Residential Sprinklers
Used In NFPA 13, 2002 Applications

A Technical Analysis:

Listings and Applications of Residential Sprinklers and the 0.1 GPM/FT^2 Minimum Density Requirement

James Golinveaux, Sr. Vice President,
Research & Development
Tyco Fire Products

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TABLES

MIN. RESIDENTIAL LISTED FLOW:

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Background

Recent changes to the National Fire Protection Association (NFPA) Standard 13 – Installation of Sprinkler Systems and revisions to Underwriters Laboratory Inc. (UL) Standard 1626 – Standard for Residential Sprinklers for Fire-Protection Service have prompted the largest revision to residential sprinklers since the early 1980's. A previous technical analysis titled "Residential Sprinklers – A Technical Analysis of Listings and Applications" explained the recent changes in residential Listings that were required to comply with new 0.05 minimum density (gpm/ft^2) specified by NFPA 13D and 13R. The 0.05 minimum densities had an immediate effect on manufacturer's listings since UL Standard 1626 was modified to require the new minimum density before the 2002 NFPA Standards had been adopted by most building codes. Now that the 2002 editions are fast becoming adopted and enforceable standards, confusion has arisen regarding the 0.1 minimum density (gpm/ft^2) requirement for residential sprinklers used in NFPA 13 occupancies. **This document provides an overview of the criteria and the options for residential sprinkler selection to optimize both performance and economics of installation.**

History

NFPA 13 recognized the use of residential sprinklers in residential portions of NFPA 13 occupancies in 1983. An increased dependence on the performance of residential sprinklers was expected, including the protection of property in addition to their life safety feature. With the debate that sparked the new minimum 0.05 minimum density in NFPA 13D and 13R, serious discussions took place in the fire protection technical community regarding the intent of residential sprinklers and the application of these life safety devices in a life/property protection standard – NFPA 13. Prior to residential sprinklers, NFPA 13 required either pipe schedule systems or hydraulically calculated systems for Light Hazard Occupancies to be designed to provide from a 0.07 gpm/sq ft over a minimum 3000 sq ft, to a 0.1 gpm/sq ft over a minimum 1500 sq ft. It was also understood that sprinklers protecting any area smaller than 1500 sq ft would also discharge a minimum 0.1 gpm/sq ft. Residential sprinklers were allowed in NFPA 13 occupancies in 1983 to protect residential portions of these occupancies with only a 4 sprinkler design. Manufacturer's were successful in obtaining densities as low as 0.03 gpm/sq ft for residential sprinkler listings. This was not acceptable to the technical committee for the protection of NFPA 13 occupancies especially since NFPA 13 requirements for residential occupancies generally involve buildings over 4 stories in height (13R applies to 4 stories or less) or hospital/nursing homes.

What the industry has done

There is no question as to the 20 year performance of residential sprinklers – the record is tremendously successful. With all of the other considerations allowed in the codes for the installation of an automatic sprinkler system came the question, 'is the residential minimum density adequate for larger occupancies?' Accordingly, two significant changes were made in the NFPA standards: first – 13D and 13R were changed to require a minimum density of 0.05 gpm/sq ft (this means no lower than 0.05, higher densities are allowed); and second – NFPA 13 adopted section 11.2.3.5.2 which states:

> ***"11.2.3.5.2 – Unless the requirements of 11.2.3.5.3 are met, the minimum required discharge from each of the four hydraulically most demanding sprinklers shall be the greater of the following:***
>
> ***(1) In accordance with minimum flow rates indicated in individual listings***
>
> ***(2) Calculated based on delivering a minimum of 0.1 gpm/ft² (4.1 mm/min) over the design area in accordance with the provisions of 8.5.2.1"***

This section has caused some confusion within the industry, and a breakdown of the requirements is in order. There are two density rules here. The key to understanding the difference is in the first sentence that states ***"the minimum required discharge from each of the four hydraulically most demanding sprinklers shall be the greater (emphasis added) of the following***." So what makes one greater than the other? A more detailed understanding of the hydraulic calculation rules for residential sprinklers is necessary.

Item (1) ***"In accordance with minimum flow rates indicated in individual listings"***, requires that the minimum flow cannot be less than the "Listing" for the individual sprinkler. It is very important to understand that residential sprinklers are listed in intervals of maximum spacing. For example a residential pendent sprinkler listed for a 20 x 20 ft spacing at a discharge of 20 gpm (0.05 minimum density x 400 sq ft) requires the same minimum discharge if the actual spacing is 20 x 12 ft. The principle is that there is a minimum pressure required to throw water in the maximum direction – therefore, the maximum dimension (20 ft) dictates the minimum flow regardless of the smaller dimension. Extended coverage Light and Ordinary Hazard upright and pendent sprinklers are designed to the same concept – the larger dimension is squared to obtain the minimum discharge. Sidewall residential sprinklers are listed in 2 ft increments – but again, the maximum dimension dictates the minimum flow. See the manufactures listing information for minimum flows to obtain the value of this item (1). Fire testing and certification testing are performed to validate these minimum flows.

Item (2) – ***"Calculated based on delivering a minimum of 0.1 gpm/ft² (4.1 mm/min) over the design area in accordance with the provisions of 8.5.2.1"*** *is a new twist to the application of residential sprinklers. We first have to see the reference to section 8.5.2.1 to understand this new rule:*

> ***"8.5.2.1 Determination of the Protection Area of Coverage.***
>
> ***8.5.2.1.1 The protection area of coverage per sprinkler (As) shall be determined as follows:***

(1) Along branch lines as follows:

(a) Determine distance between sprinklers (or to wall or obstruction in the case of the end sprinkler on the branch line) upstream and downstream.

(b) Choose the larger of either twice the distance to the wall or the distance to the next sprinkler.

(c) This dimension will be defined as S.

(2) Between branch lines as follows:

(a) Determine perpendicular distance to the sprinkler on the adjacent branch line (or to a wall or obstruction in the case of the last branch line) on each side of the branch line on which the subject sprinkler is positioned.

(b) Choose the larger of either twice the distance to the wall or obstruction, or the distance to the next sprinkler.

(c) This dimension will be defined as L.

8.5.2.1.2 The protection area of coverage of the sprinkler (A_S) shall be established by multiplying the S dimension by the L dimension, as follows: A_S = S x L"

See Figure 1 for an example of S x L spacing.

People experienced in the application of NFPA 13 refer to this rule as the S x L rule. This rule differs from extended coverage rules or the previous application of residential sprinklers – no longer does the maximum dimension govern the minimum discharge. Keep in mind, however, that we are looking for the "greater" of (1) or (2). With this in mind, our previous example of a pendent residential sprinkler listed at a minimum 20 gpm for 20 x 20 ft coverage does not default to 40 gpm (400 sq ft x 0.1 gpm/sq ft density) if one dimension of the spacing is 20 ft, as the S x L rule for the application will now take precedence. The example referenced of 20 x 12 ft (20 x 12 = 240 sq ft x 0.1 gpm/sq ft = 24 gpm) coverage would require 24 gpm minimum. Comparing (1) 20 gpm – the Listing, and (2) 24 gpm – the S x L rule, the minimum discharge to be calculated for the 4 sprinkler minimum would be 24 gpm, the greater number of (1) and (2).

It seems against the logic that the sprinkler now knows the difference between a 20 x 20 ft room and a 20 x 12 ft room; however, keep in mind that there is a safety net at the minimum performance. Item (1) will not let the minimum discharge fall below its listed minimum for the maximum room/spacing dimension. The following examples further clarify the application.

1.) An example of this would be a residential sprinkler in an NFPA 13 application, spaced at 14 x 17 ft (Table 1 – 238 sq ft). The 0.1 calculation would be based on 238 sq ft x 0.1 gpm = 23.8 gpm (Table 2); the "Listed" minimum flow for 18 x 18 (17 ft rounded up to the next 2 ft interval = 18 ft) may be 17gpm (depending on model and Listing). The greater flow is 23.8 gpm, and, per the new rules, 23.8 gpm is the minimum flow allowed for the 4 head calculation.

2.) An example in the other direction is a spacing of 8 x 20 (Table 1 – 160 sq ft.). The 0.1 calculation would be based on 160 sq ft x 0.1 gpm = 16 gpm (Table 2); the "Listed" residential flow may be 20 gpm (the flow for 20 x 20 spacing). The greater flow is 20-gpm (the residential flow), so 20 gpm is the minimum flow for the 4 head calculation.

The lesson of the minimum flow is – **the greater of** – the S x L rule **or** the minimum Listed residential flow.

