NFSA TechNotes
The Voice of the Fire Sprinkler Industry

Editor-Kenneth E. Isman, P.E. Issue# 266 May 14, 2013

Best of April 2013

This month, we have selected the following dozen questions as the “Best of April 2013” answered by the engineering staff as part of the NFSA’s EOD member assistance program.

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. These have not been processed as a formal interpretation in accordance with the NFPA Regulations Governing Committee Projects and should therefore not be considered, nor relied upon, as the official position of the NFPA or its Committees.

Question 1 – Sprinklers in a Paint Spray Booth Duct

We are providing sprinklers for a paint spray booth and duct in accordance with NFPA 33. The sprinkler requirements for the duct in NFPA 33, which are repeated in NFPA 13 (section 22.4.2.1) and NFPA 1 (section 43.1.7.4.6), call for sprinklers to be installed with a maximum of 12 ft between sprinklers. Does this mean that the first sprinkler in the duct can be 12 ft from the spray booth, or is this distance limited to 6 ft (half the allowable distance between sprinklers)? Also, if the duct is at an angle, is this distance measured vertically or along the path of travel of the duct?

Answer: Whenever a maximum distance between sprinklers is given, the distance from the sprinkler to where it begins its protection should not exceed one-half of that maximum allowable distance. This is the essence of section 8.5.3.2.1 of NFPA 13. In your case, this means that the first sprinkler in the duct should not be more than 6 ft from the paint spray booth. The dimension needs to be measured in the path of travel of the duct, not vertically.

Question 2 – Trapeze Section Modulus Calculation

We have a situation where we need to install a trapeze hanger to support steel pipe in a building where the structural members are more than 16 ft apart. How can we calculate the section modulus since the tables in Chapter 9 of NFPA 13 only go up to a 16 ft span?

Answer: Victoria Valentine, NFSA's expert in the hanging and bracing of fire sprinkler systems, developed the following procedure that led to the section modulus tables in NFPA 13. The assumption in these formulas is that the trapeze member is made up of a single piece of steel (not short lengths of pipe cobbled together with fittings). The same process can be used to determine the section modulus for other situations where trapeze hangers made up of single pieces of steel are being used to support steel pipe:

1) Determine the load "P" that the hanger will need to support in pounds. This is the weight of the water-filled pipe plus 250 lbs. The easiest way to get this number is to use Table A.9.3.5.9 from NFPA 13 and multiple the value from this table by the distance between hangers along the pipe, then add 250 lbs.

2) Calculate the Maximum Moment "MM" by taking the load "P" from step 1, multiplying by the length of the trapeze "L" in inches and dividing by 4 (a safety factor for design). Be careful with the units! The length of the trapeze (also the span between the structural members supporting the trapeze) needs to be in inches for this formula to work.

3) The Section Modulus "Z" can be calculated by dividing the MM from step 2 by the maximum allowable stress in the steel, which is 15,000 psi (a number agreed upon by the sprinkler committee as conservative for the steel in sprinkler pipe and reasonable to use to standardize the approach to calculations). This will give you the Section Modulus for any steel pipe support situation.

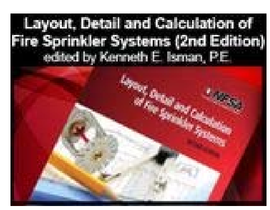
For example, if a 4-inch schedule 40 main was going to be supported by a trapeze member that spanned 18 ft between structural members with 15 ft between hangers, the section modulus calculation would look like this:

1) P = (15 x 16.4) + 250 = 496 lbs

2) MM = PL/4 = 496 x 18 x 12/4 = 26,784 inch-pounds

3) Z = MM/15,000 = 26,784/15,000 = 1.79

In this case, you would not be allowed to use 3-inch schedule 40 pipe to make the trapeze member, but you would be allowed to use 3½-inch (if you could find any) or 4-inch pipe as long as you could find a piece just over 18 ft long (needs to be slightly longer than the span so that hangers can be attached at both ends).



