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

TechNotes

Editor - Mark Hopkins, P.E | Issue # 426 | October 8, 2019

October 8, 2019
Best of September 2019

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 September 2019. This information is being brought forward as the "Best of September 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 - ESFR System with Office area Subsystem

A new ESFR system is being designed for a 40 ft high warehouse. There is also a 10,000 sq. ft office area within the warehouse with a ceiling height of 10 ft.

Is it permissible to connect to the overhead ESFR system with a valve and tamper switch to provide protection for the offices?

Answer: Yes, there is nothing in NFPA 13 that prohibits the office area subsystem from being supplied by the same mains that serve the ESFR sprinkler system, provided the overall system protection limits are not exceeded. Section 4.5.3 in the 2019 edition of NFPA 13 (Section 8.2.3 in the 2016 edition) states: "Where single systems protect extra hazard, high-piled storage, or storage covered by other NFPA standards, and ordinary or light hazard areas, the extra hazard or storage area coverage shall not exceed the floor area specified for that hazard, and the total area coverage shall not exceed 52,000 sq. ft."

Upcoming Technical Tuesdays

October 15, 2019

NFPA 75

Presented by Kevin Hall, P.E., Manager of Engineering Research

Register Here

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 (443) 863-4464**, or you can e-mail us at eod@nfsa.org. Last year we answered more than 1400 requests for assistance.

View older issues in the "Member's Only" section

Question 2 - Aircraft Hanger Protection: IBC vs NFPA 409

A design professional has chosen to follow a provision of the IBC (2015 IBC 412.4.6) that requires a fire suppression system for an aircraft hangar but exempts the system from foam requirements. Is the use a water-only sprinkler system allowable per the code and standard?

You have noted that the IBC also requires compliance with NFPA 409 and that there are no criteria for standalone wet pipe sprinkler systems for Group 2 hangars in NFPA 409. The use of Section 7.2 design criteria in NFPA 409 (2016 edition) is tied to the simultaneous use of either a low-expansion foam system per Section 7.1.1(2) or a high-expansion foam system in accordance with 7.1.1(3).

Answer: Because legally-adopted building and fire codes supersede standards referenced by those codes, the use of a water-only system as specifically permitted under the stated conditions is acceptable. However, the IBC reference does not specifically state that you can use the NFPA 409 Section 7.2 design (0.17 gpm per sq. ft over 5,000 sq. ft) for the water-only system and doing so could potentially lead to a concern that a substandard system was being provided.

For this reason we have previously recommended to members that where a water-only system is being provided, it would be appropriate to increase the density to 0.2 gpm per sq. ft over 5,000 sq. ft to qualify as Extra Hazard Group 1 protection for an aircraft hangar as identified in A.5.4.1(1) of NFPA 13 (2016 edition). The slight increase in density to meet the NFPA 13 requirement for Extra Hazard Group 1, along with the IBC code reference, should provide you with documentation of a design compliant with published codes and standards.

Question 3 - NFPA 13D Water Tanks

We have always sized our tanks based on the two most remote sprinklers in a house. An example would be the use of sprinklers with a listing of 13gpm@7psi for 16x16 spacing. Using the 2 most hydraulically remote sprinklers, the tank must be sized to at least 260 gallons of water. We have heard from a few people that we should size the NFPA13D pump based on the most demanding two sprinklers, but size the tank based on the two least demanding sprinklers. Is this the case?

Answer: No. The water supply must be sized to adequately supply the two most hydraulically demanding sprinklers, since this is specifically required

by the standard (Section 10.2.1 in the 2019 edition).

The concern is that two sprinklers of the same type operating closer to the water supply could flow more water than the most hydraulically demanding sprinklers and deplete the water supply prior to the 10-minute period on which it is based. This has been a concern occasionally raised over the years for NFPA 13 systems as well.