The S x L rule for square footage can be summarized by the Table 1. The result is the square foot coverage of the sprinkler. Using the chart spacing – top row = S and the vertical column = L. S x L = the square footage. The actual spacing dimensions do not have to be rounded in the S x L calculation, 18'-4½" x 10'-0" would be 184 sq ft. See Figure 1 for further clarification of S x L.

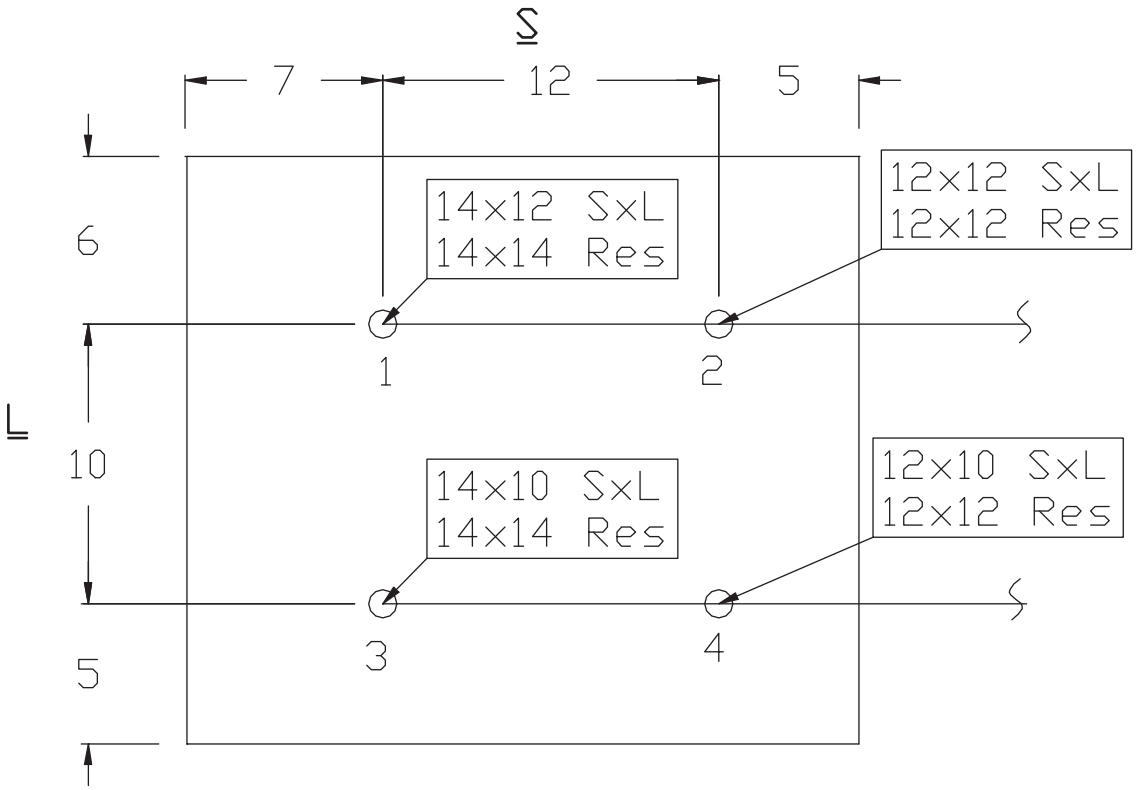

Figure 1 – Spacing Rules Example for S x L and Residential

Spacing (sq ft - SxL rule)													
Spacing (ft)	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
8	64	72	80	88	96	104	112	120	128	136	144	152	160
9	72	81	90	99	108	117	126	135	144	153	162	171	180
10	80	90	100	110	120	130	140	150	160	170	180	190	200
11	88	99	110	121	132	143	154	165	176	187	198	209	220
12	96	108	120	132	144	156	168	180	192	204	216	228	240
13	104	117	130	143	156	169	182	195	208	221	234	247	260
14	112	126	140	154	168	182	196	210	224	238	252	266	280
15	120	135	150	165	180	195	210	225	240	255	270	285	300
16	128	144	160	176	192	208	224	240	256	272	288	304	320
17	136	153	170	187	204	221	238	255	272	289	306	323	340
18	144	162	180	198	216	234	252	270	288	306	324	342	360
19	152	171	190	209	228	247	266	285	304	323	342	361	380
20	160	180	200	220	240	260	280	300	320	340	360	380	400

Table 1 – S x L Spacing = Square Footage

The formula to establish the minimum flow for the S x L rule can be summarized as follows:

S x L x 0.1 density = Minimum GPM

Table 2 gives minimum flow examples of even one foot intervals in spacing, however, actual spacing should be used for minimum flow calculations.

Minimum NFPA 13 Flow for Residential Sprinklers (gpm) based on S x L x 0.1 gpm/sq ft													
Spacing (ft)	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
8	6.4	7.2	8.0	8.8	9.6	10.4	11.2	12.0	12.8	13.6	14.4	15.2	16.0
9	7.2	8.1	9.0	9.9	10.8	11.7	12.6	13.5	14.4	15.3	16.2	17.1	18.0
10	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
11	8.8	9.9	11.0	12.1	13.2	14.3	15.4	16.5	17.6	18.7	19.8	20.9	22.0
12	9.6	10.8	12.0	13.2	14.4	15.6	16.8	18.0	19.2	20.4	21.6	22.8	24.0
13	10.4	11.7	13.0	14.3	15.6	16.9	18.2	19.5	20.8	22.1	23.4	24.7	26.0
14	11.2	12.6	14.0	15.4	16.8	18.2	19.6	21.0	22.4	23.8	25.2	26.6	28.0
15	12.0	13.5	15.0	16.5	18.0	19.5	21.0	22.5	24.0	25.5	27.0	28.5	30.0
16	12.8	14.4	16.0	17.6	19.2	20.8	22.4	24.0	25.6	27.2	28.8	30.4	32.0
17	13.6	15.3	17.0	18.7	20.4	22.1	23.8	25.5	27.2	28.9	30.6	32.3	34.0
18	14.4	16.2	18.0	19.8	21.6	23.4	25.2	27.0	28.8	30.6	32.4	34.2	36.0
19	15.2	17.1	19.0	20.9	22.8	24.7	26.6	28.5	30.4	32.3	34.2	36.1	38.0
20	16.0	18.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0	36.0	38.0	40.0

Table 2 – Minimum Flow 0.1 Density Based on S x L Spacing (GPM)

Caution: Table 2 shows minimum flow for even 1 ft intervals, always use actual spacing for S x L.

With the minimum flow established for the S x L rule, the Listed residential minimum flow needs to checked against the minimum S x L flow. No calculation is necessary for establishing this number. Simply obtain the Tyco Fire and Building Products (TFBP) data sheets for the intended residential sprinkler to be used and retrieve the minimum flow for the maximum spacing being used. See Figure 1 for a residential spacing example. Tables 3 and 4 summarize the listed minimum flows for the TFBP LFII residential pendent series for respective room/spacing. As stated previously, residential sprinklers are listed in 2 ft intervals; for consistency with Table 2, flows are shown for 1 ft intervals but are based on the 2 ft listings. Tyco's LFII pendent series sprinklers are listed for spacing of 12, 14, 16, 18 and 20 ft. Odd spacing, such as 17 ft, will be rounded to the 18 ft minimum flow (the flow shown in the 17 ft column is the 18 ft number).

TFBP 4.9 Minimum Flow (gpm) for Residential Spacing (ft)													
Spacing (ft)	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
8	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	17.0	17.0	20.0	20.0
9	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	17.0	17.0	20.0	20.0
10	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	17.0	17.0	20.0	20.0
11	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	17.0	17.0	20.0	20.0
12	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	17.0	17.0	20.0	20.0
13	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	17.0	17.0	20.0	20.0
14	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	17.0	17.0	20.0	20.0
15	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	17.0	17.0	20.0	20.0
16	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	17.0	17.0	20.0	20.0
17	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	20.0	20.0
18	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	20.0	20.0
19	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
20	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0

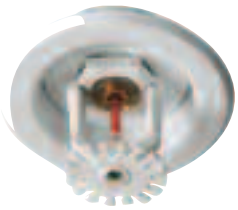

Table 3 – Minimum Residential Listed Flow for TFBP LFII (TY2234) K4.9 Pendent/Recessed Pendent Sprinkler (GPM)

TFBP 6.9 Minimum Flow (gpm) for Residential Spacing (ft)													
Spacing (ft)	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
8	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	22.0	22.0
9	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	22.0	22.0
10	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	22.0	22.0
11	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	22.0	22.0
12	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	22.0	22.0
13	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	22.0	22.0
14	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	22.0	22.0
15	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	22.0	22.0
16	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	22.0	22.0
17	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	22.0	22.0
18	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	22.0	22.0
19	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
20	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0

Table 4 – Minimum Residential Listed Flow for TFBP LFII (TY4234) K6.9 Pendent/Recessed Pendent Sprinkler (GPM)

Knowing that the S x L rule is simple math and the residential sprinkler listings are published numbers, **tables 5 and 6 conclude the required minimum flow (based on the greater of the two minimums)** for the TFBP LFII Series Pendent K4.9 and K6.9 respectively for various spacings. Appendix A contains tables for the remainder of the Tyco Fire Products' line of residential sprinklers. Be sure to use the actual (non-rounded) dimensions for the S x L rule and check the minimum flow on the data sheet for the Residential minimum flow. Tables 5 and 6 assume even 1 ft spacing which does not occur often in most sprinkler spacing.

