NFSA The Voice of the Fire Sprinkler Industry

TechNotes

Editor-Kenneth E. Isman, P.E. Issue# 293 May 6, 2014

Best of April 2014

This month, we have selected the following baker's dozen (13) questions as the "Best of April 2014" answered by the engineering staff as part of the NFSA's EOD member assistance program. If you have a question (and you're a member of the NFSA), you can send your question to eod@nfsa.org and we'll answer it as soon as we can.

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 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 – Hydraulic Calculations for Sprinklers Under Obstructions

We have a situation where we have sprinklers at the ceiling and obstructions more than 4 ft wide, so we are putting sprinklers under the obstructions. How do we handle the hydraulic calculations? Do we include all of the sprinklers in 1500 sq ft including the sprinklers at the ceiling and the sprinklers under the obstructions?

Answer: No. You only need to calculate the sprinklers at one level, the sprinklers at the ceiling or under the obstructions, whichever are most demanding. Section 23.4.4.6.3 (and its two subsections) cover this subject (similar sections in previous editions). Typically, the sprinkler system at the ceiling will be the most demanding. However, the sprinklers under the obstruction might be more demanding if a small diameter pipe is used to feed many sprinklers. In the 2013 edition of NFPA 13, the committee has expressly stated that sprinklers under obstructions are assumed to be less demanding as long as the same pipe sizes and lengths are used under the obstructions as at the ceiling (23.4.4.6.3.2).

Question 2 – ESFR Sprinkler System Design Area

In older editions of NFPA 13, ESFR sprinklers had a minimum design area of 12 sprinklers, but also 960 sq ft. So, if sprinklers were installed at their minimum spacing, there may have been more than 12 sprinklers in the design area. We have a situation where we are installing ESFR sprinklers at 64 sq ft spacing in one portion of the building in accordance with the 2013 edition of the standard, do we need to calculate the system with 15 sprinklers (960/64=15)?

Answer: No. There was a minimum design area in NFPA 13 for ESFR sprinklers up to the 2007 edition. When preparing the 2010 edition, the committee eliminated the minimum area requirement with the following

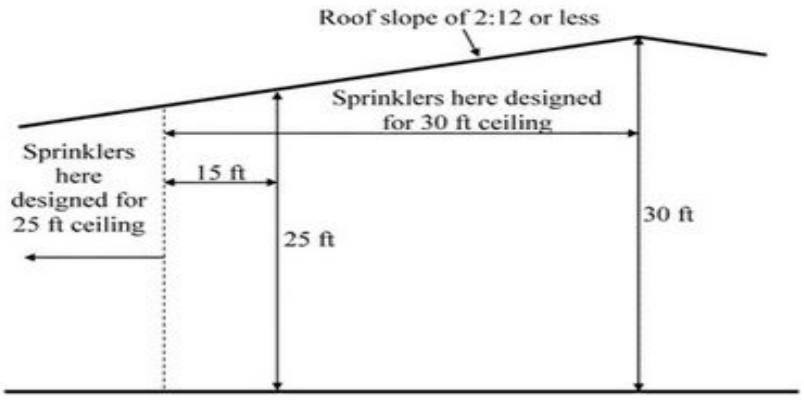
statement:

Analysis from Factory Mutual has determined that the 960 sq ft design area is not necessary as long as the minimum spacing rules are followed.

Question 3 – Protecting Storage at Different Ceiling Elevations

We have a situation with a storage occupancy and a sloped ceiling (the slope is less than 2 in 12, so we can use NFPA 13) where the height of the building at the peak is 30 ft. We'll use sprinklers at the peak that can protect storage at that building height, but further down the slope, can we switch to the sprinklers that can handle the lower ceiling height like 25 ft?

Answer: Yes, but if there is no vertical barrier to the hot gasses from a fire under the higher ceiling area, you have to use the sprinklers for the higher area at least 15 ft horizontally beyond the point where the roof comes down to 25 ft above the floor in order to meet section 12.3. The following figure might be helpful to summarize the rules.