In an actual fire, it is rare that two sprinklers operate at the same exact time, so that alone extends the time period over which a nominal 10-minute water supply would be distributed. Further, it has always been understood that more water delivered earlier to the fire can provide more effective fire control and suppression. That is a finding that dates back to studies involving fire department hose stream effectiveness and is also reflected in the fact that the traditional density/area curves in NFPA 13 require less water at the base of the curve than at the top. For example, the low point on the light hazard curve of 0.1 gpm/sq. ft over 1500 sq. ft requires a flow of 150 gpm, but the end point of 0.07 gpm/sq. ft over 3,000 sq. ft requires a flow of 210 gpm.

Because NFPA 13D specifically allows the use of the NFPA 13 hydraulic calculation method in Section 10.4.3(d), the same philosophy would hold with regard to water storage, and the use of the two most hydraulically demanding sprinklers is appropriate for water supply calculations.

Question 4 - Isolation valves for individual tenant spaces within a shopping mall

In a normal strip mall building with multiple tenants all having an NFPA 13 system, are isolation valves required for each tenant space per NFPA 13? A concern was raised during a renovation of tenant spaces with no isolation valves regarding hydrostatic testing. The concern is putting 200 psi of water for 2 hours on the system since it will also pressurize the other tenant spaces, which are already occupied.

Answer: No. NFPA 13 neither requires nor prohibits isolation valves for individual tenant spaces, although the maximum system size limitations within the standard would normally require multiple separate systems within the mall, with each system having its own control valve, water flow alarm and drain.

It is typical for shopping malls to have a plan for tenant sprinkler system connections to water supply piping, since the connections could theoretically be made either to piping serving common mall areas at the front of tenant spaces, or to piping in service areas at the rear of tenant spaces. A degree of diligence is required to

This Month in Engineering

Layout Technician Training:

https://LayoutTechnicianClass

Layout Technician Training - Fundamentals
Online Training
Open for Registration
Jan 1 - Dec 31, 2019

Layout Technician Training -

ensure that all sprinklers in all tenant areas are properly connected to some source of supply.

For the concern mentioned relative to pressure testing, as well as other possibilities, it is not unreasonable to have a tenant isolation valve, but a check of the tenant lease is in order before any such isolation valves are installed, and all such valves should be properly supervised to ensure that they are maintained in an open position when the system is in service. If a new sectional valve is installed, an updated information sign must be provided at the system riser in accordance with Section 4.1.9 of NFPA 25 (2017 edition) indicating the presence and location of such a sectional valve and the area it serves.

Question 5 - Partial Sprinkler System

On an existing two-story building, the owner elected to provide sprinklers on the ground floor only. The specifications state that sprinkler protection be provided to the stairwells. As the system is limited to the ground floor, a sprinkler was provided on the ground floor level of the stairwell but not at any upper floor levels of the stairwell as this was not specified in the contract.

If an owner elects to complete a limited area fire protection system, are they required to sprinkler the entire stairwell top and bottom? And does NFPA or the IBC offer any guidance on limited area system requirements?

Answer: First, we suggest that you take sufficient measures to convince your customer that partial sprinkler protection is a bad idea. In many cases the basic system control equipment and water supply is included in the cost of providing partial sprinkler protection, and the marginal cost of extending the system throughout the building is substantially less. Your efforts to provide NFPA 13-compliant protection should be well documented to protect your own company in the event of any potential future litigation.

NFPA 13 does recognize that complete protection is not always provided. In the 2016 edition, for example, Section 8.1.1 states the basic principle that sprinklers be installed throughout the premises except where specifically allowed to be omitted by the standard. However, Annex sections A.8.1 and A.8.1.1 offer guidance when partial protection is provided.

