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

TechNotes

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Best of April 2017

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 March 2017. This information is being brought forward as the "Best of April 2017." 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 - Fire Resistance-Rated Concealed Space

A building is constructed with 1-hour fire resistance-rated walls and floor/ceiling assemblies of concrete-over-timber. A code review has identified the floor/ceiling assemblies as providing 1-hour fire resistance with the heavy timber exposed below. There will be a drop ceiling installed below the concrete-over-timber floor/ceiling assembly creating a combustible concealed space between the finish ceiling and structural ceiling. Does the fire resistance rating of the concrete-over-timber floor/ceiling assembly negate the need to provide sprinklers in the concealed space over the drop ceiling.

Answer: No, the requirement to provide sprinklers is not based on the ability of the floor/ceiling assembly overall to resist fire penetration but on the existence of exposed

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combustible construction in the concealed space". Unless one of the exceptions to NFPA 13 (2016) 8.15.1.1 can be met, sprinklers are required in this combustible concealed space.

> **8.15.1.1 Concealed Spaces Requiring Sprinkler Protection.** Concealed spaces of exposed combustible construction shall be protected by sprinklers except in concealed spaces where sprinklers are not required to be installed by 8.15.1.2.1 through 8.15.1.2.18 and 8.15.6.

Question 2 - Sprinklers as Membrane Penetrations

In regards to membrane penetrations, NFPA 221-2015 section 4.9.7.1(2) provides that no additional protection is required if annular space created by a fire sprinkler penetration is covered by a metal escutcheon plate.

> **NFPA 221-2015 - 4.9.1.7.1** The firestop system or device shall be tested in accordance with ASTM E84 or UL 1479 under a minimum positive pressure differential of 0.01 in water column (2.5 Pa) between the exposed and the unexposed surface of the test assembly, unless one of the following test criteria is met.
> ...
> **(2)**Annular space created by the membrane penetration of a fire sprinkler, provided that the space is covered by a metal escutcheon plate

There is also similar exceptions provided in the IBC-2015 and NFPA 13-2016

> **IBC- 2015 714.4.2, Exception 5**. The annular space created by the penetration of a fire sprinkler, provided it is covered by a metal escutcheon plate.
>
> **NFPA 13-2016 - 6.2.7.1** Plates, escutcheons, or other devices used to cover the annular space around a sprinkler shall be metallic or shall be listed for use around a sprinkler.

Is additional firestopping required in regards to a recessed or concealed sprinkler assembly per section 6.2.7.2 of NFPA 13?

Answer: No, the presence of a properly listed and installed metal escutcheon is all that is required to protect a membrane penetration. Note that 6.2.7.1 provides the option for escutcheons to be other than metal if they are

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listed for that use. Such escutcheons would be permissible for protecting membrane penetrations if their listing specifically included that allowance.

It should be noted that the use of fire caulk or similar firestop products in contact with the escutcheon is prohibited by both NFPA 13 and NFPA 25.

Question 3 - Long Trapeze Members Section Modulus

NFPA 13 (2010) table 9.1.1.6.1(a) only provides prescriptive section modulus data for trapeze members spanning up to 10 feet. For a trapeze member that spans 27 ½ feet, is it permissible to extrapolate section modulus from the values provided in the table.

Answer: No, not directly. Section 9.1.1.2 of NFPA 13-2010 requires that hangers not in compliance with the prescriptive requirements of Section 9.1 must be certified by a registered professional engineer". While it is possible that such an extrapolation would be part of an engineer's design, doing so without certification and the accompanying documentation would exceed the prescriptive scope of NFPA 13 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 (114 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 4 - PVC as Acceptable Underground Pipe Material

AWWA C900 pipe extends horizontally under a building foundation before transitioning to vertical ductile iron pipe at the 90 degree upwards elbow. Annex commentary NFPA 24 (2010) A.10.6.5 and note in Figure A.10.6.5 labels the horizontal pipe in this scenario only as "acceptable pipe material". Does AWWA C900 PVC pipe qualifies as "acceptable pipe material"?

Answer: AWWA C900 pipe is included in the list of acceptable pipe standards in Table 10.1.1". The annex diagram is labeled "acceptable pipe material" to indicate that any material complying with 10.1.1 is permissible in that example. As long as it is installed with regard to the other requirements regarding clearance and fittings, AWWA C900 pipe is acceptable in this application.

