NFSA NATIONAL FIRE SPRINKLER ASSOCIATION
The Voice of the Fire Sprinkler Industry

TechNotes

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Following are a dozen questions answered by the engineering staff as part of the NFSA's Expert of the Day (EOD) member assistance program during the month of January 2019. This information is being brought forward as the "Best of January 2019." If you have a question for the NFSA EOD (and you are an NFSA member), send your question to eod@nfsa.org and the EOD will get back to you.

It should be noted that the following are the opinions of the NFSA Engineering Department staff, generated as members of the relevant NFPA technical committees and through our general experience in writing and interpreting codes and standards. They have not been processed as formal interpretations in accordance with the NFPA Regulations Governing Committee Projects and should therefore not be considered, nor relied upon, as the official positions of the NFPA or its Committees. Unless otherwise noted the most recent published edition of the standard referenced was used

Question #1 - Air Venting

Is an automatic air vent required to have provision for drainage?

Answer: The answer to your question is "no." The standard does not specifically require a drain since the purpose of the air vent is to exhaust air from the system after filling to prevent corrosion." However, provisions for drainage are an optional feature for some available equipment in the market. Since the air vents will discharge water after trapped air is evacuated a connection to a drain should be considered if a collection pan is not provided or is insufficient for the connections.

Question #2 - Pressure Reducing Valves

Are two pressure regulating valves in series required for systems serving multiple hose connections downstream?

Answer: Yes, per NFPA 14-2019 section 7.2.4(3) "Regulating devices, such as pressure reducing valves (PRVs), shall be arranges so that the failure of any single device does not allow pressure in excess of 175 psi to any hose connections downstream."

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Presented by Roland Asp, Manager of Installation Standards

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Did You Know??

The NFSA assigns a member of the Engineering Department staff every business day to answer your technical questions. We call this the Expert of the Day (EOD) program and it is available to our members by phone, or e-mail. Call us at (845) 878-4200 and press 2, or you can e-mail us at eod@nfsa.org. Last year we answered more than 1400 requests for assistance.

By installing two PRV's in series, you are ensuring that if one fails to reduce the pressure the other will operate. The standard assumes that only one valve will fail at a time and they are required to fail in the open position. Keep in mind that each valve will typically have a minimum fixed loss of 10 psi but should verified by the technical data sheet prepared by the manufacturer for the selected valves. You were correct in applying NFPA 14 section 7.2.4, which contains additional requirements beyond what is specifically discussed in this response:

> ***7.2.4**** *Where more than two hose connections are used downstream of a pressure-regulating device, the following conditions shall apply:*
>
> *(1) In systems with multiple zones, pressure-regulating device(s) shall be permitted to be used in lieu of providing separate pumps to control pressure in the lower zone(s) as long as the devices comply with all requirements of 7.2.4.*
> *(2) A method to isolate the pressure-regulating device(s) shall be provided for maintenance and repair.*
> *(3) Regulating devices shall be arranged so that the failure of any device does not allow pressure in excess of 175 psi to any of the multiple hose connections downstream*
> *(4) An equally sized bypass around the pressure-regulating device(s), with a normally closed control valve, shall be installed.*
> *(5) Pressure-regulating device(s) shall be installed not more than 7 ft 6 in. above the floor.*
> *(6) The pressure-regulating device shall be provided with inlet and outlet pressure gauges.*
> *(7) The fire department connection(s) shall be connected to the system side of the outlet isolation valve.*
> *(8) The pressure-regulating device shall be provided with a pressure relief valve in accordance with the manufacturer's recommendations.*
> *(9) Remote monitoring and supervision for detecting high pressure failure of the pressure-regulating device shall be provided in accordance with NFPA 72.*

The bypass referenced in NFPA 14 Figure A.7.2.4 provides a means to both service any individual valve without taking the entire system out of service and to perform the required full flow test per NFPA 25 on each valve individually. This is purely for maintenance and not intended to be utilized in the event of a failure. When a PRV fails, it should fail in the open position and not reduce the pressure in the system. A valve that fails in the closed position would be unacceptable. In addition, a relief valve is required downstream of the PRVs in accordance with manufacturers recommendations to provide additional safety against overpressure.