The International Building Code, where it requires sprinkler protection, calls for compliance with NFPA 13, 13R or 13D as applicable. However, the IBC has for many years also recognized the use of limited area sprinkler systems, allowing fewer than 20 sprinklers on any single connection to be supplied from the domestic

Fundamentals and Practicum
Baltimore, MD
Oct 14 - Oct 25, 2019

Layout Technician Training - In Class Practicum
Baltimore, MD
Oct 21 - Oct 25, 2019

Upcoming In-Class Seminars

Inspecting and Testing for the Sprinkler Industry
Elmira, NY
October 8, 2019

Understanding, Applying and Enforcing NFPA 25
Northbrook, IL
October 22, 2019

Inspection, Testing and Maintenance for the Building Owner or Manager
Oak Brook, IL
October 23, 2019

Register Here

water service when a wet automatic standpipe is not available. In the 2015 edition the fewer than 20 sprinkler allowance was change to 6 sprinklers or less in a single fire area. It would be possible to have more than 6 sprinklers on a limited area system but would limit the number of sprinklers in any specific fire area to 6. Keep in mind that these systems are permitted as an option for protection of specific hazards such as those found in IBC Table 509.4.2 for incidental use areas.

Obviously, the use of partial sprinkler protection would not be permitted by the IBC if the full occupancy were required by the code to be sprinklered. Nor can building "trade-offs" permitted by the IBC in favor of sprinklers be used, since such construction alternatives are only permitted where sprinklers are installed "throughout" in accordance with NFPA 13.

If, however, the Code Official has permitted limited area sprinkler protection, then NFPA 13 rules relating to protection of fire-rated staircases do not apply. Whatever sprinklers are provided are expected to be spaced, positioned and provided with a sufficient water supply in accordance with the rules of NFPA 13 as reflected in their product listings. This is consistent with the advice given in A.8.1.1: "The requirements of this standard should be used insofar as they are applicable. The authority having jurisdiction should be consulted in each case."

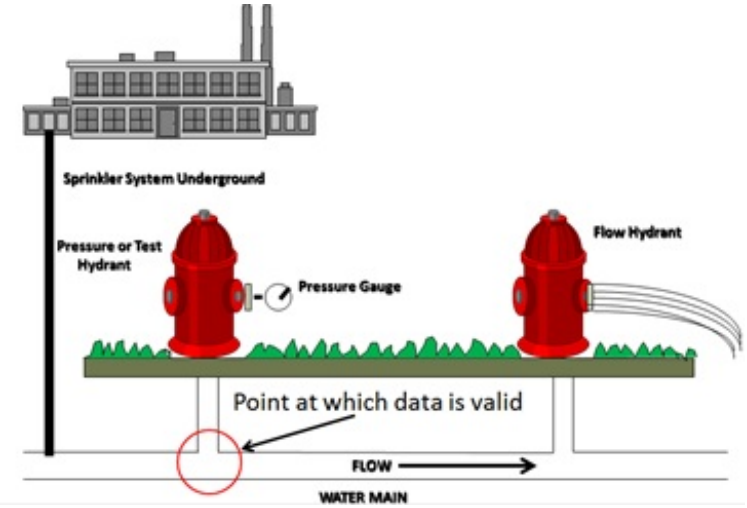
Question 6 - Effective Point of a Flow Test

A number of questions were asked regarding the effective point of a flow test for a water supply and how to carry the hydraulic calculations to this effective point. The process for determining the effective point is described in the responses to the following series of questions.

Question 6.1: Where is the effective point for a hydrant flow test?

Answer to Question 6.1: When you perform a water supply test, a minimum of two fire hydrants are needed on the same water supply. One hydrant gets designated as the "Gauge or Test Hydrant" and the other hydrant is designated as the "Flow Hydrant". While water is discharged from the "Flow Hydrant", residual pressure is measured at the "Gauge Hydrant". A data point is also taken while no water is flowing (called the "static pressure"). The results of the test are plotted on log 1.85 graph paper and are considered the "available water supply". It is important to know that the graph of the data is valid at the gauge hydrant as shown in the figure below and not the flow hydrant. The flow hydrant is just a convenient place to create flow in the water supply system. The location of

the Flow Hydrant must create flow downstream of the Gauge Hydrant. The following picture comes from the NFSA and shows the important information:



Section 23.4.1.6 of NFPA 13-2016 requires the hydraulic calculations to be carried to the "effective point of the water supply where the characteristics of the water supply are known." This is the point where the Gauge Hydrant connects to the water utility main.