> **10.1.1* Listing.** Piping shall be listed for fire protection service or shall comply with the standards in Table 10.1.1.

Question 5 - Protecting Spray Paint Exhaust Piping

A project has paint spray booths on the first floor and exhaust discharge is through the roof of an eleven-story high rise building. Referring to NFPA 33-2011 as the appropriate referenced standard, where would you find the requirements regarding the vertical spacing of sprinklers in a vertical exhaust duct for a paint spray booth.

Answer: NFPA 33-2011 does not provide specific requirements for vertical spacing, but rather section 9.4.6 (1) provides a generic spacing of 12 feet for sprinklers in ducts. Clarification has been added to NFPA 33-2016, section 9.4.6 indicating that a sprinkler is to be installed at the top of each vertical riser and at the mid-point of each offset. Additional sprinklers are required to be installed at 24 feet on center if the rise is greater than 24 feet, as is the case for the eleven-story building. In order to use these requirements, you would likely need to discuss this with the AHJ and relate this to NFPA 33-2011, section 1.5 for equivalency.

As indicated, there are concerns regarding compliance with the routing of exhaust ducts in accordance with NFPA 33-2016, section 7.4

Question 6 - Fire Pump for NFPA 13D Application

A 10 hp, 6-inch high-capacity submersible well pump will be used to supply a NFPA 13D sprinkler system. The depth of the well is 450 feet. A manufacturer's pump curve and pre-calculated wellhead flow chart for the pump under consideration. The pump will also be controlled by a 40-60 psi flow switch. What manufacturer supplied flow values would be appropriate for use in a water supply calculations?

Answer: Based on the information provided, there are three basic options:

Option 1) Use the same calculation procedures that you would use with a fire pump.

This would require calculating the sprinkler system demand all the way back to the pump (including all elevation and friction losses) and determining the static and residual flows developed at the pump discharge. Based on the manufacturer's pump curve, the zero-flow static pressure would be 807 feet of head or 349.4 psi (807 ft x 0.433 psi/ft). Selecting a point from the pump curve near the end of the pump's "best efficiency range", a residual flow can be estimated as 58 gpm at 450 ft of head or 194.9 psi (450 ft x 0.433 psi/ft).

Option 2) Use a simplified calculation procedure based on the pre-calculated wellhead flow chart.

This would require calculating sprinkler system demand to the top of the wellhead. That system demand would then be compared to the appropriate chart values corrected for friction loss in the drop pipe. For example, assuming a system demand of 26 gpm at 45 psi and assuming a friction loss on the order of 3 psi for 450 feet of 2-inch drop pipe, the chart indicates that there should be at least 47 gpm available at the desired pressure (450 foot lift column; 10 hp / 50 psi row used for up to 47 gpm).

Below is an excerpt from the pump chart for the 10 hp pump at a depth of 450 feet:

20 psi @ 56 gpm
30 psi @ 52 gpm
40 psi @ 49 gpm
50 psi @ 47 gpm
60 psi @44 gpm

Option 3) Consult pump manufacturer for best fit compatibility.

This would require calculating sprinkler system demand to the top of the wellhead. Given the demand needed at the wellhead and the particulars of the well in question, a pump manufacturer can generally provide expert guidance on the best product to meet that demand.

Question 7 - Accelerator for Dry System Modification

There is an existing dry pipe sprinkler system which has a capacity of 1068 gallons. An addition is proposed to provided an addition of 187 gallons of piping to this system, for a total of 1255 gallons on the system. Would this trigger the requirement for an accelerator?

Answer: No, you are not required to install an accelerator

on a system, provided you can meet the water delivery times required by NFPA 13-2016 (or the edition adopted in your jurisdiction). There is no requirement in NFPA 13 to require a quick opening device (accelerator) for any circumstance but rather they are permitted to be installed on dry pipe systems where otherwise a water delivery time could not be met. Accelerators improve water delivery time by hastening the operation of the dry pipe valve.

If after providing this additional piping to the system, the water delivery times can not meet those outlined in section 7.2.3 of NFPA 13, then installing an accelerator would likely solve this problem.

Question 8 - Dual Feed of Sprinkler System from Standpipes

A project specifications require that each floor sprinkler system must be supplied from the standpipes in both stairwells. There is concern for both the potential for service issues due to the dual feed and for potential problems with the main drain test. How should the main drain test be performed on a floor sprinkler system supplied by redundant connections from two combination risers.