Question #3 - In-rack Demand for Flammable Liquids

Does the ceiling sprinkler demand need to be balanced with the in-rack sprinkler demand when protecting Class 1B Liquids per NFPA 30 Table 16.5.2.1?

Answer: It depends upon the design scheme in Section 16.6. Per NFPA 30-2015:

> ***16.5.1.3*** *In-rack sprinklers shall be installed in accordance with the provisions of NFPA 13, Standard for the Installation of Sprinkler Systems. In addition, the following modifications shall apply:*
>
> *(1) In-rack sprinklers shall be laid out in accordance with 16.5.1.10 and Section 16.6, as applicable.*

Hydraulic calculation requirements depend on the design scheme used for the in-rack protection and individual container capacity. The specific standard references are extracted below.
For in-rack sprinklers installed per the requirements of Design Scheme 'A', balancing of the overhead and in-rack demand is not required. Per NFPA 30-2015:

> ***16.6.1.6*** *Ceiling sprinkler demand shall not be included in the hydraulic calculations for in-rack sprinklers.*

For in-rack sprinklers installed per the requirements of Design Scheme 'B', balancing of the overhead and in-rack demand is dependent on the container size. Per NFPA 30-2015:

> ***16.6.2.7*** *Ceiling sprinklers for containers that exceed 1 gal capacity, but do not exceed 60 gal, shall meet the following requirements:*
>
> *(1) Ceiling sprinkler protection shall provide a minimum density of 0.45 gpm/ft2 over the most hydraulically remote 3000 ft2, using high-temperature, standard-response sprinklers of nominal K-factor of 11.2 or greater. Other types of sprinklers shall not be used.*
>
> *(2) Ceiling sprinkler water demand and the in-rack sprinkler demand shall be balanced at the point of connection.*

Please note for this option that the density is required to be increased from 0.40 gpm/sq. ft to 0.45 gpm/sq. ft and you are limited to the sprinklers specified in the first bullet.

For in-rack sprinklers installed per the requirements of Design Scheme 'C', balancing of the overhead and in-rack demand is not required. Per NFPA 30-2015:

> ***16.6.3.5*** *Ceiling sprinkler demand shall not be included in the hydraulic calculations for in-rack sprinklers.*

Question #4 - Residential Sprinkler Discharge in NFPA 13R Systems

Using NFPA 13R-2013, what is the required design criteria for residential sprinklers?

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Sprinkler System Plan Review - Fort Wayne, IN
February 19 - 20, 2019

Answer: Per NFPA 13R-2013 section 7.1.1.1, the density provided by each individual sprinkler shall be the greater of 0.05 gpm/ft2 or the listed flow divided by the area of coverage of the sprinkler. Because NFPA 13R is being used in this application a 0.1 gpm/ft2 density is not necessary unless the sprinklers are protecting certain areas outside the dwelling unit. NFPA 13 requires this because it provides a greater level of property protection than the residential standards of NFPA 13R and NFPA 13D.

Residential sprinklers are typically listed for a specific flow, so the required densities vary based on the installed spacing. For example, in the table below the first three columns show discharge requirements for a particular sprinkler, and the shaded columns show the calculated area of coverage and minimum density supplied when using the required pressure and flow at the maximum spacing:

Maximum Coverage Area (ft x ft)	Flow (gpm)	Pressure (psi)	Maximum Coverage Area (sq. ft)	Min. Density (gpm/sq. ft)
12 x 12	8	7.0	144	0.056
14 x 14	10	11.0	196	0.051
15 x 15	12	16.0	225	0.053
16 x 16	13	18.8	256	0.051

When the sprinkler is spaced to the maximum allowable area of coverage based on its required discharge pressure and flow, the achieved densities are slightly over 0.05 gpm/sq. ft. for all conditions. As with most installations, all sprinklers are typically not installed at the maximum coverage area. Any reduction in area of coverage would increase the density as the flow required per the listing remains the same.