Question 6.2: Can the hydraulic test node be placed at the connection of the sprinkler system underground to the water utility main?

Answer to Question 6.2: In general, this works well for most sprinkler systems. Technically, the hydraulic test node should be placed at the connection to the gauge hydrant, which should be somewhat close to the connection of the sprinkler system underground (lead in). The difference would be negligible as long as the water utility main is 4-inch pipe or larger. Typical sprinkler demands (not including hose streams) are 250 gpm or less. At 250 gpm, friction loss in 4-inch pipe is about 1 psi per 100 ft of pipe, so the smaller the sprinkler demand and the larger the water utility pipe, the less important it is to carry the sprinkler calculation to the Gauge Hydrant. If you want to be a purist, you should carry the hydraulic calculation to the point where the Gauge Hydrant connects to the water utility main.

Question 6.3: Is there a maximum distance away from the system connection where you should no longer place the test node at the system connection?

Answer to Question 6.3: There is no stated maximum distance in NFPA 13 for the location of the test node. Under most circumstances, you should be fine by ending your calculations at the connection of the underground sprinkler pipe to the water utility main as discussed in the answer to Question 1 above. However,

evaluation may be warranted if there is excessive distance between the gauge hydrant and the lead in for the sprinkler system.

Question 6.4: Should the hydraulic calculations be taken to the flow hydrant?

Answer to Question 6.4: No. The residual pressure is measured at the gauge hydrant, not the flow hydrant. The residual pressure is dependent on flow, but it does not matter where that flow is created as long as it is downstream of the gauge hydrant.

Question 6.5: How is the smaller size pipe between the water utility main and the fire hydrant accounted for?

Answer to Question 6.5: You don't need to. The pressure at the gauge hydrant is sensed through the small pipe, but there is no flow in that line, so you don't have to worry about pressure drop in that line.

Question 7 - Firestopping of Sprinkler Penetrations

Recessed pendent fire sprinklers are installed in a one-hour fire rated ceiling. Do the penetrations through the ceiling need to be sealed with fire stopping?

Answer: The answer depends on just what type of penetration is being created and the building code that applies to the construction. There are two types of penetrations:

1) Through Penetrations

2) Membrane Penetrations

Typically, a floor/ ceiling assembly has several elements necessary to achieve the fire resistance rating (an upper level deck that carries the floor load of the story above, a middle portion with structural elements to transfer the load, and a lower membrane that isolates the assembly). A "Through Penetration" goes all the way through the entire assembly from below the bottom membrane to above the top deck. A "Membrane Penetration" only goes through one piece of the assembly.

Most sprinkler installations only penetrate the bottom membrane of the floor/ceiling assembly, so they are a "Membrane Penetration." Most building codes specifically exempt Membrane Penetrations from being firestopped as long as the penetrating item is a fire sprinkler with a metallic escutcheon. Section 714.3.2(5) of the IBC specifically covers this situation. This is the building code most frequently used within the United States.

If, in the rare circumstance you are creating a Through Penetration with the sprinkler pipe, you would be required to provide some sort of protection of the penetration. Section 714.3.1 of the IBC provides some options for how to handle that situation with material other than caulk.

Question 8 - Friction Loss for Roll Grooved Pipe and Grooved Couplings

NFPA 13-2019 section 27.2.4.8.1(1) references "Pipe, fittings, and devices such as valves, meters, flow switches...". Do the words "pipe" and "fittings" mean that any friction losses created by rolled grooves themselves and/or grooved couplings need to be included in the hydraulic calculations?

Answer: No. Like flows through a tee on the run, while there is turbulence in the flow, the friction loss is negligible and can be disregarded in the hydraulic calculations."

