recessed Horizontal Sidewalls

# Flush Pendent



### Flow (GPM)

Room Size ft. X ft.	Sprinkler Temperature Rating (F)	Central, Gem and Star 4.2 TY2284		Viking		Reliable		Victaulic 4.1		Globe 4.1	
		Flat	8/12 slope	Flat	8/12 slope	Flat	8/12 slope	Flat	8/12 slope	Flat	8/12 slope
12 X 12	165	13	14*/17	na	na	na	na	11	na	11	22
14 X 14	165	13	14*/17	na	na	na	na	11	na	11	22
16 X 16	165	14	14*/17	na	na	na	na	13	na	13	22
18 X 18	165	18	18*/19	na	na	na	na	17	na	17	22
20 X 20	165	22	24	na	na	na	na	20	na	20	22

\* 3 sprinkler design

### Pressure (PSI)

Room Size ft. X ft.	Sprinkler Temperature Rating (F)	Central, Gem and Star 4.2 TY2284		Viking		Reliable		Victaulic 4.1		Globe 4.1	
		Flat	8/12 slope	Flat	8/12 slope	Flat	8/12 slope	Flat	8/12 slope	Flat	8/12 slope
12 X 12	165	9.6	11.1*/16.4	na	na	na	na	7.2	na	7.2	28.8
14 X 14	165	9.6	11.1*/16.4	na	na	na	na	7.2	na	7.2	28.8
16 X 16	165	11.1	11.1*/16.4	na	na	na	na	10.1	na	10.0	28.8
18 X 18	165	18.4	18.4*/20.5	na	na	na	na	17.2	na	17.2	28.8
20 X 20	165	27.4	32.7	na	na	na	na	23.8	na	23.8	28.8

\* 3 sprinkler design

Figure 6 - Flows and Pressures for Flush Pendent

## Flat Plate Concealed Pendant



		<b>Flow (GPM)</b>								<b>Pressure (PSI)</b>							
Room Size ft. X ft.	Temperature Rating (F)	<b>Central, Gem and Star 4.2 TY2596</b>			<b>Viking 4.1</b>		<b>Reliable 5.6</b>		<b>Central, Gem and Star 4.2</b>			<b>Viking 4.1</b>		<b>Reliable 4.9</b>			
		Flat	4/12 Slope	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	4/12 Slope	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope		
12 X 12	165	13	18	18	15.0	na	18	na	9.6	18.4	18.4	13.4	na	10.3	na		
14 X 14	165	14	18	18	16.0	na	26	na	11.1	18.4	18.4	15.2	na	21.6	na		
16 X 16	165	16	18	18	20.0	na	26	na	14.5	18.4	18.4	23.8	na	21.6	na		
18 X 18	165	20	20	na	na	na	na	na	22.7	22.7	na	na	na	na	na		
20 X 20	165	24	26	na	na	na	na	na	32.7	38.3	na	na	na	na	na		

Figure 7 - Flows and Pressures for Flat Plate Concealed

## Domed Plate Concealed Pendant

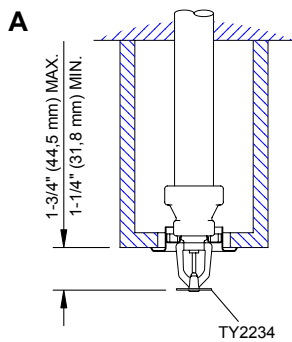
		<b>Flow (GPM)</b>								<b>Pressure (PSI)</b>							
Room Size (ft. X ft.)	Sprinkler Temperature Rating (F)	<b>Central, Gem and Star</b>		<b>Victaulic 4.9/4.9</b>		<b>Reliable 4.9</b>		<b>Globe 4.1</b>		<b>Central, Gem and Star</b>		<b>Victaulic 4.9/4.9</b>		<b>Reliable 4.9</b>		<b>Globe 4.1</b>	
		Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope	Flat	8/12 Slope
12 X 12	165	na	na	13/13	na	13	25*	11	na	na	na	7.0/7.0	na	7.0	26.0*	7.2	na
14 X 14	165	na	na	13/17	na	13	25*	15	na	na	na	7.0/12.0	na	7.0	26.0*	13.4	na
16 X 16	165	na	na	14/17	na	14	25*	15	na	na	na	8.2/12.0	na	8.2	26.0*	13.4	na
18 X 18	165	na	na	na/17	na	18	na	na	na	na	na	na/12.0	na	13.5	na	na	na
20 X 20	165	na	na	na/20	na	20	na	na	na	na	na	na/16.7	na	16.6	na	na	na

