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## Best of February 2013

This month, we have selected the following dozen questions as the "Best of February 2013" answered by the engineering staff as part of the NFSA's EOD member assistance program. This month, we had a bunch of good questions regarding some unusual subjects like the protection of aircraft hangars and the design of standpipe systems. So, we'll start the list with some questions for NFPA 409, NFPA 14, and the International Codes, and then we'll fill in with some sprinkler questions from NFPA 13 and NFPA 13R.

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 – Fire Pumps for Aircraft Hangars**

We will be providing fire protection for a Group II Aircraft Hangar. The entire fire protection demand can be met with a 1000 gpm fire pump boosting the pressure from the city main. We will inspect and test the pump completely in accordance with NFPA 25. At no time other than a power outage or maintenance should the fire pump be "out of service". If the pump will be out of service there will be some sort of supplemental plan for fire protection. How many pumps are needed when the system demand can be safely provided with one?

Answer: Section 6.2.10.8.2 of NFPA 409 would require two fire pumps if the system demand can be met with one. While the fire pump might be well maintained, there are all kinds of possibilities for fire pumps to be out of service when a part breaks, an engine or motor needs work, or a power outage occurs. NFPA 409 does not want any delay in providing fire protection, even during these unusual outages. Waiting for fire departments or fire brigades to supply systems creates an unacceptable delay given the incredible value of the aircraft in the hangar. NFPA 409 requires a back-up pump.

Section 6.2.10.8.2 is written in a little bit of an unusual manner. The reason that the section is written this way is to give you a break so that you do not have to purchase completely redundant pumps if you need two or three fire pumps to meet your system demand (which is common given the flow demands for some very large hangars). If you need two pumps to meet your system demand, then this section would require that you install three, with the third sized as large as the biggest of the two needed for the demand. This helps you in that you would not need to install four to be completely redundant.

**Question 2 – Aircraft Hangars and Column Protection**

Does NFPA 409 require columns to be protected with additional sprinklers and is the flow from these sprinklers required to be added to the ceiling protection hydraulic calculations?

Answer: Yes, NFPA 409 requires columns to be protected in some manner. Section 5.6 gives the user options for protecting main supporting columns as follows:

1. Protect columns with materials that have a fire-resistive rating of not less

than two hours.

2. Use a foam-water system at the ceiling with additional discharge devices as an extension of the overhead system to protect the columns. Note that by saying, “additional discharge devices”, NFPA 409 is indicating that counting on overspray of the ceiling foam system to protect the columns is not sufficient. Devices are required every 10 ft vertically on the columns.

3. Use a sprinkler system at the ceiling with additional fixed water spray nozzles or sprinklers as an extension of the overhead system to protect the columns. Note that by specifying additional nozzles or sprinklers, NFPA 409 is indicating that counting on overspray of the ceiling sprinkler system to protect the columns is not sufficient. Devices are required every 10 ft vertically on the columns.

The designer of the aircraft hangar can select any of the three options above. If option 2 or 3 is selected, the additional demand of the foam-water or water spray devices protecting the columns in the design area need to be added to the ceiling sprinkler hydraulic calculations. The nozzles, sprinklers or discharge devices are required to discharge a minimum density of 0.25 gpm per sq ft on the columns. Any orifice discharge device is permitted to be used, but if a device with a k-factor less than 2.8 is used, a strainer needs to be installed on the supply side of the device.

**Question 3 – Aircraft Hangar Design Area**

We are considering a closed head foam-water sprinkler system to protect a 20,000 sq ft Group 2 Aircraft Hangar with no dividers or walls in the aircraft storage area (one large open hangar). We understand that the maximum system area is 15,000 sq ft, so we know that we need to provide two systems for the hangar. We also understand that the minimum density that we need is 0.16 gpm per sq ft. Will the calculations need to assume that every sprinkler on a single system will be open, or both systems?