If a product has a friction loss equivalent length significantly different than those shown in NFPA 13, it should be documented on the product's data sheet and that value should be used in the calculations.

Question 9 - Trapeze Assembly Run Through a Wall

Can a trapeze assembly run through a wall to get to a joist/beam that is on the other side of a full height wall?

Answer: There is nothing in the standard that prohibits this installation provided that the trapeze hanger is supported solely and independently by the structure. Trapeze hangers like other hangers are intended to be attached to the building structural members.
If the wall being penetrated has a required fire resistance rating, the penetration will need to be fire stopped to maintain the required fire resistance rating.

Question 10 - Is NFPA 13R an Option for Hotel with a Spa?

Is NFPA 13R appropriate for use in accessory occupancies, such as a spa (with locker rooms, treatment rooms, a waiting room with retail) located in a basement of a three-story R-1 occupancy (hotel)?

Answer: Using NFPA 13R for nonresidential accessory occupancies depends on the application of the rules of the standard and the rules for separated and nonseparated mixed occupancies in the International Building Code (IBC). For this instance, the 2018 IBC and 2016 NFPA 13R are referenced below:

1. Is the building residential?

a. Yes, a hotel is considered to be an R-1 (residential) occupancy and the IBC permits an NFPA 13R sprinkler system to protect through Section 903.3.1.2.

i. The spa is considered to be a B (business) occupancy and could be protected by an NFPA 13R system when located in a hotel but would be limited in size and may require fire rated separation.

2. Are there four or fewer stories?
   a. Yes, then NFPA 13R applies.
   b. No, then NFPA 13 applies.
3. How is NFPA 13R applied to the spa?
   a. The IBC identifies accessory uses (IBC Section 508.2.3) as occupying 10 percent of the floor area. An accessory use area is not required to have a fire-rated separation. If the spa exceeds 10 percent of the area it can be considered as a separate occupancy and not part of the residential occupancy. In these cases, use of NFPA 13R would not be applicable in the spa as discussed in items b and c below.

      i. It would be possible to protect the spa using NFPA 13R if the spa is less than 10 percent of the total basement floor area (the remaining 90% is residential). In this case, the spa would be considered as an accessory use to the otherwise predominantly residential occupancy. There is justification to use NFPA 13R because the ancillary use of the spa correlates to the residential use. NFPA 13R does have criteria to protect non-residential uses outside the dwelling unit rules (see Sections 6.2.2 and 7.2).

      ii. If the spa is over 10 percent, then the user goes to nonseparated and separated occupancies in the IBC (Sections 508.3 and 508.4) for applying NFPA 13 or NFPA 13R.

   b. If the nonseparated occupancies approach is used, then IBC Section 508.3.1 would apply NFPA 13 throughout, since NFPA 13R would not be applicable for protection of B occupancies.

   c. If the separated occupancies approach is used, then IBC Section 508.4 would allow NFPA 13R for the residential and NFPA 13 for the B occupancy.

This is a controversial and complicated issue that cannot be answered in a generic manner. It is recommended to discuss the design approaches with the architect, professional engineer and authority having jurisdiction.

Question 11 - Large Ceiling Fans

A project was identified that has large (14' diameter) ceiling fans installed in a light hazard occupancy. The fans are more than 50% open. Standard spray upright sprinklers are installed at a minimum of 6 ft. above the fan blades. How are these large fans treated in accordance with NFPA 13?

Answer: Since the fans have diameters greater than 60 in., air movement resulting from the operation of the fan is as important as consideration as an obstruction. Due to the size of the fan, this would either be considered an HVLS fan or outside the scope of NFPA 13. Determination would depend on the rotational speed of the fan as identified in the definition in NFPA 13-2016 section 3.3.14.