Question 4 – Dry System Protecting Rack Storage

For a dry-pipe or preaction system protecting rack storage with control mode density area protection at the ceiling and in-rack sprinklers, does the increase in the design area apply to the ceiling sprinklers only or do we need to increase the in-rack sprinkler protection area as well?

Answer: The increase in the design area only applies to the ceiling sprinklers. No increase is required for the in-rack sprinklers.

Question 5 – Remote Area Shape with QREC Sprinklers

In a situation where quick response extended coverage sprinklers are used and the design area is reduced to 900 sq ft, we have less than five sprinklers in the design area. Once we increase the design area to five sprinklers, which area do we use to determine the number of sprinklers on the branch line to calculate? Should we use 900 sq ft or the area covered by five sprinklers in the formula "1.2 times the square root of the design area"?

Answer: Once you increase the design area to five sprinklers, this becomes your design area to plug into the formula 1.2 times the square root of the design area. So, for example, if your sprinklers are being used at an 18 ft x 18 ft spacing, five of them would cover 1620 sq ft (5 x 18 x 18 = 1620). Your design area would need to be at least 48.3 ft in the direction parallel to the branch lines. This would include three sprinklers along the branch line (and the rest of the design area would be another 2 sprinklers

on the next branch line).

You can't use 900 sq ft in the formula 1.2 times the square root of the design area because that is not your final design area. The formula can only be used after all adjustments are complete. The increase of the design area to five sprinklers is one of the adjustments that needs to be made prior to determining the length of the design area parallel to the branch line.

Question 6 – Ammonium Nitrate Protection

Given recent explosions involving ammonium nitrate, we have been asked to design a sprinkler system for a facility that has this material. Would a deluge system be recommended?

Answer: The answer to this question is complicated. There is no single source to go to for sprinkler system discharge criteria for this kind of hazard. The following resources might be helpful:

http://www.epa.gov/emergencies/docs/chem/AN_advisory.pdf

http://www.ime.org/userfiles/files/AN%20Guidelines_IAFC-IME-NSSGA(FINAL)(1).pdf

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9755

To answer a question like this, a responsible design professional needs to determine some basic performance goals and objectives. Is the goal going to be to assure life safety in the room that the ammonium nitrate is being stored in if combustion occurs? Is the goal going to be to prevent an explosion? Is the goal going to be to allow combustion of the product as long as it does not get beyond the building of origin? Once a design professional who understands ammonium nitrate's combustion properties answers these questions, they can begin answering the questions as to which type of system to install and what the discharge criteria might be to achieve the stated goals and objectives.

Ammonium Nitrate is a special problem requiring special care. While NFPA 400 indicates that it can be protected as a Class I, Class II or Class III commodity (depending on the packaging), it is a hazardous material and some coordination between the sprinkler system and other building systems would be advisable. For example, NFPA 400 calls for a containment area around ammonium nitrate storage to contain spills. If a sprinkler system is installed, the containment area would need to be expanded to accommodate the volume of water that might discharge which could be quite large with a deluge system.

Question 7 – Measuring Sprinkler Spacing in an Attic

When we lay out a sprinkler line in a roof truss for an attic system, where do we measure our furthest dimension from? Do we measure from the very outmost point of the eave (which in our case is outside the perimeter of the building wall) or is it from the interior wall intersection or some other point?

Answer: Assuming that the attic meets the criteria for section 8.6.4.1.4, the answer is in section 8.6.4.1.4.3 (and is shown in Figure 8.6.4.1.4). The measurement begins at the point where the intersection of the trusses occurs. The way that we like to remember this is to say that the measurement starts where the bottom of the top chord of the truss meets the top of the bottom chord of the truss.