TFBP 4.9 Minimum Flow (gpm) for NFPA 13 (0.1 density at even 1 ft intervals) - Residential/SxL Sprinkler Spacing (ft)													
Spacing (ft)	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
8	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	17.0	17.0	20.0	20.0
9	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.5	14.4	17.0	17.0	20.0	20.0
10	13.0	13.0	13.0	13.0	13.0	13.0	14.0	15.0	16.0	17.0	18.0	20.0	20.0
11	13.0	13.0	13.0	13.0	13.2	14.3	15.4	16.5	17.6	18.7	19.8	20.9	22.0
12	13.0	13.0	13.0	13.2	14.4	15.6	16.8	18.0	19.2	20.4	21.6	22.8	24.0
13	13.0	13.0	13.0	14.3	15.6	16.9	18.2	19.5	20.8	22.1	23.4	24.7	26.0
14	13.0	13.0	14.0	15.4	16.8	18.2	19.6	21.0	22.4	23.8	25.2	26.6	28.0
15	13.0	13.5	15.0	16.5	18.0	19.5	21.0	22.5	24.0	25.5	27.0	28.5	30.0
16	13.0	14.4	16.0	17.6	19.2	20.8	22.4	24.0	25.6	27.2	28.8	30.4	32.0
17	17.0	17.0	17.0	18.7	20.4	22.1	23.8	25.5	27.2	28.9	30.6	32.3	34.0
18	17.0	17.0	18.0	19.8	21.6	23.4	25.2	27.0	28.8	30.6	32.4	34.2	36.0
19	20.0	20.0	20.0	20.9	22.8	24.7	26.6	28.5	30.4	32.3	34.2	36.1	38.0
20	20.0	20.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0	36.0	38.0	40.0

Table 5 – The Greater of Listing vs. S x L Minimum Flow in GPM for TFBP LFII (TY2234) K4.9 Pendent/Recessed Pendent

Caution: Table 5 shows minimum flow for even 1 ft intervals. Always use actual spacing for S x L and the technical data sheet for minimum Listed flow calculations.

TFBP 6.9 Minimum Flow (gpm) for NFPA 13 (0.1 density at even 1 ft intervals) Residential/SxL Sprinkler Spacing (ft)													
Spacing (ft)	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
8	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	22.0	22.0
9	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	22.0	22.0
10	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	22.0	22.0
11	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.8	22.0	22.0
12	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.2	20.4	21.6	22.8	24.0
13	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.5	20.8	22.1	23.4	24.7	26.0
14	19.0	19.0	19.0	19.0	19.0	19.0	19.6	21.0	22.4	23.8	25.2	26.6	28.0
15	19.0	19.0	19.0	19.0	19.0	19.5	21.0	22.5	24.0	25.5	27.0	28.5	30.0
16	19.0	19.0	19.0	19.0	19.2	20.8	22.4	24.0	25.6	27.2	28.8	30.4	32.0
17	19.0	19.0	19.0	19.0	20.4	22.1	23.8	25.5	27.2	28.9	30.6	32.3	34.0
18	19.0	19.0	19.0	19.8	21.6	23.4	25.2	27.0	28.8	30.6	32.4	34.2	36.0
19	22.0	22.0	22.0	22.0	22.8	24.7	26.6	28.5	30.4	32.3	34.2	36.1	38.0
20	22.0	22.0	22.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0	36.0	38.0	40.0

Table 6 – The Greater of Listing vs. S x L Minimum Flow in GPM for TFBP LFII (TY4234) K6.9 Pendent/Recessed Pendent

Caution: Table 6 shows minimum flow for even 1 ft intervals. Always use actual spacing for S x L and the technical data sheet for minimum Listed flow calculations.

Establishing the minimum required flow is important. However, this is only the beginning of the process of selecting the most optimum sprinkler for the application. Operating pressure will play an important role in NFPA 13 applications of residential sprinklers. Minimum operating pressure is the next concern for the selection of the appropriate orifice size. Tables 7 and 8 show the minimum operating pressure for the TFBP LFII K4.9 and K6.9 residential sprinklers at the flows shown in Tables 5 and 6 (minimum for NFPA 13 applications). Again, Tables 7 and 8 assume an even 1 ft spacing for the SxL rule calculation. The actual spacing should be used for the SxL rule to establish the pressure and the data sheet for the residential minimum pressure.

Tables 5 through 8 are useful tools to establish the minimum flow and pressure when using the TFBP LFII series pendent and recessed pendent sprinklers. Appendix A demonstrates the minimum flows and pressures for the remainder of the LFII family.

TFBP 4.9 Minimum Pressure (psi) for NFPA 13 (0.1 density at even 1 ft intervals) Residential/SxL Sprinkler Spacing (ft)													
Spacing (ft)	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
8	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	12.0	12.0	16.7	16.7
9	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.6	8.6	12.0	12.0	16.7	16.7
10	7.0	7.0	7.0	7.0	7.0	7.0	8.2	9.4	10.7	12.0	13.5	16.7	16.7
11	7.0	7.0	7.0	7.0	7.3	8.5	9.9	11.3	12.9	14.6	16.3	18.2	20.2
12	7.0	7.0	7.0	7.3	8.6	10.1	11.8	13.5	15.4	17.3	19.4	21.7	24.0
13	7.0	7.0	7.0	8.5	10.1	11.9	13.8	15.8	18.0	20.3	22.8	25.4	28.2
14	7.0	7.0	8.2	9.9	11.8	13.8	16.0	18.4	20.9	23.6	26.4	29.5	32.7
15	7.0	7.6	9.4	11.3	13.5	15.8	18.4	21.1	24.0	27.1	30.4	33.8	37.5
16	7.0	8.6	10.7	12.9	15.4	18.0	20.9	24.0	27.3	30.8	34.5	38.5	42.6
17	12.0	12.0	12.0	14.6	17.3	20.3	23.6	27.1	30.8	34.8	39.0	43.5	48.1
18	12.0	12.0	13.5	16.3	19.4	22.8	26.4	30.4	34.5	39.0	43.7	48.7	54.0
19	16.7	16.7	16.7	18.2	21.7	25.4	29.5	33.8	38.5	43.5	48.7	54.3	60.1
20	16.7	16.7	16.7	20.2	24.0	28.2	32.7	37.5	42.6	48.1	54.0	60.1	66.6

Table 7 – Minimum Pressure in PSI for TFBP LFII (TY2234) K4.9 Pendent/Recessed Pendent based on Table 5

Caution: Table 7 shows minimum pressure for even 1 ft intervals. Always use actual spacing for S x L and the technical data sheet for minimum Listed pressure calculations.

TFBP 6.9 Minimum Pressure (psi) for NFPA 13 (0.1 density at even 1 ft intervals) Residential/SxL Sprinkler Spacing (ft)													
Spacing (ft)	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
8	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	10.2	10.2
9	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	10.2	10.2
10	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	10.2	10.2
11	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	8.2	10.2	10.2
12	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.7	8.7	9.8	10.9	12.1
13	7.6	7.6	7.6	7.6	7.6	7.6	7.6	8.0	9.1	10.3	11.5	12.8	14.2
14	7.6	7.6	7.6	7.6	7.6	7.6	8.1	9.3	10.5	11.9	13.3	14.9	16.5
15	7.6	7.6	7.6	7.6	7.6	8.0	9.3	10.6	12.1	13.7	15.3	17.1	18.9
16	7.6	7.6	7.6	7.6	7.7	9.1	10.5	12.1	13.8	15.5	17.4	19.4	21.5
17	7.6	7.6	7.6	7.6	8.7	10.3	11.9	13.7	15.5	17.5	19.7	21.9	24.3
18	7.6	7.6	7.6	8.2	9.8	11.5	13.3	15.3	17.4	19.7	22.0	24.6	27.2
19	10.2	10.2	10.2	10.2	10.9	12.8	14.9	17.1	19.4	21.9	24.6	27.4	30.3
20	10.2	10.2	10.2	10.2	12.1	14.2	16.5	18.9	21.5	24.3	27.2	30.3	33.6

Table 8 – Minimum Pressure in PSI for TFBP LFII (TY4234) K6.9 Pendent/Recessed Pendent based on Table 6

Caution: Table 8 shows minimum pressure for even 1 ft intervals. Always use actual spacing for S x L and the technical data sheet for minimum Listed pressure calculations.