Answer: In order to fully evaluate both water supply sources independently, two main drain tests could be conducted; one supplied from each standpipe riser. Strictly speaking, it would be permissible to conduct a single main drain test. Any significant supply restriction in either standpipe should show itself as reduced residual riser pressure during the main drain test. Any deficiencies in the riser system should be detected during periodic standpipe system tests. However, if the connection to multiple standpipes is intended to provide water supply redundancy, it would be reasonable to perform main drain tests from each standpipe in turn allowing an evaluation of each water supply riser individually. Redundant testing methods and results would need to be documented as a reference baseline for future periodic testing.

It should be noted that 6.6.4.3.1 addresses additional signage required where closing more than one control valve is necessary to service a sprinkler system.

> **6.6.4.3.1*** Systems that have more than one control valve that must be closed to work on a system or space shall have a sign referring to existence and location of other valves.
>
> **A.6.6.4.3.1** Care should be taken to ensure that all water supplies are isolated before work begins. Work

on systems by shutting one valve and not knowing about another valve could result in unexpected water discharge.

The assumption has been made in this response that the intent is to cross connect the standpipe risers to supply a single floor control assembly as opposed to providing complete floor control assemblies at each standpipe to supply a shared network of sprinkler pipe. Such a configuration would not be prohibited but it would provide additional challenges in both design and testing.

Question 9 - Replacing Sprinklers

A situation arose at a Health Care facility where there are sprinklers requiring replacement. The existing sprinklers having a K-factor of 3.0 are no longer available. The closest option identified is a sprinkler with a K-factor of 4.3. Does NFPA 13 address replacement of sprinklers that are no longer available?

Answer: This depends on the type of sprinklers in question. Based on the K-factors not appearing in NFPA 13 (2016) Table 6.2.3.1, it is assumed that the sprinklers in question are residential sprinklers as per 6.2.3.4. 11.3.1.4 does provide some options where the issue is discharge criteria but it still requires a comparable K-factor for replacement sprinklers. Given that there are residential sprinklers available on the market with a K-factor of 3.0 from at least two manufacturers, finding a replacement sprinkler with the same K-factor and an appropriate listed coverage area would appear to be a preferable option to switching to a sprinkler with a K-factor of 4.3 without conducting new hydraulic calculations. Given the nature of the occupancy, it would be especially important to clear any substitutions with the AHJ.

> **6.2.3.4 Residential Sprinklers.** Residential sprinklers shall be permitted with K-factors other than those specified in Table 6.2.3.1.
>
> **11.3.1.4** For modifications or additions to existing systems equipped with residential sprinklers, the listed discharge criteria less than 0.1 gpm/ft2 (4.1 mm/min) shall be permitted to be used.
>
> **11.3.1.4.1** Where replacing residential sprinklers manufactured prior to 2003 that are no longer available from the manufacturer and that are installed using a design density less than 0.05 gpm/ft2 (2.04 mm/min), a residential sprinkler with an equivalent K-factor (± 5 percent) shall be permitted to be used provided the currently listed coverage area for the replacement sprinkler is not exceeded.

Question 10 - Cloud Ceiling Arrangement - Varying Height

A project is proposed where there is a cloud ceiling arrangement of varying size clouds at varying elevation. This cloud ceiling arrangement has clouds at 9 foot A.F.F. of uniform size (under 4 feet wide) at a uniform spacing in the center of a large room and then also two different groups of clouds of varying shapes (over 4 feet wide) and spacing at 9 foot 6 inch A.F.F. elevation around the edges of this large room. The ceiling is 12 foot A.F.F.The building owner has also indicated that you are unable to penetrate the clouds on this project. What approach could be taken to protect his arrangement?

Answer: NFPA 13-2016 is the first edition to provide prescriptive requirements to protect cloud ceiling configurations. This criteria is based on the Fire Protection Research Foundations project in which you can provide sprinklers below cloud panels where there is no more than 20% openings to the ceiling above, and when you follow the criteria outlined in section 8.15.24. Unfortunately, this requires the cloud ceiling to be in a single plane throughout the compartment and limits the size of the gaps based on the height of the ceiling. Since you have varying shapes/elevations, you would then not be able to apply the criteria.