In the Figure in NFPA 13, the intersection of the chords of the truss occurs

just inside the vertical line of the wall and other lumber is used to make the eaves. But in your situation, the intersection occurs farther outside the vertical line of the wall and the bottom chord of the truss forms the eaves. Therefore, for your situation, you have to measure out to the intersection of the truss chords, which will take you outside the vertical line of the walls. This is the area the sprinkler is intended to protect, so this is where you need to start the measurement.

Note that section 8.6.4.1.4.3 and Figure 8.6.4.1.4 only apply to certain concealed spaces (those with members less than 3 ft on center and a slope greater than 4 in 12). For other concealed spaces, the answer to your question would be different. For example, if you had a concealed space made of double joist construction and a slope less than 4 in 12, Figure 8.6.4.1.5.1 shows that the sprinkler distance measurement starts at the location where there is 6 inches of vertical clear space between the bottom of the top joist and the top of the bottom joist. This would be well inside the vertical line of the walls.

Question 8 – Exposed CPVC Pipe in Ordinary Hazard

We are using CPVC pipe in a very small mechanical room (ordinary hazard) in accordance section 6.3.7.6 of NFPA 13. Is the pipe permitted to be exposed?

Answer: Yes, as long as the exposed rules of the CPVC listing is followed. Many of the manufacturers of CPVC pipe have exposed listings for their pipe that limit the pipe to horizontal runs of pipe connecting quick response sprinklers that need to be closer to the ceiling than the 12 inch limit allowed by NFPA 13. So, make sure you follow any special requirements of the exposed listing.

Question 9 – Sway Brace Tables

What do the numbers mean at the top of Table 9.3.5.5.2(a)?

Answer: These numbers represent the maximum spacing (in feet) of lateral sway bracing based on the maximum horizontal force (F_{pw}) in the zone of influence (ZOI) on a specific size of pipe. Lateral sway bracing has a maximum spacing of 40 feet along mains (or any pipe over 2-1/2 inches), but this maximum spacing is reduced (to 20, 25, 30, or 35 feet) where high lateral forces or heavy branch lines are present.

Question 10 – Break Tank Auto Fill Lines

Regarding break tanks, NFPA 22, section 14.5.3.1.1 states, “Dual automatic refill lines, each capable of refilling the tank at a minimum rate of 150 percent of the fire pump(s) capacity, shall be installed.” Please clarify the piping arrangement required to meet the intent of this section. Assume the break tank is installed inside a building that is not a high-rise. Do we need to install two independent underground water source supplies coming to the tank, each with its own refill piping? Or is a single underground supply source acceptable to supply the break tank, with a split aboveground feeding two automatic refill pipe arrangements?

Answer: One line from the city main with two separate refill mechanisms would meet the requirements of this section. The concern with this section is with the refill mechanism itself and not the number of water lines.

A break tank with its refill capabilities is in essence taking the place of a single supply line feeding a fire pump. This single line is thought of as

View older issues in the "Members Only" section.

Upcoming In-Class Seminars

May 6 Colorado Sprgs, CO
Intro to Sprinklers, Standpipes & Fire Pumps

May 7 Colorado Sprgs, CO
Residential Sprinklers: Homes to High-Rise

May 8 Colorado Sprgs, CO

sufficient and no redundancy of this suction line is required as long as the building is not considered a high-rise. The same may be said about break tanks and the associated refill line. A single supply line from the city main should be sufficient. The intent of the dual refill terminology is to provide redundancy to the refill mechanism and not to the line feeding it.

Note that for a high-rise building, the International Building Code and Fire Code require two separate lines from street mains to the fire pump. Therefore, the requirements for a break tank would be different. However, due to a combination of other rules for fire pumps and standpipes, it might not be possible to use a break tank in many situations in a high-rise building anyway.

Question 11 – Automatic Refill for Full Size Tank

We have a tank that is fully sized to handle the total fire protection system demand of a building that is not a high-rise. Do we need to put an automatic refill mechanism on the tank? The AHJ is telling us that we do because of a statement in NFPA 20 (section 4.6.4.1) regarding break tanks having automatic refills. The tank is a back-up water supply if that makes a difference.