\* = 3 head design

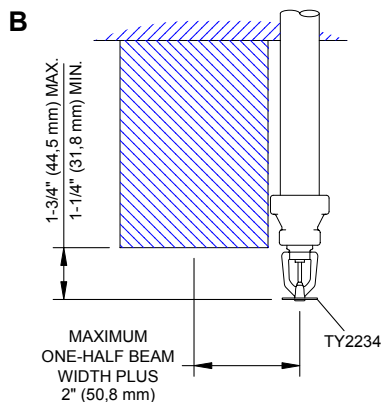
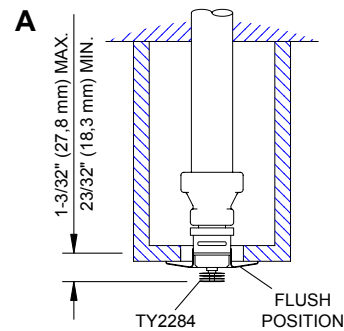
Figure 8 - Flows and Pressures for Domed Concealed Pendant

BEAMED CEILINGS

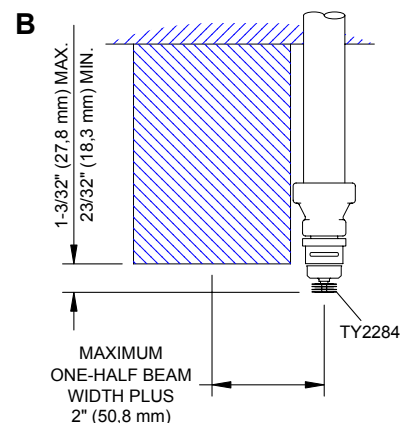
Keeping with the tradition of innovation, Tyco Fire Products approached UL with a program to confirm the location of a residential sprinkler at the bottom of a ceiling beam. This testing was being conducted by Tyco in support of the Rural Metro Scottsdale Arizona Fire Department. Locating the sprinklers below the beams allows the distribution to be unaffected by the beams (being located beneath them, see Figures 9 and 10). The alternate solution of placing sprinklers in every pocket is costly and burdensome. Again, working with AHJs, contractors and industry association members to identify the most common beam sizes and depths, TFP established application Listings for its Pendent, Recessed Pendent, and Flush sprinklers in beamed (beams to 14 inches deep) ceiling applications. See Figures 11 through 14 for beam spacing guidelines.



*Figure 9 - Pendent/Recessed Pendent sprinkler beam location*



*Figure 10 - Flush sprinkler beam location*





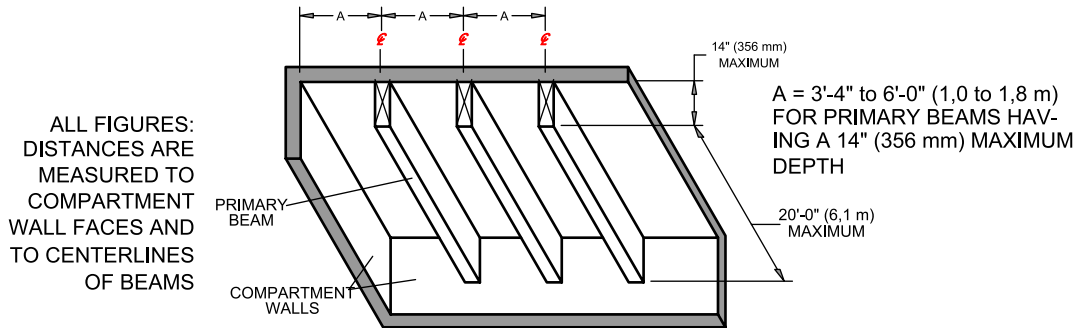


Figure 11 - Primary Beam Spans Up To 20 ft.