Since there are no specific criteria for protecting this cloud ceiling arrangement, you would be required to treat each panel as an obstruction. As you had noted that the ceiling is at a 12 foot elevation A.F.F., the applicable obstruction criteria would only be for obstruction preventing discharge from reaching hazard below. This requires you to install a sprinkler below each obstruction where the width is greater than 4 feet. Based on the drawing, you the two sets of cloud panels on either edge of the room would then require a sprinkler below each obstruction. NFPA 13-2016 has provided additional guidance when it comes to installing sprinklers below these types of obstructions. Sprinklers are required to be upright or pendent, and installed directly underneath the obstruction up to 3 inches from the outside edge. The sprinkler below obstructions are also required to be of a similar type (Standard spray, ESFR, CMSA, or Residential) as the ceiling sprinklers.

Per the letter of the standard, there would not be sprinklers required below the 3.5 foot x 3.5 foot obstructions, since they are greater than 18 inches from the ceiling sprinklers and not greater than 4 feet wide. However, section 8.1.1(3) does specify "Sprinklers shall be positioned and located so as to provide satisfactory performance to activation time

and distribution" and is important to consider when laying out a fire sprinkler system. While the standard does not specifically require sprinklers to be below an individual 3.5 foot x 3.5 foot square panel, the presence of multiple panels in a cloud ceiling configuration would likely affect the performance of the ceiling sprinklers by preventing discharge from reaching the hazard below. Therefore some consideration should be taken into providing sufficient coverage for the area below this portion of the cloud ceiling arrangement. One option would be to provide some lay-in between a group of these panels, effectively making them a larger single obstruction and then providing a sprinkler below this adjusted obstruction.

Question 11 - Attics with Combustible Roof Sheathing

You have asked if the attic space (beneath a roof and above a ceiling) in a building having steel structural members with ¾" conventional, non-fire retardant, plywood would be considered a combustible, non-combustible, or limited combustible concealed space. You have indicated that plywood sheathing is used for approximately 6,050 ft² while the remaining portion of the 13,850 ft² building is constructed using steel trusses and metal roof decking with TPO roof membrane. You have also indicated that the intent to install CPVC pipe in this space.

Answer: The answer to your question is that the portion of the building using untreated plywood would be considered to have a combustible concealed space. The wood sheathing is considered to be part of the building structure and as a result must be considered with respect to providing sprinklers. Use of CPVC pipe would be limited to conditions identified on CPVC pipe manufacturer's product data and installation sheets. In addition, use of sprinklers specifically listed for use in concealed spaces with CPVC pipe would also be necessary.

Question 12 - Adjacent Hazards Design Area

Two different approaches have been proposed for a project involving a primarily light hazard (LH) building containing a loading dock and storage room having an area of approximately 600 sq. ft., which is ordinary hazard (OH). The first approach was to make the remote area the size of the OH area which was about 600 sq ft. The other approach was to extend the remote area into the surrounding light hazard areas to meet the 1,500 sq. ft. requirement. Use of the room design method would not be permitted since the room does not have rated walls or automatic closing doors. The ceiling height is greater than 20 ft. so a design area reduction based on the use of quick

response sprinklers would not be permitted. It was also noted that sprinkler operating pressures in the combined hazard approach have been set to provide a density of 0.15 gpm/sq.ft. in the OH areas and 0.1 gpm/sq.ft. in the LH areas. What is the appropriate approach to setting the design area?

Answer: The approach using a remote area of 600 sq. ft. is not acceptable unless done in accordance with NFPA 13-2016 sections 23.4.4.2.4 and 23.4.4.2.5.

Section 23.4.4.2.4 states "Where the available floor area for a specific area/density design criteria, including any extension of area as required by 11.1.2 and Section 12.3, is less than the required minimum design area, the design area shall be permitted to only include those sprinklers within the available design area."

Section 23.4.4.2.5 states " Where the total design discharge from these operating sprinklers is less than the minimum required discharge determined by multiplying the required design density times the required minimum design area, an additional flow shall be added at the point of connection of the branch line to the cross main furthest from the source to increase the overall demand, not including hose stream allowance, to the minimum required discharge."

Use of this method would require the addition of a "phantom flow" of 135 gpm (900 sq.ft. x 0.15 gpm/sq.ft.) at the point of connection of the branch line to the cross main furthest from the source based on the requirements of sections 23.4.4.2.4 and 23.4.4.2.5.

The second method using additional area from the light hazard occupancy areas would be permitted and would not require further adjustment.