Question 3 – Big Orifice Sprinklers with ½-inch Threads

Section 8.3.5 of NFPA 13 appears to contradict Table 6.2.3.1. The table appears to allow sprinklers with k-factors of 8.0 and 11.2 to be manufactured with ½-inch threads, yet section 8.3.5 appears to prohibit their use. Can you please explain?

Answer: It is important with codes and standards to read all the way to the end of the sentence. Section 8.3.5 prohibits the ½-inch thread from being used on sprinklers with a k-factor larger than 5.6 "in new sprinkler systems".

These sprinklers are allowed to be used in existing sprinkler systems, which is why they are in the table. They are specifically manufactured so that a building owner can increase the flow from an existing sprinkler system in situations where they have something more hazardous in the building than when the system was originally designed. An old system with ½ inch outlets is extremely difficult to re-vamp if you have to remove all of the ½ inch tees and replace them with tees having ¾ inch outlets. So, manufacturers make sprinklers with a k-factor of 8.0 and a k-factor of 11.2 with ½ inch threads. In order to do this, the wall of the sprinkler orifice is thinner, so we only want people using these sprinklers in revamping existing systems. For new systems, they should install tees with ¾ inch outlets for sprinklers having k-factors of 8.0 and 11.2.

Question 4 – Storage Above Doors

In a warehouse we are protecting, the owner plans to use the space above the doors for additional storage, including idle pallets. Normally, idle pallet storage is limited to 8 ft above the floor when the density is 0.45 gpm per sq ft [see Table 12.12.1.2(a)], but our doors are higher than that. Will this owner be allowed to store idle pallets above the doors?

Answer: Yes. The last sentence of section 12.1.3.3 allows the height of storage above doors to be calculated from the base of the storage, not the actual floor. So, if the storage above the doors started 12 ft above the floor, the 8 ft high storage of idle pallets would be 20 ft above the floor and would still be permitted to be protected with a 0.45 density.

Question 5 – Check Valve in Discharge from Suction Tank

Is a suction tank feeding only water to a fire pump required to have a check valve in the discharge of the tank? We note that Figure A.6.3.1(a) in NFPA 20 shows a suction tank and pump with all of the appurtenances and that there is no check valve shown in the tank discharge. If a check valve is required, why is it required from a technical standpoint?

Answer: The first part of Section 14.2.11 in NFPA 22 requires a check valve in the discharge of the tank and it applies to all tanks regardless of the purpose of the tank. In your case, the discharge pipe of the tank becomes the suction piping for the pump and requires a check valve. The Figure in NFPA 20 is interesting, but it does not show the check valve because that is outside the jurisdiction of NFPA 20. The Figure in NFPA 20 is just showing the equipment required by NFPA 20. The check valve is required for two technical reasons:

1. From a philosophical standpoint, we always protect the water supply with a check valve. The tank is your water supply in this case.

2. If pressure gets into an atmospheric tank, it turns the tank into a pressure tank. The construction of an atmospheric tank is not designed to handle additional water pressure. Any pressure getting into the tank risks causing the tank to explode and cause serious injury, not to mention taking the fire protection system out of service. Any fire pump situation, especially one with multiple pumps, can't anticipate every possible combination of events that might occur. When one pump is running, the check valve on the other might not close completely, allowing the pressure to get back to the tank. Another possibility is that the fire department might pump into the FDC, which should be

connected to the discharge pipe, but again, the failure of the discharge check could cause a problem at the tank. The check valve at the tank is an extra level of protection.