Optimum Performance – Mixing Orifice Sizes

The traditional approach of the lowest flow and lowest pressure is not the appropriate sprinkler selection tool for residential sprinklers used in NFPA 13 occupancies. The introduction of the TFBP LFII K6.9 pendent/recessed pendent/domed concealed and the K5.6 sidewall/recessed sidewall was done to accommodate the 0.1 gpm/sq ft requirement of NFPA 13 2002 edition. However, the use of these sprinklers exclusively may not be the best choice for the entire occupancy. Simply stated, optimum design performance can be achieved by selecting the appropriate orifice size for the actual spacing of the sprinklers. The introduction of the larger orifice residential sprinklers compliment's the smaller (originally introduced K4.2 and K4.9) orifice sizes of the LFII family.

The K6.9 and K5.6 should be used where individual sprinkler spacing benefits from the larger orifice size. The lower start pressures of these larger orifice sizes can prevent excessive over discharge from adjacent residential sprinklers. Unlike standard spray sprinklers, residential sprinklers can have different orifice sizes within the same room as long as the spacing (area of protection of the individual sprinkler) per sprinkler is different – this is **not** considered hydraulic balancing that is prohibited by NFPA 13.

Mixing orifice sizes of residential sprinklers in NFPA 13 occupancies is allowed as long as the following condition exists:

1. The spacing (area of protection of the individual sprinkler) is different. For example – a sprinkler in a living room protects a 18 ft x 18 ft (324 sq ft) space and uses a K6.9 residential sprinkler; the sprinkler adjacent to the living room in the entrance that protects an 8 ft x 10 ft (80 sq ft) area can utilize a K4.9 residential sprinkler to prevent over discharge for the protected area. No physical separation is required other than observing minimum spacing rules. This is not considered hydraulic balancing since the area of protection is different – See NFPA 13 1999 edition section 8-4.4.6 Exception No. 2:

"Exception No. 2 – Extended-coverage sprinklers with a different orifice size shall be acceptable for part of the protection area where installed in accordance with their listing."

Also see NFPA 13 2002 edition section 14.4.4.6.3:

"14.4.4.6.3 Extended-coverage sprinklers with a different orifice size shall be acceptable for part of the protection area where installed in accordance with their listing."

All of Tyco's residential sprinklers are extended coverage in their listing application. NFPA 13D references a maximum 144 sq ft protection area for residential sprinklers, while all of Tyco's residential sprinklers have been tested and Listed for areas greater than 144 sq ft (extended coverage).

The following are examples of actual residential sprinkler layouts within an NFPA 13 2002 Edition occupancy. Notice that based on spacing, the optimized layout for both spacing and hydraulic characteristics is a combination of orifice sizes. Generally, any spacing (by the S x L rule) that is 170 sq ft or greater should use the K6.9 LFII Pendent/Recessed Pendent. Sprinkler spacing less than 170 sq ft should use the K4.9 LFII, or similar family member, to prevent over discharge for the intended area of protection.

Examples of optimum performance by selecting the appropriate orifice sizes are shown in Figures 2 through 4.

Figure 2 is a typical residential layout for NFPA 13 applications. There are two 4 head remote areas that need to be checked in this unit – the first is labeled with letters (A, B, C & D), and the second is labeled with numbers (1, 2, 3 & 4). Each sprinkler in the unit is shown with a larger circle containing the sq ft coverage (S x L) over the residential spacing (rounded up to 2 ft spacing). Figures 3 and 4 represent the lettered remote area and the numbered remote area respectively. Hydraulic calculations were performed as stated below.

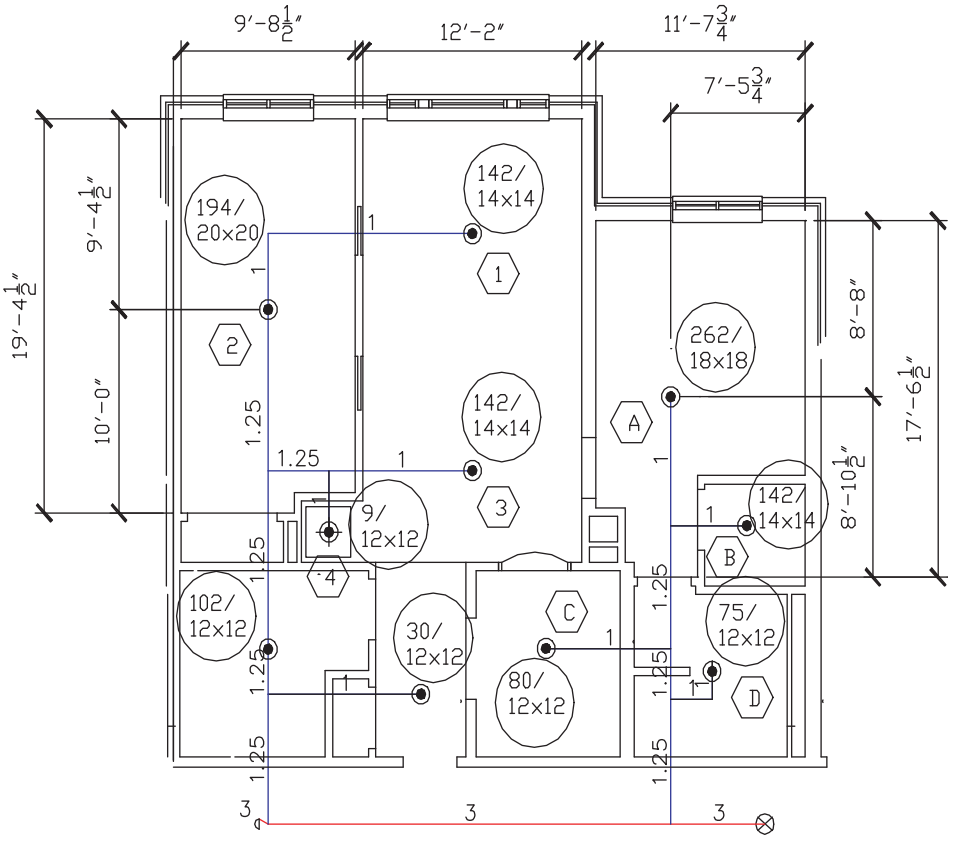

Figure 2 – Typical NFPA 13 Application of Residential Sprinklers

Looking first at the most demanding 4 heads in the lettered area shows the vast spread in coverage areas based on the spacing rules. Sprinkler A covers 262 sq ft based on SxL, while sprinkler D covers only 75 sq ft. At this point, the designer needs to evaluate the 0.1 density times the SxL rule, or the residential listed minimum flow for the coverage area, to determine the required minimum flow from each sprinkler. Sprinkler A requires the highest flow at 26.2 gpm (the residential minimum is 17 gpm). If the same orifice size is used, Sprinklers B, C, and D will all flow a minimum of 26.2 based on their location from A. Mixing orifice sizes based on spacing will provide the best hydraulic design, for example:

1.) Assume all of the sprinklers are K4.9, the total system demand is **105.1 gpm at 43.3 psi.**

2.) Assume all of the sprinklers are K6.9, the total system demand is **105.4 gpm at 27.2 psi.**

3.) With Sprinkler A being a K6.9 and the remainder (under 170 sq ft) being K4.9 the demand is **83.8 gpm at 23.4 psi.**

4.) Using a competitor's K5.8 pendent, with Sprinkler A being a K5.8 and the remainder (under 170 sq ft) being K4.9, the demand is **93.6 gpm at 31.1 psi** – obviously, this would not be the best choice.

Mixing orifice sizes based on actual spacing does provide the best hydraulic system.