Question #5 - Sprinklers at Top of Stair Shaft

In a noncombustible stair shaft, are sprinklers required to cover the entire area of the shaft at the top?

Answer: The answer to your question is "Yes."

NFPA 13-2007 section 8.15.3.2.1 reads as follows:

> ***8.15.3.2.1*** *In noncombustible stair shafts having noncombustible stairs with noncombustible to limited-combustible finishes, sprinklers shall be installed at the top of the shaft and under the first accessible landing above the bottom of the shaft.*

The intent of this section is to provide sprinkler coverage for the entire shaft at the top and under any space under the first landing that can be used for storage. While the handbook shows a diagram with only one sprinkler at the top of the shaft, proper coverage should be used to protect the entire footprint of the shaft.

Question #6 - Protection of Saunas

A prefabricated dry sauna is to be installed in a gym locker room. The sauna manufacturer states that there are no provisions for installing a sprinkler in the sauna and that drilling into the unit would void the warranty. Are there any provisions in NFPA 13-2016 to exempt sprinklers from inside saunas?

Answer: No, the standard does not provide any exceptions that would apply to an occupiable sauna". The basic premise of NFPA 13-2016 section 4.1 is that sprinklers must be installed throughout the building unless a specific exception is provided by the standard (See also 8.1.1(1) & (4) [9.1.1(1) & (4) in the 2019 edition]). No applicable exception appears in the standard for saunas. Note that, although it could be argued that a small prefab sauna unit could be described as 'furniture', the exception provided in section 8.1.1(7) [9.2.9 in the 2019 edition] does not apply to occupiable furniture.

> ***4.1 Level of Protection**. A building, where protected by an automatic sprinkler system installation, shall be provided with sprinklers in all areas except where specific sections of this standard permit the omission of sprinklers.*
>
> ***8.1.1*** The requirements for spacing, location, and position of sprinklers shall be based on the following principles:*
>
> *(1) Sprinklers shall be installed throughout the premises.*
> *[...]*
> *(4) Sprinklers shall be permitted to be omitted from areas specifically allowed by this standard.*
> *[...]*
> *(7) Furniture, such as portable wardrobe units, cabinets, trophy cases, and similar features not intended for occupancy, does not require sprinklers to be installed in them. This type of feature shall be permitted to be attached to the finished structure.*
> *[...]*

Note that the annex commentary in A.8.3.2.5(1) [A.9.4.2.5(1) in the 2019 edition] demonstrates that the Technical Committee anticipated that sprinklers would be provided in saunas.

> **8.3.2.5*** The following practices shall be observed to provide sprinklers of other than ordinary-temperature classification unless other temperatures are determined or unless high-temperature sprinklers are used throughout, and temperature selection shall be in accordance with Table 8.3.2.5(a), Table 8.3.2.5(b), Table 8.3.2.5(c), and Figure 8.3.2.5:
>
> (1)* Sprinklers in the high-temperature zone shall be of the high-temperature classification, and sprinklers in the intermediate-temperature zone shall be of the intermediate-temperature classification.
>
> **A.8.3.2.5(1)** Areas used for hot yoga facilities, steam rooms, saunas, indoor areas containing hot tubs, and similar heated areas should be evaluated to determine the potential maximum ambient temperature before selection

of sprinkler temperature rating to be installed in the space.

Note that, based on the definition of a sauna as a bathing facility, it could arguably be considered permissible to omit sprinklers in a small sauna (55 square feet or less) if it is installed in a dwelling unit as permitted by 8.15.8.1.1 [9.2.4.1.1 in the 2019 edition]. This would be up to the discretion of the authority having jurisdiction.