Question 6 – Draft Stops and Closely Spaced Sprinklers with NFPA 13R

We are protecting a building in accordance with NFPA 13R. In the areas outside of the dwelling unit, we are using quick response sprinklers. In one portion of the lobby, there is an opening between the first and second floor with an open staircase. The quick response sprinklers in the ceiling of this area protect part of the first floor 16 ft below using a density/area design of 0.1 gpm per sq ft over 1035 sq ft. The AHJ is insisting on draft stops and closely spaced sprinklers 6 feet apart around the stairwell and opening between the floors. How do we perform the hydraulic calculations and are we required to balance the closely spaced sprinkler demand to the ceiling sprinklers?

Answer: Perform the hydraulic calculations for the ceiling sprinklers and the closely spaced sprinklers and add them together after balancing the lower pressure demand to the higher pressure. There is no way to tell from the information here whether the ceiling sprinklers or the closely spaced sprinklers around the opening will have a higher pressure demand. But whichever one is lower needs to be adjusted to the higher pressure demand and then the flow demands need to be added.

The calculation of the ceiling sprinkler demand is fairly straightforward with a 0.1 gpm per sq ft minimum density and an area of at least 1035 sq ft. If the sprinklers are k-5.6 and spaced at 225 sq ft per sprinkler, they will need to discharge at least 22.5 gpm at 16.1 psi to achieve their minimum density of 0.1.

The demand of the closely spaced sprinklers is a bit more difficult to calculate. Even though this is an NFPA 13R system, the rules for this calculation come from NFPA 13 section 11.3.3. The number of sprinklers in the design area for the closely spaced sprinklers will be the number in the length 1.2 times the square root of the design area. In this case, that would be 7 sprinklers around the perimeter of the opening (1.2 times the square root of 1035 is 38.6, divided by 6 ft between sprinklers gives us 6.4 sprinklers which needs to be rounded up to 7). These 7 sprinklers need to discharge at least 18 gpm (3 gpm per lineal foot, and each one covers 6 lineal feet). If the sprinklers are k-5.6, they will need a minimum pressure of 10.3 psi to achieve this discharge.

Let us say for the sake of this example that we have calculated the ceiling sprinkler demand of five sprinklers to achieve the 1035 sq ft design area and that this demand is 120 gpm at 22 psi at the point of connection to the piping feeding the closely spaced sprinklers. Let us say for the sake of this example that we have calculated the 7 closely spaced sprinklers as needing 140 gpm at 18 psi.

At this point where the piping systems connect, we have to balance the closely spaced sprinkler demand up to the pressure of the ceiling sprinkler demand and then add the flows. To do this by hand, we need a k-factor for the closely spaced sprinkler demand, which is found by dividing the flow by the square root of the pressure. In this case, that is 33.00 (140 divided by the square root of 18 is 33.00). Then use this k-factor at the higher pressure demand for the ceiling sprinklers (22 psi) to determine the flow to the closely spaced sprinklers at 22 psi using the formula "Q equals K times the square root of P". That gets us a flow of 155 gpm (33 times the square root of 22 is 155). We then have our total demand for all 12 sprinklers as 275 gpm at 22 psi by adding the 155 gpm needed for the closely spaced sprinklers to the 120 needed for the ceiling sprinklers.

Question 7 – Obstruction to EC Sidewall Sprinklers Above the Deflector

We are installing sidewall extended coverage sprinklers 12 inches down from the ceiling (they are listed for this distance). Five feet in front of the sprinklers is a beam that cuts completely across the room that comes down only 10 inches from the ceiling. Is this acceptable since the beam is above the deflector of the sprinklers?

Answer: No. Section 8.9.5.1.3 (and its associated figure and table) do not allow any obstructions within 8 ft of the sidewall sprinkler deflector, even if those obstructions are above the deflector of the sprinkler. The water leaving a sidewall sprinkler goes up before it comes back down and the sprinkler needs room to develop this spray pattern. In theory, there are some small obstructions that could be permitted where you are as far as 12 inches down from the ceiling. Section 8.9.4.1.1.1 says that the minimum distance the sprinkler needs to be from the ceiling is 4 inches. As long as the special listing for this sprinkler does not have any other minimum distance, it would appear that the sprinkler needs 4 inches of space to lob the water across the room. This would permit an obstruction to be 8 inches down from the ceiling with the sprinkler 12 inches down as an equivalency to section 8.9.4.1.1.1.