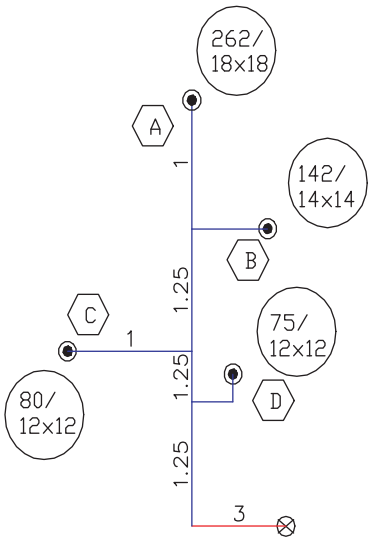

Figure 3 – Remote 4 Sprinklers (Lettered Nodes)

Looking at the most demanding 4 heads in the numbered area shows the vast spread in coverage areas based on the spacing rules. Sprinkler 2 covers 194 sq ft based on SxL, while sprinkler 4 covers only 9 sq ft. At this point, the designer will need to evaluate the 0.1 density times the SxL rule, or the residential listed minimum flow for the coverage area to determine the required minimum flow for each sprinkler. Sprinkler 2 requires the highest flow at 22.0 gpm (residential, the SxL flow is 19.4 gpm). If the same orifice size is used, Sprinklers 1, 3 and 4 will all flow nearly the minimum of 22.0 gpm based on their location from 2. Mixing orifice sizes based on spacing will provide the best hydraulic design:

5.) Assume all of the sprinklers are K4.9, the total system demand is **77.4 gpm at 27.6 psi.**

6.) Assume all of the sprinklers are K6.9, the total system demand is **82.7 gpm at 22.5 psi.**

7.) With Sprinkler 2 being a K6.9, and the remainder (under 170 sq ft) being K4.9, the demand is **67.1 gpm at 18.7 psi.**

8.) Using a competitor's K5.8 pendent, with Sprinkler A being a K5.8 and the remainder (under 170 sq ft) being K4.9 the demand is **75.5 gpm at 24.9 psi** – again, not the best choice.

Mixing orifice sizes based on actual spacing does provide the best hydraulic system.

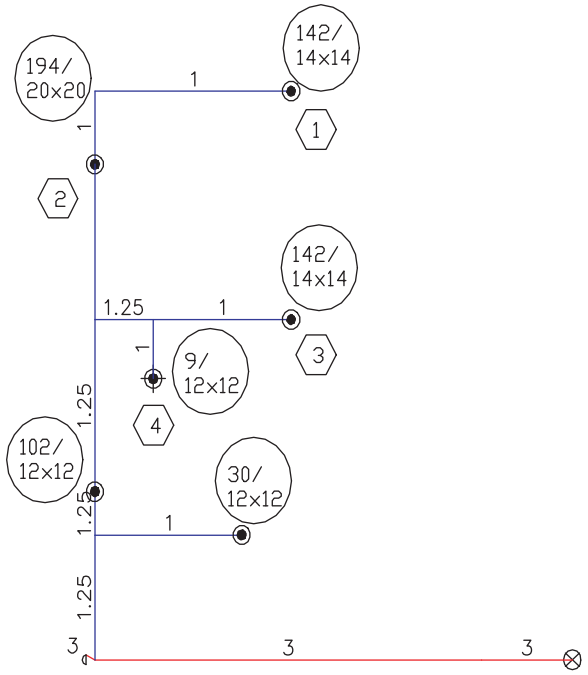

Figure 4 – Remote 4 Sprinklers (Numbered Nodes)

Conclusion:

Chart 1 graphs the required pressure for the K6.9 and K4.9 Residential sprinklers used in an NFPA 13 design. It is clear from the chart that spacing for the 0.1 minimum density requires excessive pressure from the K4.9 at or above 170 sq ft. Therefore, the optimum design for spacing above 170 sq ft is the use of the K6.9. Combining the K6.9 for 170 sq ft and greater, and the K4.9 for spacing less than 170 sq ft, will prevent over discharge for the small rooms/areas as seen in the calculations of the typical layout above.

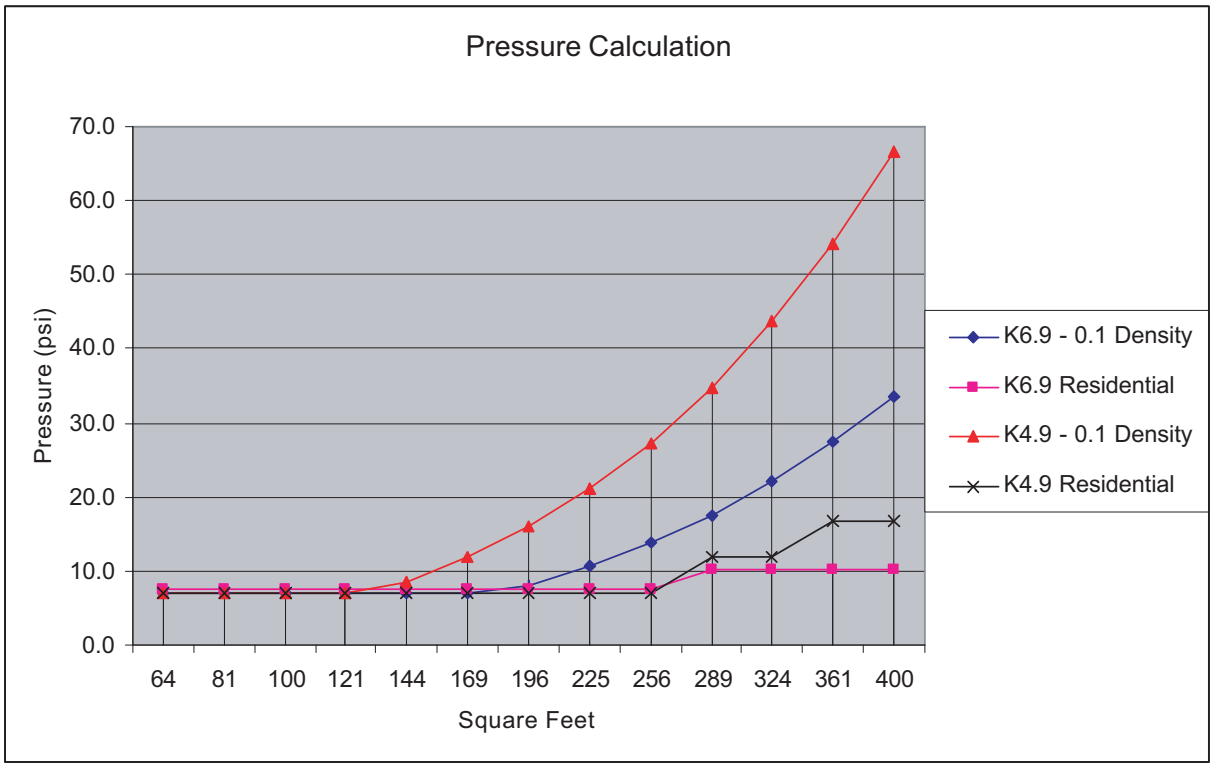

Chart 1 – Pressure Calculation for K4.9 and K6.9 Residential Sprinklers @ 0.1 Density and @ Listed Minimum Pressure

Selection of orifice size for different sprinkler spacing is important in providing a cost effective design to comply with NFPA 13 2002 Edition. With K factors ranging from 4.2 to 6.9, 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 accessing **www.tyco-fire.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.

Appendix A

Caution: Tables 9 to 20 provide minimum flow and pressure for even 1 ft intervals. Always use actual spacing for S x L and the technical data sheet for minimum Listed flow calculations.

TFBP LFII (TY2596) K4.2 Flat Plate Concealed

TFBP 4.2 Minimum Flow (gpm) for NFPA 13 (0.1 density at even 1 ft intervals) Residential/SxL Sprinkler Spacing (ft)													
Spacing (ft)	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
8	13.0	13.0	13.0	13.0	13.0	14.0	14.0	16.0	16.0	20.0	20.0	24.0	24.0
9	13.0	13.0	13.0	13.0	13.0	14.0	14.0	16.0	16.0	20.0	20.0	24.0	24.0
10	13.0	13.0	13.0	13.0	13.0	14.0	14.0	16.0	16.0	20.0	20.0	24.0	24.0
11	13.0	13.0	13.0	13.0	13.2	14.3	15.4	16.5	17.6	20.0	20.0	24.0	24.0
12	13.0	13.0	13.0	13.2	14.4	15.6	16.8	18.0	19.2	20.4	21.6	24.0	24.0
13	14.0	14.0	14.0	14.3	15.6	16.9	18.2	19.5	20.8	22.1	23.4	24.7	26.0
14	14.0	14.0	14.0	15.4	16.8	18.2	19.6	21.0	22.4	23.8	25.2	26.6	28.0
15	16.0	16.0	16.0	16.5	18.0	19.5	21.0	22.5	24.0	25.5	27.0	28.5	30.0
16	16.0	16.0	16.0	17.6	19.2	20.8	22.4	24.0	25.6	27.2	28.8	30.4	32.0
17	20.0	20.0	20.0	20.0	20.4	22.1	23.8	25.5	27.2	28.9	30.6	32.3	34.0
18	20.0	20.0	20.0	20.0	21.6	23.4	25.2	27.0	28.8	30.6	32.4	34.2	36.0
19	24.0	24.0	24.0	24.0	24.0	24.7	26.6	28.5	30.4	32.3	34.2	36.1	38.0
20	24.0	24.0	24.0	24.0	24.0	26.0	28.0	30.0	32.0	34.0	36.0	38.0	40.0