> **3.1 General**. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. Merriam-Webster's Collegiate Dictionary, 11th edition, shall be the source for the ordinarily accepted meaning.
>
> > **sauna**
> > 1: a Finnish steam bath in which the steam is provided by water thrown on hot stones
> > also: a bathhouse or room used for such a bath
> > 2: a dry heat bath
> > also: a room or cabinet used for such a bath
>
> **3.3.2* Bathroom**. Within a dwelling unit, any room or compartment dedicated to personal hygiene, containing a toilet, sink, or bathing capability such as a shower or tub.
>
> **8.15.8.1.1*** Unless sprinklers are required by 8.15.8.1.2 or 8.15.8.1.3, sprinklers shall not be required in bathrooms that are located within dwelling units, that do not exceed 55 ft2 (5.1 m2) in area, and that have walls and ceilings of noncombustible or limited-combustible materials with a 15-minute thermal barrier rating, including the walls and ceilings behind any shower enclosure or tub.

Question #7 - Golf Simulator Fabric

A golf simulator is installed with a fabric ceiling below the ceiling level sprinklers. Is NFPA 13-2016 section 8.15.15 Drop-Out Ceilings and Ceiling Materials appropriate for this scenario?

Answer: If the "fabric" has been specifically listed for this use then the answer is yes. As stated in annex section A.8.15.15.1, if the ceiling material meets UL Subject 723S, Outline of Investigation for Drop-Out Ceilings Installed Beneath Automatic Sprinklers, or as FM Class Number 4651, Plastic Suspended Ceiling Panels and is listed for this use then section 8.15.5 would be applicable.

In previous editions of NFPA 13, section 8.15.5 was limited to drop-out ceiling tiles and panels. However, during the revision of the 2016 edition of NFPA 13 the term "Ceiling Material" was added. This was added as the committee was informed that a membrane product was listed in accordance with UL Subject 723S. This change was made as Second Revision #18 with the following committee statement:

A membrane product has been evaluated by UL using UL Subject 723S and is currently listed as being suitable for being installed beneath sprinklers. This particular membrane product contains seams that will fail during a fire and as such, does not impact the ability of the water to reach the hazard being protected. The activation time for the sprinklers was minimally impacted during the UL test. The UL test acceptance criteria addresses the impact the product may have on the activation time of the sprinkler and the percent of material that needs to "drop out" so as not to significantly impact the ability of the water to reach the hazard being protected.

The NFPA Technical Committee on Finishing Processes (NFPA 33) has recommended the acceptance of the concept (involving membrane enclosures for indoor and outdoor spray applications) using the same criteria and based upon feedback from an NFPA 13 task group.

Recognition in the Standard for such listed products offers a solution that addresses those instances in which a membrane needs to be installed between the sprinklers and the floor and potentially eliminating the use of other methods that have historically been used and that are more likely to adversely impact the performance of the sprinkler system.

If the fabric installed in this situation is listed for this use and is installed in conformance with section 8.15.15 and the manufacturer's instructions, then it should be acceptable. I suggest that you contact the manufacturer of the fabric to find out if it is listed for this use.

Question #8 - Shared (Buddy) Hangers

Where it would be practical to hang a small sprinkler pipe, such as an inspector's test line, from a larger sprinkler pipe, such as a main, is it permissible per NFPA 13-2016?

Answer: Yes, but not using the prescriptive requirements of NFPA 13-2016 section9.1.1.1. All of the prescriptive hanger requirements in Section 9.1 are based on hanging a single pipe; not multiple pipes and not one pipe supporting another pipe. Although some exceptions might seem intuitively acceptable e.g. a very small pipe supported by a very large pipe using the prescriptive hanger rules for each pipe. The requirement of the standard is that any configuration not specifically addressed in the prescriptive rules must certified by a registered professional engineer as per the requirements of 9.1.1.2.