Answer: Both systems. NFPA 409 section 7.6.2 covers this situation for Group 2 hangars. Section 7.62 states that the minimum discharge density shall be 0.16 gpm per sq ft of foam solution over the entire storage and service area. Since the entire storage and service area in this case is 20,000 sq ft protected by two systems, this is what you need to calculate.

**Question 4 – Standpipe Drain Risers and “Adjacent”**

Are drain risers located at main floor landings considered “adjacent” to standpipe risers that are passing through intermediate floor landings?

Answer: Yes. Webster’s New Colligate Dictionary defines “adjacent” as, “not distant” and “nearby”. In other words, two objects do not need to be touching each other to be considered “adjacent”.

The whole purpose of the section that requires the drain riser is to make the full flow test of the pressure reducing valves easy. Prior to this rule being in NFPA 14, contractors were installing pressure reducing valves without access to drain risers, creating a situation where hundreds of feet of hose were needed in order to run full flow tests. Since most building owners did not want to pay for such expensive tests to be run, the pressure reducing valves were not being tested. After the One Meridian Plaza fire in Philadelphia, where three firefighters died (one of the causes of this large fire was that a pressure reducing valve was not operational) this requirement for the drain riser was added to the standard.

The extremely small amount of hose that would be needed to connect the pressure reducing valve at the intermediate floor landing with the drain connection at the main floor landing would still permit the full flow test to be easily performed and would meet the intent of the standard.

**Question 5 – Class III Standpipes and Stages**

Does Section 905.3.4 of the International Building Code (IBC) require a Class III standpipe system on each side of the stage in a fully sprinklered building?

Answer: No. Right under section 905.3.4 is an exception. The format of the IBC is such that exceptions override the code sections that they apply to. If you follow the exception, you do not need to follow the base paragraph. The exception to section 905.3.4 clearly states that 1-1/2 inch hose connected to the sprinkler system is an alternative to the Class III standpipe system requirement in a fully sprinklered building. Likewise, the exception allows a Class II standpipe system to be an alternate to the Class III standpipe system requirement in a fully sprinklered building. This means that in a fully sprinklered building, you have three options, any one of which meets Section 905.3.4:

1. A Class III standpipe system with outlets on both sides of the stage
2. A Class II standpipe system with outlets on both sides of the stage
3. 1-1/2 inch hoses on both sides of the stage tied into the sprinkler system in accordance with NFPA 13

**Question 6 – Sizing the Pipe in the FDC for Manual-Wet Standpipe Systems**

A combination sprinkler system (meeting NFPA 13) and manual-wet Class I standpipe system (Meeting NFPA 14) is being served by one fire department connection with four 2½-inch inlets. There are three required stairwells, so the standpipe demand is 1000 gpm (500 gpm at most remote outlets, plus 250 gpm each at the other two stairwells). The responding fire department will provide a 1000 gpm pumper truck to provide the pressure boost between the available water pressure and the required pressure of 100 psi at the remote hose outlets. The hydraulic calculations for the sprinkler systems work with 4-inch risers and a 6-inch underground water supply. How is the piping between the FDC in the yard and the point of connection to the combined sprinkler/standpipe system supposed to be sized?

Answer: The piping from the fire department connection to the system must be sized in a manner that proves that the system demand can be met from the fire department use of the fire department connection. The goals of NFPA 14 and NFPA 13 are different. The fire department needs to be able to use the fire department connection as a complete source of supply (pressure and flow) to meet the demand of the standpipe system. This is critical for any manual standpipe system, and still important for an automatic standpipe system. This is why the fire department connection for a standpipe system needs more inlets than a fire department connection for a sprinkler system. The requirement for one 2-1/2 inch outlet for every 250 gpm would make no sense if you did not expect the fire department connection to be able to supply the whole system demand.

There are two ways to determine whether the size of the pipe is sufficient: pipe schedule and hydraulic calculations. For all editions of NFPA 14 prior to 2010, there was a pipe schedule table that allowed you to size the pipe based on the number of risers downstream. This method was eliminated in the 2010 edition, even though it worked fine. It was eliminated because it is so easy to do hydraulic calculations that it was considered to be archaic.