> ***3.3.14 High Volume Low Speed Fan****. A ceiling fan that is approximately 6 ft (1.8 m) to 24 ft (7.3 m) in diameter with a rotational speed of approximately 30 to 70 revolutions per minute.*

Protection criteria for HVLS fans is included in NFPA 13-2016 section 11.1.7. This criteria was developed based on a Fire Protection Research Foundation study. The rotational velocity of the HVLS fans are limited by definition. If the speed is between 30 and 70 rpm it would be considered to be an HVLS fan, if the speed is greater than this it would be outside of the scope of NFPA 13 and protection criteria should be sought from the fan manufacturer.

> ***11.1.7* High Volume Low Speed (HVLS) Fans****.*
> *The installation of HVLS fans in buildings equipped with sprinklers, including ESFR sprinklers, shall comply with the following:*
> *(1) The maximum fan diameter shall be 24 ft (7.3 m).*
> *(2) The HVLS fan shall be centered approximately between four adjacent sprinklers.*
> *(3) The vertical clearance from the HVLS fan to sprinkler deflector shall be a minimum of 3 ft (0.9 m).*
> *(4) All HVLS fans shall be interlocked to shut down immediately upon receiving a waterflow signal from the alarm system in accordance with the requirements of NFPA 72.*

Based on the description, the fan and sprinkler installation comply with conditions (1) and (3) of section 11.1.7. However, it must be verified that the fan(s) is(are) centered between four sprinklers, and that the fan(s) is(are) interlocked with fire alarm system to shut down upon a waterflow signal.

Question 12 - Sprinkler Piping in Concrete

A building owner's representative is asking for sprinkler bulk mains to be encased in concrete or sleeved and then encased in concrete. You have indicated that you did not see any limitations in NFPA 13 or the IFC but suggest possible accessibility and maintenance concerns. You also identified that there could be compatibility issues between the chemicals in concrete and black steel sprinkler piping that could cause corrosion as well. You have asked if pouring concrete around sprinkler piping is limited by any of the NFPA standards or model building codes.

Answer: The purpose of concrete encasement in this case is unclear but is not prohibited. Application is typically limited due to potential for corrosion and inability to access for repair, modification, or replacement. NFPA 13-2019 provides generalized minimum requirements and does not account for all scenarios. The basic requirements for the installation of piping, valves and appurtenances are provided in NFPA 13 section 16.1. You are correct in your concerns. Consideration should be given to operation as well as the ability to inspect, test and maintain the system. Consideration should also be given to compatibility of materials as well as corrosion. NFPA 13 section 16.4.2 provides requirements for protection of piping against corrosion but does not specifically address corrosion related to concrete encasement.

> ***16.1 Basic Requirements.***
> ***16.1.1**** *System valves and gauges shall be accessible for operation, inspection, tests, and maintenance.*
> ***16.1.2*** *Materials and components shall be installed in accordance with material compatibility information that is available as a part of a listing or manufacturer's published information.*
>
> ***16.4.2* Protection of Piping Against Corrosion.***
> ***16.4.2.1**** *Where corrosive conditions are known to exist due to moisture or fumes from corrosive chemicals or both, special types of fittings, pipes, and hangers that resist corrosion shall be used, or a protective coating shall be applied to all unprotected exposed surfaces of the sprinkler system.*
> ***16.4.2.2*** *Where water supplies or environmental conditions are known to have unusual corrosive properties, piping shall have a corrosion resistance ratio (CRR) of 1 or more, and the system shall be treated in accordance with 5.1.5.*
> ***16.4.2.3*** *Where corrosive conditions exist or piping is exposed to the weather, corrosion-resistant types of pipe, fittings, and hangers or protective corrosion-resistant coatings shall be used.*
> ***16.4.2.4*** *Where steel pipe is used underground,*

the pipe shall be protected against corrosion.

If steel pipe is installed, an exterior coating, wrap or means of protection against external corrosion should be provided. Encasement of steel in concrete can cause accelerated corrosion. This has been observed with rebar used in concrete assembles. Access points should be provided if all pipe is encased within the concrete to allow for inspection. Sleeving should be considered if thermal expansion is a factor since the expansion rates for steel and concrete will be different.