Answer: No. You are not required to have an automatic refill on a tank that has sufficient capacity to meet the duration requirements for the fire protection system. The overall intent of NFPA 20 is expressed in section 4.6.2.1 where it says, “Any source of water that is adequate in quality, quantity, and pressure shall be permitted to provide the supply for a fire pump.” Any section that follows in any portion of 4.6 is just clarifying this basic intent. As far as this discussion goes, we will focus on the “quantity” portion of section 4.6.2.1. Any water supply that can provide a sufficient quantity of water is acceptable. If your tank supplies a sufficient quantity of water to meet your demand, no additional automatic refill is required. A manual refill would be one way to meet the requirements of NFPA 22 to have a mechanism available to refill the tank.

If you go back to the 1999 edition of NFPA 20, you’ll find similar language (back then it was in Chapter 2). Section 2-1.4 said, “A stored supply shall be sufficient to meet the demand placed upon it for the expected duration”. Note that there is no mention here of being allowed to rely on an automatic refill in order to meet your demand. This was preventing people from using break tanks in any configuration.

When writing the 2007 edition of NFPA 20, the committee decided to explicitly allow break tanks. They wrote a whole new section (5-29) on how to design break tanks (which has since been moved to Chapter 4, section 4-31). When doing this, they recognized that the base information on using stored water supplies needed to be changed. They inserted the words, “plus reliable automatic refill” to the section in question in order to allow the refill rate to count for some of the duration. If you read the committee report where this action occurred you will see that the committee stated that they are making this change to provide guidance on how to deal with a tank that does not provide the full system demand to allow for the refill to help make up the demand. They are NOT doing this to require an automatic refill on all tanks and they are NOT doing this to mandate that all refills be capable of meeting the system demand. Note that the committee IS doing this to allow break tanks, which permit at least two different tank sizing arrangements.

NFPA 20 now allows at least three different combinations of tank sizing and refill situations for tanks that serve most buildings. For super high-rise buildings (too tall to get 100 psi to the top floors from the fire department

connection at street level), the rules in Chapter 5 are different and will be discussed below. The key to understanding each of these options for buildings that are not super high-rise is the phrase, “the demand placed upon it” in section 4.6.4.1. The three options are as follows:

1. A tank that completely meets the demand of the fire protection system. In this case, the “demand placed upon” the refill mechanism would be zero. So, there is no requirement for a refill mechanism. The tank meets section 4.6.2.1 and it also meets 4.6.4.1 without any automatic refill because it can meet the “demand placed upon it” without any automatic refill.

2. A tank that does not hold the full duration requirement for the fire protection system, but does hold at least 30 minutes of water. In this situation, the tank becomes a “break tank” and needs to meet section 4.31 as well as 4.6. The “demand placed upon” the refill mechanism depends on the tank size and the system duration requirement. For example, if a 10,000 gallon tank feeds an OH-1 sprinkler system with a flow demand of 200 gpm and a duration demand of 60 minutes, the “demand placed upon” the refill mechanism is 33.3 gpm (12,000 – 10,000 divided by 60). Section 4.31.3.2.1 of NFPA 20 requires this value to be increased by 10%, so the final “demand placed upon” the refill mechanism is 36.6 gpm.

3. A tank that does not hold the full duration requirement for the fire protection system, and holds even less than 30 minutes of water. In this situation, section 4.31.3.1.1 requires the installation of two refill lines and each one needs to be capable of providing 150% of the pump’s rated capacity, although section 4.31.3.1.2 allows two slightly smaller refill lines in certain circumstances. In this circumstance, the tank is also considered a “break tank” and the two refill lines are more dependent on the rating of the fire pump than the fire protection system. For example, if an 8,000 gallon tank fed an OH-2 sprinkler system with a flow demand of 330 gpm and a duration demand of 60 minutes with a fire pump rated at 500 gpm, the refill lines would have to be sized to provide 750 gpm due to section 4.31.3.1.1. If the water supply could not provide that flow, then section 4.31.3.1.2 would allow the refill lines to be sized for 363 gpm (110% of the maximum fire protection system duration.