9.1.1.1 *Unless the requirements of 9.1.1.2 are met, types of hangers shall be in accordance with the requirements of Section 9.1.*

9.1.1.2 *Hangers certified by a registered professional engineer to include all of the following shall be an*

acceptable alternative to the requirements of Section 9.1:

(1) Hangers shall be designed to support five times the weight of the water-filled pipe plus 250 lb (115 kg) at each point of piping support.

(2) These points of support shall be adequate to support the system.

(3) The spacing between hangers shall not exceed the value given for the type of pipe as indicated in Table 9.2.2.1(a) or Table 9.2.2.1(b).

(4) Hanger components shall be ferrous.

(5) Detailed calculations shall be submitted, when required by the reviewing authority, showing stresses developed in hangers, piping, and fittings, and safety factors allowed.

Question #9 - Duct Obstructions

A 48-inch wide duct turns 90 degrees creating an elbow. Measured diagonally, the widest point of the 'elbow' would exceed 48 inches in width; approximately 68 inches. For standard spray upright sprinklers, is a sprinkler required below the obstruction created by the duct?

Answer: No, this type of situation is typically not regarded as a violation of the wide obstruction rule. The requirement is to provide sprinklers below obstructions greater than 48 inches in width. Although the argument could be made that a sprinkler is required under the obstruction based on the diagonal measurement at the elbow exceeding 48 inches. However, that would not be consistent with accepted applications of the general wide obstruction rule, NFPA 13-2016 section 8.5.5.3 [9.5.5.3 in the 2019 edition] and its subsections, nor the specific wide obstruction rule for standard spray upright sprinklers in 8.6.5.3.3 [10.2.7.3 in the 2019 edition] along with its annex commentary.

***8.5.5.3* Obstructions that Prevent Sprinkler Discharge from Reaching Hazard**. Continuous or noncontinuous obstructions that interrupt the water discharge in a horizontal plane more than 18 in. (450 mm) below the sprinkler deflector in a manner to limit the distribution from reaching the protected hazard shall comply with 8.5.5.3.*

8.5.5.3.1 *Sprinklers shall be installed under fixed obstructions over 4 ft (1.2 m) in width.*

8.5.5.3.1.1 *Sprinklers shall be located below the obstruction and not more than 3 in. (75 mm) from the outside edge of the obstruction.*

8.5.5.3.1.2 *Where sprinklers are located adjacent to the obstruction, they shall be of the intermediate level rack type.*

8.5.5.3.1.3 *The deflector of automatic sprinklers installed under fixed obstructions shall be positioned no more than 12 in. (300 mm) below the bottom of the obstruction.*

8.5.5.3.1.4 *Sprinklers shall not be required under noncombustible obstructions over 4 ft (1.2 m) wide where the bottom of the obstruction is 24 in. (600 mm) or less above the floor or deck.*

The annex commentary to section 8.6.5.3.3 clarifies that it is not the Technical Committee's intent to require sprinklers based on diagonal measurement. If that were the case, a sprinkler would be required below a 48-inch by 48-inch obstruction measured as directed by section A.8.6.5.3.3 because it would have the same 68-inch diagonal.

> ***8.6.5.3.3**** *Sprinklers shall be installed under fixed obstructions over 4 ft (1.2 m) wide.*
> ***A.8.6.5.3.3*** *When obstructions are located more than 18 in. (450 mm) below the sprinkler deflector, an adequate spray pattern develops and obstructions up to and including 4 ft (1.2 m) wide do not require additional protection underneath. Examples are ducts, decks, open grate flooring, catwalks, cutting tables, overhead doors, soffits, ceiling panels, and other similar obstructions. The width of an object is the lesser of the two horizontal dimensions (with the length being the longer horizontal dimension). Sprinkler protection is not required under objects where the length is greater than 4 ft (1.2 m) and the width is 4 ft (1.2 m) or less.*

It should be noted that there could conceivably be situations where the relationship between obstructions and overhead sprinklers warrants the addition of sprinklers below the level of the obstruction in support the principle of 8.1.1(3) even though the standard does not require them. This would be up to the layout technician depending on the particular situation.