Table 9 – The Greater of Listing vs. S x L Minimum Flow in GPM for TFBP LFII (TY2596) K4.2 Flat Plate Concealed

TFBP 4.2 Minimum Pressure (psi) for NFPA 13 (0.1 density at even 1 ft intervals) Residential/SxL Sprinkler Spacing (ft)													
Spacing (ft)	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
8	9.6	9.6	9.6	9.6	9.6	11.1	11.1	14.5	14.5	22.7	22.7	32.7	32.7
9	9.6	9.6	9.6	9.6	9.6	11.1	11.1	14.5	14.5	22.7	22.7	32.7	32.7
10	9.6	9.6	9.6	9.6	9.6	11.1	11.1	14.5	14.5	22.7	22.7	32.7	32.7
11	9.6	9.6	9.6	9.6	9.9	11.6	13.4	15.4	17.6	22.7	22.7	32.7	32.7
12	9.6	9.6	9.6	9.9	11.8	13.8	16.0	18.4	20.9	23.6	26.4	32.7	32.7
13	11.1	11.1	11.1	11.6	13.8	16.2	18.8	21.6	24.5	27.7	31.0	34.6	38.3
14	11.1	11.1	11.1	13.4	16.0	18.8	21.8	25.0	28.4	32.1	36.0	40.1	44.4
15	14.5	14.5	14.5	15.4	18.4	21.6	25.0	28.7	32.7	36.9	41.3	46.0	51.0
16	14.5	14.5	14.5	17.6	20.9	24.5	28.4	32.7	37.2	41.9	47.0	52.4	58.0
17	22.7	22.7	22.7	22.7	23.6	27.7	32.1	36.9	41.9	47.3	53.1	59.1	65.5
18	22.7	22.7	22.7	22.7	26.4	31.0	36.0	41.3	47.0	53.1	59.5	66.3	73.5
19	32.7	32.7	32.7	32.7	32.7	34.6	40.1	46.0	52.4	59.1	66.3	73.9	81.9
20	32.7	32.7	32.7	32.7	32.7	38.3	44.4	51.0	58.0	65.5	73.5	81.9	90.7

Table 10 – Minimum Pressure in PSI for TFBP LFII (TY2596) K4.2 Flat Plate Concealed based on Table 9 TFBP LFII (TY2234) K4.2

TFBP LFII (TY2234) K4.9 Domed Plate Concealed

TFBP 4.9 Minimum Flow (gpm) for NFPA 13 (0.1 density at even 1 ft intervals) - Residential/SxL Sprinkler Spacing (ft)													
Spacing (ft)	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
8	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	17.0	17.0	20.0	20.0
9	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.5	14.4	17.0	17.0	20.0	20.0
10	13.0	13.0	13.0	13.0	13.0	13.0	14.0	15.0	16.0	17.0	18.0	20.0	20.0
11	13.0	13.0	13.0	13.0	13.2	14.3	15.4	16.5	17.6	18.7	19.8	20.9	22.0
12	13.0	13.0	13.0	13.2	14.4	15.6	16.8	18.0	19.2	20.4	21.6	22.8	24.0
13	13.0	13.0	13.0	14.3	15.6	16.9	18.2	19.5	20.8	22.1	23.4	24.7	26.0
14	13.0	13.0	14.0	15.4	16.8	18.2	19.6	21.0	22.4	23.8	25.2	26.6	28.0
15	13.0	13.5	15.0	16.5	18.0	19.5	21.0	22.5	24.0	25.5	27.0	28.5	30.0
16	13.0	14.4	16.0	17.6	19.2	20.8	22.4	24.0	25.6	27.2	28.8	30.4	32.0
17	17.0	17.0	17.0	18.7	20.4	22.1	23.8	25.5	27.2	28.9	30.6	32.3	34.0
18	17.0	17.0	18.0	19.8	21.6	23.4	25.2	27.0	28.8	30.6	32.4	34.2	36.0
19	20.0	20.0	20.0	20.9	22.8	24.7	26.6	28.5	30.4	32.3	34.2	36.1	38.0
20	20.0	20.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0	36.0	38.0	40.0

Table 11 – The Greater of Listing vs. S x L Minimum Flow in GPM for TFBP LFII (TY2234) K4.9 Domed Plate Concealed

TFBP 4.9 Minimum Pressure (psi) for NFPA 13 (0.1 density at even 1 ft intervals) - Residential/SxL Sprinkler Spacing (ft)													
Spacing (ft)	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
8	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	12.0	12.0	16.7	16.7
9	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.6	8.6	12.0	12.0	16.7	16.7
10	7.0	7.0	7.0	7.0	7.0	7.0	8.2	9.4	10.7	12.0	13.5	16.7	16.7
11	7.0	7.0	7.0	7.0	7.3	8.5	9.9	11.3	12.9	14.6	16.3	18.2	20.2
12	7.0	7.0	7.0	7.3	8.6	10.1	11.8	13.5	15.4	17.3	19.4	21.7	24.0
13	7.0	7.0	7.0	8.5	10.1	11.9	13.8	15.8	18.0	20.3	22.8	25.4	28.2
14	7.0	7.0	8.2	9.9	11.8	13.8	16.0	18.4	20.9	23.6	26.4	29.5	32.7
15	7.0	7.6	9.4	11.3	13.5	15.8	18.4	21.1	24.0	27.1	30.4	33.8	37.5
16	7.0	8.6	10.7	12.9	15.4	18.0	20.9	24.0	27.3	30.8	34.5	38.5	42.6
17	12.0	12.0	12.0	14.6	17.3	20.3	23.6	27.1	30.8	34.8	39.0	43.5	48.1
18	12.0	12.0	13.5	16.3	19.4	22.8	26.4	30.4	34.5	39.0	43.7	48.7	54.0
19	16.7	16.7	16.7	18.2	21.7	25.4	29.5	33.8	38.5	43.5	48.7	54.3	60.1
20	16.7	16.7	16.7	20.2	24.0	28.2	32.7	37.5	42.6	48.1	54.0	60.1	66.6

Table 12 – Minimum Pressure in PSI for TFBP LFII (TY2234) K4.9 Domed Plate Concealed based on Table 11

TFBP LFII (TY4234) K6.9 Domed Plate Concealed

TFBP 6.9 Minimum Flow (gpm) for NFPA 13 (0.1 density at even 1 ft intervals) Residential/SxL Sprinkler Spacing (ft)													
Spacing (ft)	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
8	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	21.0	21.0	24.0	24.0
9	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	21.0	21.0	24.0	24.0
10	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	21.0	21.0	24.0	24.0
11	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	21.0	21.0	24.0	24.0
12	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.2	21.0	21.6	24.0	24.0
13	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.5	20.8	22.1	23.4	24.7	26.0
14	19.0	19.0	19.0	19.0	19.0	19.0	19.6	21.0	22.4	23.8	25.2	26.6	28.0
15	19.0	19.0	19.0	19.0	19.0	19.5	21.0	22.5	24.0	25.5	27.0	28.5	30.0
16	19.0	19.0	19.0	19.0	19.2	20.8	22.4	24.0	25.6	27.2	28.8	30.4	32.0
17	21.0	21.0	21.0	21.0	21.0	22.1	23.8	25.5	27.2	28.9	30.6	32.3	34.0
18	21.0	21.0	21.0	21.0	21.6	23.4	25.2	27.0	28.8	30.6	32.4	34.2	36.0
19	24.0	24.0	24.0	24.0	24.0	24.7	26.6	28.5	30.4	32.3	34.2	36.1	38.0
20	24.0	24.0	24.0	24.0	24.0	26.0	28.0	30.0	32.0	34.0	36.0	38.0	40.0

Table 13 – The Greater of Listing vs. S x L Minimum Flow in GPM for TFBP LFII (TY4234) K6.9 Domed Plate Concealed

TFBP 6.9 Minimum Pressure (psi) for NFPA 13 (0.1 density at even 1 ft intervals) Residential/SxL Sprinkler Spacing (ft)													
Spacing (ft)	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
8	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	9.3	9.3	12.1	12.1
9	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	9.3	9.3	12.1	12.1
10	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	9.3	9.3	12.1	12.1
11	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	9.3	9.3	12.1	12.1
12	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.7	9.3	9.8	12.1	12.1
13	7.6	7.6	7.6	7.6	7.6	7.6	7.6	8.0	9.1	10.3	11.5	12.8	14.2
14	7.6	7.6	7.6	7.6	7.6	7.6	8.1	9.3	10.5	11.9	13.3	14.9	16.5
15	7.6	7.6	7.6	7.6	7.6	8.0	9.3	10.6	12.1	13.7	15.3	17.1	18.9
16	7.6	7.6	7.6	7.6	7.7	9.1	10.5	12.1	13.8	15.5	17.4	19.4	21.5
17	9.3	9.3	9.3	9.3	9.3	10.3	11.9	13.7	15.5	17.5	19.7	21.9	24.3
18	9.3	9.3	9.3	9.3	9.8	11.5	13.3	15.3	17.4	19.7	22.0	24.6	27.2
19	12.1	12.1	12.1	12.1	12.1	12.8	14.9	17.1	19.4	21.9	24.6	27.4	30.3
20	12.1	12.1	12.1	12.1	12.1	14.2	16.5	18.9	21.5	24.3	27.2	30.3	33.6