If the building is a super high-rise (too tall to get 100 psi to the top floors from the fire department connection at street level), then Chapter 5 requires an automatic refill valve and it has to be sized to provide the entire fire protection system flow demand, regardless of the size of the tank. In this case, the “demand placed upon” the refill mechanism is the fire protection system demand due to the language of Chapter 5.

In your question, you also mentioned the fact that this is a back-up tank and asked if this makes a difference. In general, the fact that it is a back-up tank makes no difference. The demand requirement is usually the same for fire protection system back-up supplies as it is for main supplies. The one exception to this statement would be where the International Building Code IBC) requires a back-up tank in certain buildings in certain seismic zones. In this case, the code specifically only requires a 30 minute water supply for this back-up tank rather than a longer supply that might be required by NFPA 13 for the sprinkler system. In this case, the “demand placed upon” any refill mechanism would need to be evaluated based on the 30 minute demand if the tank was a back-up that was only being installed to satisfy this one seismic provision of the IBC.

As you can see, the language in NFPA 20 section 4.6.4.1 may not be perfect, but it is the best language that the committee could come up with that would work with all of the different options as well as the super high rise

Did You Know??

The NFSA keeps a member of the Engineering Department staff on duty every business day to answer your technical questions live. We call this the Expert of the Day (EOD) program and it is available to our members by phone, fax, or e-mail. Call us at (845) 878-4200 and press 5, or you can send a fax to (845) 878-4215, or you

rules of Chapter 5. Anyone who tries to use the language in section 4.6.4.1 to say that an automatic refill mechanism is required is misreading the section and implying words that are not there.

can e-mail us at eod@nfsa.org. Last year we answered more than 2600 requests for assistance.

Question 12 – Sizing Pipes to Test Headers

NFPA 20 (section 4.20.3.4) allows the user to ignore the minimum sizes for the pipes going out to the fire pump test header if hydraulic calculations prove that the smaller size that you want to use will work. How would someone do that calculation?

Answer: Basically, you need to prove that at the maximum flow for the pump (usually 150% of rated flow) the water will get to the hose nozzles at the end of the hose connected to the test header at a high enough pressure to put a pitot gage in the flow stream and get the pressure necessary to prove that the right flow came through the hose. There are a number of ways to do this including the following basic procedure:

1. Calculate the discharge pressure of the pump at the maximum flow.

2. Calculate all of the pressure losses (friction and elevation) between the pump discharge flange and the test header.

3. Calculate the friction loss of the water in the hose.

4. Subtract the losses is steps 2 and 3 from the discharge pressure in step 1.

5. If the resulting pressure in step 4 is enough to create the flow necessary through the hose, then the situation would work. If not, then the pipe size will need to be increased or some other change will need to be made such as moving the test header to a different (closer or lower elevation) location.

For more information on this subject, see the worksheet in NFPA 20 Figure A.4.20.3.4(2) and the article, Sizing Fire Pump Test Header Supply Lines by Kenneth E. Isman in the Fall 2003 issue of Sprinkler Quarterly magazine.

Question 13 – Internal Pipe Inspections

We have a 40 story building that is fully sprinklered. NFPA 25 requires an internal inspection every five years. Can we just do one internal inspection in the whole building or does each floor need to have its own internal inspection?

Answer: Given the definition of a “sprinkler system”, each floor of the building is really its own sprinkler system, therefore, you need to do an internal inspection on each floor. Once NFPA 25 clarified that each floor of a high-rise building is its own system, the committee also inserted a section to say that in buildings with multiple wet pipe systems, the internal inspection can be alternated so that only half of the systems are inspected at five years and the other half need to be done within the next five years. In the end, this equates to an internal inspection every 10 years where there are multiple wet pipe systems in a building.