> ***8.1* Basic Requirements.***
> ***8.1.1**** *The requirements for spacing, location, and position of sprinklers shall be based on the following principles:*
> *[...]*
> *(3)*Sprinklers shall be positioned and located so as to provide satisfactory performance with respect to activation time and distribution.*

Question #10 - Riser Clearance

Does NFPA 13 or NFPA 25 mandate a minimum required distance sprinkler risers and HVAC equipment, walls, or features?

Answer: No, NFPA 13 or NFPA 25 does not mandate a specific minimum distance between a sprinkler riser and other equipment or walls. That being said, a level of common sense must be applied. Adequate working space is needed to access the equipment for maintenance, inspection and future replacement of the riser components. Probably the best reference is found in the International Fire Code. the 2018 edition, section 901.4.6 reads as follows:

> ***901.4.6*** *Pump and riser room size. Where provided, fire pump rooms and automatic sprinkler system riser rooms shall be designed with adequate space for all equipment necessary for the installation, as defined by the manufacturer, with sufficient working space around the stationary*

equipment. Clearances around equipment to elements of permanent construction, including other installed equipment and appliances, shall be sufficient to allow inspection, service, repair or replacement without removing such elements of permanent construction or disabling the function of a required fire-resistance-rated assembly. Fire pump and automatic sprinkler system riser rooms shall be provided with doors and unobstructed passageways large enough to allow removal of the largest piece of equipment.

While no minimum distances are cited, this reference does state:

> *Clearances around equipment to elements of permanent construction, including other installed equipment and appliances, shall be sufficient to allow inspection, service, repair or replacement without removing such elements of permanent construction or disabling the function of a required fire-resistance-rated assembly.*

This section also indicates that the required clearance is defined by the manufacturer of the equipment. Product data sheets for valves, backflow preventers and other equipment often provide specific clearance requirements for inspection, testing and maintenance purposes. Absent information from the manufacturer, common sense must be used to determine how much space is needed to perform the necessary inspection, maintenance and replacement of the riser components.

Question #11 - Design Areas

Is it permitted to exclude the area occupied by a fire resistance rated stair enclosure from the design area when using the occupancy hazard fire control approach (density/area method)?

Answer: No, fire resistance ratings of walls and openings are only taken into consideration when using the room design method. When determining the design area for the density/area method, interior walls are ignored; regardless of fire resistance rating. NFPA 13-2016 section 23.4.4.2 [27.2.4.2.1 in the 2019 edition] requires that the dimension of the design area parallel to the branch line must be of a specified length. No exception is provided to revise that length if the branch passes through an interior wall. The design area is not intended to reflect a realistic fire scenario but simply to represent a reasonably sized discharge area at the hydraulically most demanding part of the system.

> ***23.4.4.2 Density/Area Method.***
> ***23.4.4.2.1**** *Where the design is based on the density/area method, the design area shall be a rectangular area having a dimension parallel to the branch lines at least 1.2 times the square root of the area of sprinkler operation (A) used, which shall permit the inclusion of sprinklers on both sides of the cross main.*

Question #12 - Fire Pump Discharge Reducers

Does NFPA 20 allow an eccentric reducer (increaser) on the discharge side of a fire pump? NFPA 20 section 4.14.6.4 identifies that an eccentric reducer is required on the suction side of a fire pump but there is no similar requirement stating that a concentric reducer is required on the discharge side of the fire pump.

Answer: Yes, an eccentric reducer can be used on the discharge side of the fire pump. The reason that NFPA 20-2016 section 4.15.6.4 specifically requires an eccentric reducer on the suction of the pump is to prevent air pockets from entering the fire pump which would be problematic since the air would cause cavitation. This would result in small explosive type reactions as the air pockets expand and contract due to the change in pressure resulting from the centrifugal force caused by the rotation of the impeller. There is no similar constraint on the discharge side of the pump. As a result, either an eccentric reducer or concentric reducer is permitted to be used.