Table 14 – Minimum Pressure in PSI for TFBP LFII (TY4234) K6.9 Domed Plate Concealed based on Table 13

TFBP LFII (TY2284) K4.2 Flush Pendent

TFBP 4.2 Minimum Flow (gpm) for NFPA 13 (0.1 density at even 1 ft intervals)- Residential/SxL Sprinkler Spacing (ft)													
Spacing (ft)	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
8	13.0	13.0	13.0	13.0	13.0	13.0	13.0	14.0	14.0	18.0	18.0	22.0	22.0
9	13.0	13.0	13.0	13.0	13.0	13.0	13.0	14.0	14.4	18.0	18.0	22.0	22.0
10	13.0	13.0	13.0	13.0	13.0	13.0	14.0	15.0	16.0	18.0	18.0	22.0	22.0
11	13.0	13.0	13.0	13.0	13.2	14.3	15.4	16.5	17.6	18.7	19.8	22.0	22.0
12	13.0	13.0	13.0	13.2	14.4	15.6	16.8	18.0	19.2	20.4	21.6	22.8	24.0
13	13.0	13.0	13.0	14.3	15.6	16.9	18.2	19.5	20.8	22.1	23.4	24.7	26.0
14	13.0	13.0	14.0	15.4	16.8	18.2	19.6	21.0	22.4	23.8	25.2	26.6	28.0
15	14.0	14.0	15.0	16.5	18.0	19.5	21.0	22.5	24.0	25.5	27.0	28.5	30.0
16	14.0	14.4	16.0	17.6	19.2	20.8	22.4	24.0	25.6	27.2	28.8	30.4	32.0
17	18.0	18.0	18.0	18.7	20.4	22.1	23.8	25.5	27.2	28.9	30.6	32.3	34.0
18	18.0	18.0	18.0	19.8	21.6	23.4	25.2	27.0	28.8	30.6	32.4	34.2	36.0
19	22.0	22.0	22.0	22.0	22.8	24.7	26.6	28.5	30.4	32.3	34.2	36.1	38.0
20	22.0	22.0	22.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0	36.0	38.0	40.0

Table 15 – The Greater of Listing vs. S x L Minimum Flow in GPM for TFBP LFII (TY2284) K4.2 Flush Pendent

TFBP 4.2 Minimum Pressure (psi) for NFPA 13 (0.1 density at even 1 ft intervals) - Residential/SxL Sprinkler Spacing (ft)													
Spacing (ft)	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
8	9.6	9.6	9.6	9.6	9.6	9.6	9.6	11.1	11.1	18.4	18.4	27.4	27.4
9	9.6	9.6	9.6	9.6	9.6	9.6	9.6	11.1	11.8	18.4	18.4	27.4	27.4
10	9.6	9.6	9.6	9.6	9.6	9.6	11.1	12.8	14.5	18.4	18.4	27.4	27.4
11	9.6	9.6	9.6	9.6	9.9	11.6	13.4	15.4	17.6	19.8	22.2	27.4	27.4
12	9.6	9.6	9.6	9.9	11.8	13.8	16.0	18.4	20.9	23.6	26.4	29.5	32.7
13	9.6	9.6	9.6	11.6	13.8	16.2	18.8	21.6	24.5	27.7	31.0	34.6	38.3
14	9.6	9.6	11.1	13.4	16.0	18.8	21.8	25.0	28.4	32.1	36.0	40.1	44.4
15	11.1	11.1	12.8	15.4	18.4	21.6	25.0	28.7	32.7	36.9	41.3	46.0	51.0
16	11.1	11.8	14.5	17.6	20.9	24.5	28.4	32.7	37.2	41.9	47.0	52.4	58.0
17	18.4	18.4	18.4	19.8	23.6	27.7	32.1	36.9	41.9	47.3	53.1	59.1	65.5
18	18.4	18.4	18.4	22.2	26.4	31.0	36.0	41.3	47.0	53.1	59.5	66.3	73.5
19	27.4	27.4	27.4	27.4	29.5	34.6	40.1	46.0	52.4	59.1	66.3	73.9	81.9
20	27.4	27.4	27.4	27.4	32.7	38.3	44.4	51.0	58.0	65.5	73.5	81.9	90.7

Table 16 – Minimum Pressure in PSI for TFBP LFII (TY2284) K4.2 Flush Pendent based on Table 15

TFBP LFII (TY2384) K4.2 Flush Sidewall

TFBP 4.2 Minimum Flow (gpm) for NFPA 13 (0.1 density at even 1 ft intervals)- Residential/SxL Sprinkler Spacing (ft)													
Spacing (ft)	Length												
Width	8	9	10	11	12	13	14	15	16	17	18	19	20
8	13.0	13.0	13.0	13.0	13.0	16.0	16.0	20.0	20.0				
9	13.0	13.0	13.0	13.0	13.0	16.0	16.0	20.0	20.0				
10	13.0	13.0	13.0	13.0	13.0	16.0	16.0	20.0	20.0				
11	13.0	13.0	13.0	13.0	13.2	16.0	16.0	20.0	20.0				
12	13.0	13.0	13.0	13.2	14.4	16.0	16.8	20.0	20.0				
13	16.0	16.0	16.0	16.0	16.0	16.9	18.2	20.0	20.8				
14	16.0	16.0	16.0	16.0	16.8	18.2	19.6	21.0	22.4				
15	20.0	20.0	20.0	20.0	20.0	20.0	21.0	22.5	24.0				
16	20.0	20.0	20.0	20.0	20.0	20.8	22.4	24.0	25.6				

Table 17 – The Greater of Listing vs. S x L Minimum Flow in GPM for TFBP LFII (TY2384) K4.2 Flush Sidewall

TFBP 4.2 Minimum Pressure (psi) for NFPA 13 (0.1 density at even 1 ft intervals)- Residential/SxL Sprinkler Spacing (ft)													
Spacing (ft)	8	9	10	11	12	13	14	15	16	17	18	19	20
8	9.6	9.6	9.6	9.6	9.6	14.5	14.5	22.7	22.7				
9	9.6	9.6	9.6	9.6	9.6	14.5	14.5	22.7	22.7				
10	9.6	9.6	9.6	9.6	9.6	14.5	14.5	22.7	22.7				
11	9.6	9.6	9.6	9.6	9.9	14.5	14.5	22.7	22.7				
12	9.6	9.6	9.6	9.9	11.8	14.5	16.0	22.7	22.7				
13	14.5	14.5	14.5	14.5	14.5	16.2	18.8	22.7	24.5				
14	14.5	14.5	14.5	14.5	16.0	18.8	21.8	25.0	28.4				
15	22.7	22.7	22.7	22.7	22.7	22.7	25.0	28.7	32.7				
16	22.7	22.7	22.7	22.7	22.7	24.5	28.4	32.7	37.2				

Table 18 – Minimum Pressure in PSI for TFBP LFII (TY2384) K4.2 Flush Sidewall based on Table 17

TFBP LFII (TY1334) K4.2 Sidewall

TFBP 4.2 Minimum Flow (gpm) for NFPA 13 (0.1 density at even 1 ft intervals) Residential/SxL Sprinkler Spacing (ft) – 4-6" down, 155F													
Spacing (ft)	Length												
Width	8	9	10	11	12	13	14	15	16	17	18	19	20
8	12.0	12.0	12.0	12.0	12.0	14.0	14.0	16.0	16.0	19.0	19.0	23.0	23.0
9	12.0	12.0	12.0	12.0	12.0	14.0	14.0	16.0	16.0	19.0	19.0	23.0	23.0
10	12.0	12.0	12.0	12.0	12.0	14.0	14.0	16.0	16.0	19.0	19.0	23.0	20.0
11	12.0	12.0	12.0	12.1	13.2	14.3	15.4	16.5	17.6	19.0	19.8	23.0	23.0
12	12.0	12.0	12.0	13.2	14.4	15.6	16.8	18.0	19.2	20.4	21.6	23.0	24.0
13	14.0	14.0	14.0	14.3	15.6	16.9	18.2	19.5	20.8	22.1	23.4	24.7	26.0
14	14.0	14.0	14.0	15.4	16.8	18.2	19.6	21.0	22.4	23.8	25.2	26.6	28.0
15	16.0	16.0	16.0	16.5	18.0	19.5	21.0	22.5	24.0	25.5	27.0	28.5	30.0
16	16.0	16.0	16.0	17.6	19.2	20.8	22.4	24.0	25.6	27.2	28.8	30.4	32.0