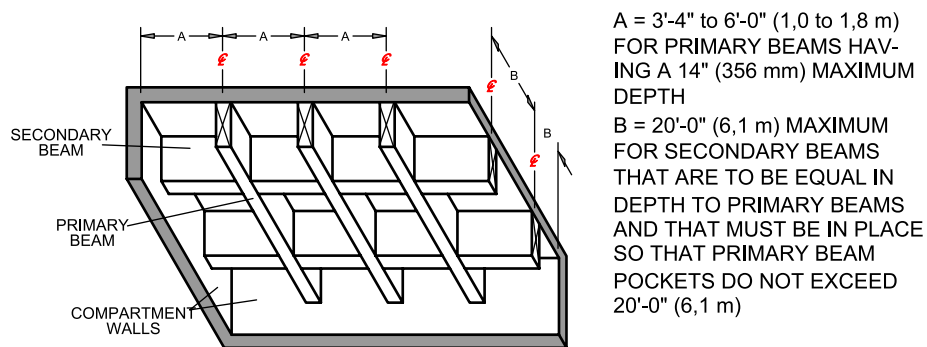


Figure 12 - Primary Beam Spans Greater Than 20 ft.

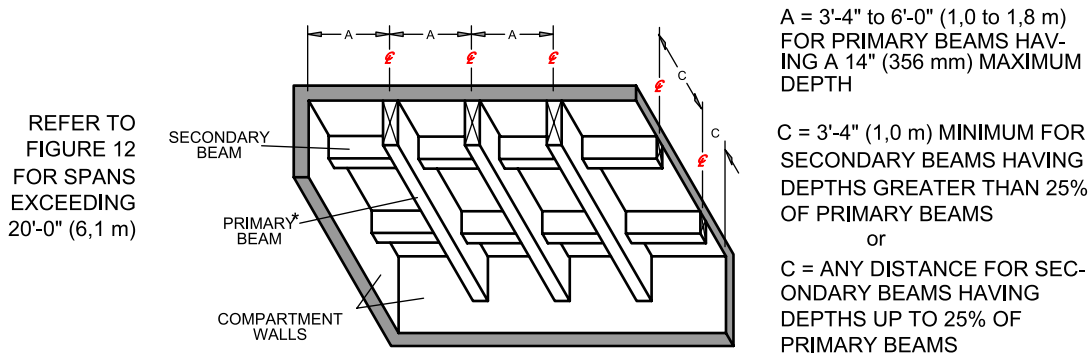


Figure 13 - Combinations of Primary and Secondary Beams

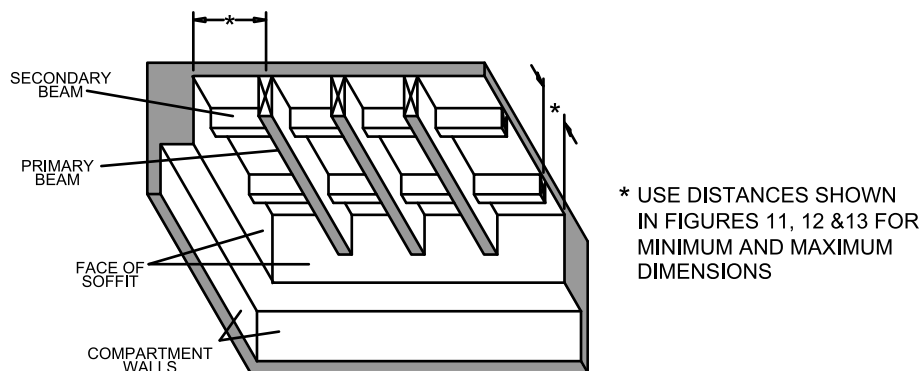


Figure 14 - Soffits and Combinations of Primary and Secondary Beams

**Pendent,  
Recessed Pendent  
Under Beamed Ceilings**



Room Size ft. X ft.	Rating (F)	4.9 TY2234	
		Flow (gpm)	Pressure (psi)
12 X 12	155	13	7.0
12 X 12	175	13	7.0
14 X 14	155	13	7.0
14 X 14	175	13	7.0
16 X 16	155	13	7.0
16 X 16	175	13	7.0
18 X 18	155	17	12.0
18 X 18	175	17	12.0
20 X 20	155	20	16.7
20 X 20	175	20	16.7