The second method of determining the correct pipe size for the fire department connection piping is to perform hydraulic calculations. These calculations would need to show that 100 psi at 250 gpm was available at the most remote outlet with all other required flowing outlets providing 250 gpm at a pressure greater than or equal to 100 psi. The calculation needs to terminate at the fire department connection and then the demand needs to be compared to the ability of the local fire department's truck that will most likely respond to the fire.

From the information you have provided, the local fire department has a 1000 gpm pump on their fire truck, which is a fairly common size for most fire departments. Fire truck pumps are rated in a different way than stationary fire pumps. According to NFPA 1901, a fire truck rated at 1000 gpm has to be capable of producing 1000 gpm at a net pressure of 150 psi. This means that the pressure that the fire truck's pump can produce at the fire department connection is greater than 150 psi, assuming that the flow is being taken from fire hydrant(s). The water will come from the fire hydrant at some positive pressure. Most water utilities will not allow the fire department to take the water below 20 psi, so you can safely assume that the fire department can provide 170 psi at 1000 gpm to the fire department connection, minus any friction loss in the hose. If you know the water supply information in the main connected to the hydrant, the pressure available at 1000 gpm might be higher, which would permit an even higher pressure available at the fire department connection.

**Question 7 – Filling Water Tanks**

Does NFPA 22 have sizing and fill time requirements for a domestic water line filling a tank?

Answer: Yes. Section 14.4 of NFPA 22 requires that the mechanism used to fill the tank be sized to fill the tank in a maximum time of 8 hours. Since you are proposing to fill the tank from the domestic water system, also look at section 14.4.8, which requires the fill pipe (from a potable water source) to be installed per local health authority regulations. This may require a backflow prevention device or airgap device to protect the domestic supply.

**Question 8 – Sprinklers Protecting Ovens**

Does NFSA have any data or experience on the reaction of water in high temperature applications such as bake ovens. Specifically the concern is if the water from an activated sprinkler system is introduced into the hot oven (500°F), will it form steam too quickly and cause an explosion?

Answer: The NFSA does not have any formal papers or research on protecting hot atmosphere's with sprinklers, but we are not aware of a sprinkler system casuing a problem when the discharge is quickly converted to steam. Such a problem typically only occurs when water turns to steam within a combustible liquid and expands,

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distributing the combustible liquid itself. Both NFPA 13 and NFPA 86 (The Standard for Ovens and Furnaces) regard water based fire protection systems as an appropriate method of fire protection, so concerns of steam expansion do not appear to be well founded. NFPA 13 specifically references equipment designed for this kind of operation in Table 6.2.5.1 where sprinklers rated at 650°F are required to be used in locations where the ambient temperature is up to 625°F. NFPA 13 would not allow sprinklers to be used in this type of situation if the steam was going to be a problem.

**Question 9 – Check Valves on Risers**

Is a check valve is required on the riser of a sprinkler system? In our case, the sprinkler system is fed from an underground main. The FDC ties into the underground and a backflow preventer is installed at the connection of the underground main to the city water main.

Answer: It depends on the arrangement of the fire department connection (FDC) and the automatic water supply.

Section 8.16.1.1.3 requires a check valve for each water supply (to prevent the water from one water supply going to the other water supply rather than the sprinklers during a fire). In this case, the FDC counts as a water supply. You need a check valve that is located so that the water being pumped into the fire department connection does not return to the automatic water supply or the hydrant where it is originally being pumped from.

Most fire sprinkler systems have the FDC tied into the system at the system riser, so the check valve needs to be on the system riser as well, just below the location where the FDC meets the riser. But if the FDC is tied into the system at a different location, this eliminates the need for the check valve to be on the riser; however it makes the rest of NFPA 13 more difficult to meet if the FDC is tied into the underground and there are hydrants on the underground. Having the check valve on the riser solves a number of other problems, but it is not mandated by NFPA 13.