Question 8 – Pressure Change due to Temperature Change During Air Test

During the 24-hour air test on a dry-pipe system (starting at 40 psi per the acceptance testing criteria of NFPA 13), a dramatic temperature change occurred (75°F down to 45°F). Is there a formula we can use to calculate what the loss in pressure was due to the change in temperature?

Answer: Yes. The formula is $P2 = P1(T2/T1)$. In using the formula, you need to be careful with the units. The units of pressure are pounds per square inch absolute (psia) and the units of temperature are absolute as well (degrees Rankin works best in our system of units). To convert from gage pressure to absolute pressure, add 14.7. To convert from degrees F to degrees R, we add 460. So, 75°F is 535°R and 45°F is 505°R and 40 psi gage pressure is 54.7 psia. This means that the pressure after the due in temperature would be:

$P2 = 54.7(505/535) = 51.6$ psia

A pressure of 51.6 psia is equal to a gage pressure of 36.9 psi. So, during the test, if the gage pressure on the system dropped from 40 psi to 36.9 psi when the temperature dropped from 75 to 45 degrees, the system did not lose any pressure due to leakage. NFPA 13 allows the user to take this into account because the air pressure test specifically says that air pressure loss due to leakage is the concern, not air pressure loss in general.

Question 9 – In-Rack Sprinkler Selection

Are in-rack sprinklers required to be standard response or are they allowed to be quick response?

Answer: It does not matter. Section 8.13.2.1 of NFPA 13 specifies that either standard or quick response sprinklers can be used for in-rack sprinklers.

Question 10 – Garage Doors as Obstructions under NFPA 13

Are we permitted to omit sprinklers from being installed underneath overhead garage doors in NFPA 13? We note that NFPA 13R allows this practice.

Answer: No. NFPA 13 has a different level of protection in mind than NFPA 13R. NFPA 13 treats garage doors as obstructions and sprinklers are required beneath the doors. Section 8.4.2(3) allows sidewall sprinklers to be used for this purpose even if the area under the doors is not light or ordinary hazard.

Question 11 – Seismic Separations Versus Expansion Joints

What is the difference was between a seismic separation and an expansion joint?

Answer: In building terms, a seismic separation is a break in between two sections of a building that allows those two sections of the building to move completely independently of each other in the event of an earthquake. The two building sections must be able to move in three dimensions: up and down, side to side, and closer and further from each other independently. Any mechanical systems, such as sprinkler systems, that pass over this separation are required to do the same. In these situations it is necessary to use a seismic separation assembly as defined by NFPA 13, 2013 Edition, Section 3.11.10 (similar sections in previous editions).

An expansion joint is a break in the building that allows the building to expand and contract due to changes in temperature. These joints only allow movement of the two sections of the building to go closer and further from each other. Once again the mechanical systems going through these sections of the building must be designed to do this as well. However the couplings required to do this are much simpler as there is only two directions of movement.

Question 12 – Manual Standpipe System Testing

Under the 2011 edition of NFPA 25, automatic standpipe systems are required to be full flow tested every 5 years. But what about manual systems? Are they required to be full flow tested?

Answer: At this point in time, section 6.3.1 of NFPA 25 is limited to automatic standpipe systems. Manual-wet systems and manual-dry systems are not required to be flow tested. However, the NFPA is currently working on a new edition of NFPA 25 and tentative approval has been given to removing the word "automatic" in this section so that every standpipe system has to be flow tested every 5 years. Since manual systems do not have a sufficient water supply for such a test, this would mean that the contractor would have to bring a sufficiently sized pump and connect it to an adequate water supply to run the test. This change has not yet been finalized, but the NFSA will keep its

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