*Figure 15 - Flows and Pressures for Pendent and Recessed Pendent*

**Flush Pendent  
Under Beamed Ceilings**



Room Size ft. X ft.	Rating (F)	4.2 TY2284	
		Flow (gpm)	Pressure (psi)
12 X 12	165	13	9.6
14 X 14	165	13	9.6
16 X 16	165	14	11.1
18 X 18	165	18	18.4
20 X 20	165	22	27.4

*Figure 16 - Flows and Pressures for Flush Pendent*

**CONCLUSION:**

Residential sprinkler protection criteria have changed. Tyco Fire Products (Central, Gem and Star) has developed a new, simple line of residential sprinklers in response to the changes in product and installation standards to the needs of our customers. Tyco Fire Products (Central, Gem and Star) looked at the new criteria not as an obstacle, but as an opportunity. Tyco's line represents state of the art achievements across the entire line. No other manufacturer can boast the breadth of line and performance that Tyco has achieved. Technical data sheets are available on the Internet by starting with [www.tyco-fireproducts.com](http://www.tyco-fireproducts.com), Central Gem and Star websites can also be accessed from the Tyco site. With the new line of residential sprinklers, more applications for life safety protection will be available to our industry.

## ABOUT THE AUTHOR

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### **JAMES E. GOLINVEAUX**

Senior Vice President, Research & Development

Mr. Golinveaux's areas of interest include the research, design and applications of automatic fire sprinklers as well as their history. His interest in the fire sprinkler industry was sparked by his father's 27 years in the fire service.

Beginning as a designer in the early 1980's and later as a design manager for a fire protection firm in California, he applied local and national standards to develop working drawings for automatic fire sprinkler systems. Mr. Golinveaux became active and continues his involvement today through his membership on numerous committees such as the National Fire Protection Association (Member of NFPA 13 Discharge & Installation), International Conference of Building Officials, Society of Fire Protection Engineers and Southern Building Code Congress International. By 1991, Mr. Golinveaux's strong application knowledge of the automatic fire sprinkler industry afforded him the opportunity to work on the East Coast as the Director of Technical Services for Central Sprinkler Company. Mr. Golinveaux was responsible for the technical responses to worldwide production of automatic fire sprinkler system components. He continued his involvement in the industry and represented Central on many national committees including the National Fire Protection Research Foundation, Research and Advisory Council on Fire Suppression Futures and Underwriters Laboratories Industry Advisory Committee for automatic sprinklers. Mr. Golinveaux's many talents and wealth of knowledge were recognized by Central where he was Senior Vice President of Engineering and was directly responsible for the Production Plant with over 600 employees, the Engineering/R & D, Quality Control and Technical Services operations. Currently, Mr. Golinveaux is Senior Vice President of Research and Development for Tyco Fire & Building Products, which represents Central, Gem and Star branded products.

In addition to the support of the industry through his numerous committee memberships, Mr. Golinveaux also contributes his time as a speaker for national education seminars sponsored by organizations such as the Society of Fire Protection Engineers, Universities, Highly Protected Risk (HPR) Insurance Companies, National Apprenticeship and Training, and Trade Associations as well as state and local fire authorities. He has educated many on the latest sprinkler technology and its associated codes and standards.

Mr. Golinveaux has authored "*A Technical Analysis: The Use and Maintenance of Dry Type Sprinklers*", "*A Technical Analysis: Variables That Affect the Performance of Dry Pipe Systems*" and has co-authored the published article "*Fire Test Performance of Extra Large Orifice Sprinklers in Rack Storage of Group A Plastics in Warehouse-Type Retail Occupancies.*" He is also named on numerous U.S. Patents relating to automatic sprinklers.

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