Table 19 – The Greater of Listing vs. S x L Minimum Flow in GPM for TFBP LFII (TY1334) K4.2 Sidewall

TFBP 4.2 Minimum Pressure (psi) for NFPA 13 (0.1 density at even 1 ft intervals) - Residential/SxL Sprinkler Spacing (ft) – 4-6" down, 155F													
Spacing (ft)	8	9	10	11	12	13	14	15	16	17	18	19	20
8	8.2	8.2	8.2	8.2	8.2	11.1	11.1	14.5	14.5	20.5	20.5	30.0	30.0
9	8.2	8.2	8.2	8.2	8.2	11.1	11.1	14.5	14.5	20.5	20.5	30.0	30.0
10	8.2	8.2	8.2	8.2	8.2	11.1	11.1	14.5	14.5	20.5	20.5	30.0	22.7
11	8.2	8.2	8.2	8.3	9.9	11.6	13.4	15.4	17.6	20.5	22.2	30.0	30.0
12	8.2	8.2	8.2	9.9	11.8	13.8	16.0	18.4	20.9	23.6	26.4	30.0	32.7
13	11.1	11.1	11.1	11.6	13.8	16.2	18.8	21.6	24.5	27.7	31.0	34.6	38.3
14	11.1	11.1	11.1	13.4	16.0	18.8	21.8	25.0	28.4	32.1	36.0	40.1	44.4
15	14.5	14.5	14.5	15.4	18.4	21.6	25.0	28.7	32.7	36.9	41.3	46.0	51.0
16	14.5	14.5	14.5	17.6	20.9	24.5	28.4	32.7	37.2	41.9	47.0	52.4	58.0

Table 20 – Minimum Pressure in PSI for TFBP LFII (TY1334) K4.2 Sidewall based on Table 19

TFBP LFII (TY3334) K5.6 Sidewall

TFBP 5.6 Minimum Flow (gpm) for NFPA 13 (0.1 density at even 1 ft intervals) - Residential/SxL Sprinkler Spacing (ft) – 4-6" down, 155F													
Spacing (ft)	Length												
Width	8	9	10	11	12	13	14	15	16	17	18	19	20
8	17.0	17.0	17.0	17.0	17.0	19.0	19.0	24.0	24.0	26.0	26.0	29.0	29.0
9	17.0	17.0	17.0	17.0	17.0	19.0	19.0	24.0	24.0	26.0	26.0	29.0	29.0
10	17.0	17.0	17.0	17.0	17.0	19.0	19.0	24.0	24.0	26.0	26.0	29.0	29.0
11	17.0	17.0	17.0	17.0	17.0	19.0	19.0	24.0	24.0	26.0	26.0	29.0	29.0
12	17.0	17.0	17.0	17.0	17.0	19.0	19.0	24.0	24.0	26.0	26.0	29.0	29.0
13	19.0	19.0	19.0	19.0	19.0	19.0	19.0	24.0	24.0	26.0	26.0	29.0	29.0
14	19.0	19.0	19.0	19.0	19.0	19.0	19.6	24.0	24.0	26.0	26.0	29.0	29.0
15	20.0	20.0	20.0	20.0	20.0	20.0	21.0	24.0	24.0	26.0	27.0	29.0	30.0
16	20.0	20.0	20.0	20.0	20.0	20.8	22.4	24.0	25.6	27.2	28.8	30.4	32.0

Table 21 – The Greater of Listing vs. S x L Minimum Flow in GPM for TFBP LFII (TY3334) K5.6 Sidewall

TFBP 5.6 Minimum Pressure (psi) for NFPA 13 (0.1 density at even 1 ft intervals) - Residential/SxL Sprinkler Spacing (ft) – 4-6" down, 155F													
Spacing (ft)	8	9	10	11	12	13	14	15	16	17	18	19	20
8	9.2	9.2	9.2	9.2	9.2	11.5	11.5	18.4	18.4	21.6	21.6	26.8	26.8
9	9.2	9.2	9.2	9.2	9.2	11.5	11.5	18.4	18.4	21.6	21.6	26.8	26.8
10	9.2	9.2	9.2	9.2	9.2	11.5	11.5	18.4	18.4	21.6	21.6	26.8	26.8
11	9.2	9.2	9.2	9.2	9.2	11.5	11.5	18.4	18.4	21.6	21.6	26.8	26.8
12	9.2	9.2	9.2	9.2	9.2	11.5	11.5	18.4	18.4	21.6	21.6	26.8	26.8
13	11.5	11.5	11.5	11.5	11.5	11.5	11.5	18.4	18.4	21.6	21.6	26.8	26.8
14	11.5	11.5	11.5	11.5	11.5	11.5	12.3	18.4	18.4	21.6	21.6	26.8	26.8
15	12.8	12.8	12.8	12.8	12.8	12.8	14.1	18.4	18.4	21.6	23.2	26.8	28.7
16	12.8	12.8	12.8	12.8	12.8	13.8	16.0	18.4	20.9	23.6	26.4	29.5	32.7

Table 22 – Minimum Pressure in PSI for TFBP LFII (TY3334) K5.6 Sidewall based on Table 20

About the Author

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 "A Technical Analysis: Listings and Applications of Residential Sprinklers". He has contributed to the NFPA Fire Protection Handbook 19th Edition as well as the 2002 Automatic Sprinkler System Handbook. He is also named on numerous U.S. Patents relating to automatic sprinklers.

WORLDWIDE HEADQUARTERS

Tyco Fire & Building Products
451 N. Cannon Avenue
Lansdale, PA 19446
215-362-0700, 800-523-6512
Fax 215-362-5385
www.Tyco-Fire.com

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National Distribution Facility
PO Box 2806
Lubbock, TX 79408-2806

CUSTOMER SERVICE CENTER
7071 S. 13th Street, Ste. 103
Oak Creek, WI 53154
877-436-8926, Fax 877-866-9250

CANADA

Regional Headquarters
12-16715 Yonge Street, Suite 316
Newmarket, Ontario L3X 1X4
705-422-0010, Fax: 705-422-1396

LATIN AMERICA

Regional Headquarters
South America, Central America & Caribbean
1802 S.W. 2nd St.
Pompano Beach, FL 33069
954-781-0866, Fax 954-781-9330

Regional Headquarters - Mexico
Hamburgo 231A Piso 2
Colonia Juarez
Mexico, D.F. 06600 Mexico
525-55-2075766, Fax: 525-55-2077566

EUROPE & MIDDLE EAST

Regional Headquarters
Kopersteden 1, NL-7547 TJ Enschede
P.O. Box 198, 7500 AD
Enschede, The Netherlands
31-53-428-4444, Fax 31-53-428-3377

Stockport, UK: Tel: 44-161-477-1886, Fax 44-161-477-6729
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Lørenskog, Norway: Tel: 47-67-91-77-00, Fax 47-67-91-77-15
Lammhult, Sweden: Tel: 46-472-269-980, Fax 46-472-269-989
Dublin, Ireland: Tel: 353-166-839-82, Fax 353-166-822-54
Bolzano, Italy: Tel: 39-0471-252-091, Fax 39-0471-254-058
Milano, Italy: Tel: 39-0293-548-736, Fax 39-0293-548-690
Dubai, United Arab Emirates: Tel: 971-488-38689, Fax 971-488-38674
Budapest, Hungary: Tel: 36-148-11-383, Fax 36-120-34-427
Wels/Thalheim, Austria: Tel: 43-072-42-65-054, Fax 43-072-42-74-393

ASIA

Regional Headquarters
No.45 Tuas Avenue 9,
Singapore 639189

Central Sprinkler Company
Singapore: 65- 6743-3212, Fax 65-6743-9181
Shanghai, China: 86-21-5868-3300, Fax 86-21-5868-1160
Beijing, China: 86-10-6515-6191, Fax 86-10-6515-6157
Chengdu, China: 86-28-689-9440, Fax 86-28-666-2538

Gem Sprinkler Company & Star Sprinkler Inc.
Singapore: 65-6861-1655, Fax 65-6861-1312
Kuala Lumpur, Malaysia: 60-3-8024-6773, Fax 60-3-8024-2180
Hong Kong: 852-2595-0686, Fax 852-2505-5826

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