Tying the FDC into the underground pipe presents some interesting challenges. If there are fire hydrants on the underground pipe as well, then you need check valves between the FDC and the hydrants to prevent the water that is being taken from the hydrant and pumped into the FDC from returning to the hydrant (as required by section 8.16.1.1.3). This can be difficult to do in underground pipe, especially an underground loop. Even if the pipe is not a loop, putting a check valve in the underground can be challenging. Section 8.1.2 requires all valves, including check valves, to be accessible for inspection, testing and maintenance. If you bury the check valve in the underground, it will not be accessible and you will violate section 8.1.2.

In order to meet both sections 8.16.1.1.3 and 8.1.2 on a system fed with private underground mains with fire hydrants, many people tie the FDC into the system riser and keep a check valve on the riser. It is the easiest way to meet all of the rules of NFPA 13.

If the underground pipe has no hydrants and the FDC is tied into the underground, then the check valve is not needed on the riser and no check valve is needed in the underground either. The backflow preventer serves as the check valve required by 8.16.1.1.3 for the FDC connection (see section 8.16.1.1.3.2).

**Question 10 – Flexible Couplings on Drops to Pendent Sprinklers**

Section 9.3.2.4 in the 2013 edition of NFPA 13 seems to require flexible couplings on drops to pendent sprinklers in a cooler. Does this rule also apply to sprinkler systems designed today in a jurisdiction that is still using the 2010 edition?

Answer: Under the 2013 edition of NFPA 13, there is no question that flexible couplings are required on drops to pendent sprinklers serving a cooler.

Under the 2010 edition of NFPA 13, the requirement was not clear. While coolers or other freestanding structures were not listed in section 9.3.2.4, there is a general concept in all of section 9.3 where flexibility is needed for sprinkler piping serving portions of the building that are going to move differentially. During an earthquake, the cooler will not move exactly with the building around it. Somehow, the strain of the differential movement on the drop needs to be dealt with. If you don't put flexible couplings on the drops, how were you planning on dealing with the differential movement?

Whenever a new edition of a standard comes out, there is always some difficulty in the transition as we get used to new ways of doing things. We can't hide behind the fact that older editions of the standard were not as clear as they needed to be because now we know better. From a liability perspective, it is difficult to hide behind the 2010 edition of the standard if anything ever goes wrong in this building. It is hard to say that you did not know that it was a good idea to put them in.

In the fire sprinkler business, we made a good living in the 1980's because people sued hotel owners for not putting in sprinkler systems in their hotels. These people won (the hotels lost) even though the codes did not require sprinklers. We successfully convinced the court to look beyond what the code required at the time the hotels were built and look instead at the "state of the art". We can't go back and argue the opposite side of that argument now. The "state of the art" is that flexible couplings need to be installed. Therefore, they should be installed.

We certainly understand the dilemma that contractors are in at this point in time. It is possible that jobs were put out for bid under the 2010 edition, long before the 2013 edition came out and the person responsible for preparing the bid response was not aware of the particular concern regarding the flexible couplings on the drop. Those kinds of projects sometimes move ahead slowly, and may be installed after the 2013 edition is published. In this instance, the insurance company may be able to provide some financial consideration for providing the flexible couplings that will help the owner consider this a legitimate change order so that you can get paid for putting the couplings in. But going forward, systems that are being designed now should include flexible couplings on drops to structures like coolers and freezers.

**Question 11 – Walls that Don't Go All the Way to the Ceiling in Ordinary Hazard**

Section 8.6.5.2.2 of NFPA 13 (along with its figure and table) allows sprinklers to protect on the opposite side of a partition that does not go all the way to the ceiling, even when the partition gets within 18 inches of the sprinkler deflector. But the problem is that this section, figure and table only apply to light hazard occupancies. How do we protect an ordinary hazard occupancy with very small compartments that have walls that do not go all the way to the ceiling? The walls stop within 10 inches of the ceiling, leaving a clear space at the ceiling.

Answer: You are correct that section 8.6.5.2.2 is only for light hazard occupancies. In the situation that you have described, you have four options that we can see:

1. Put standard spray sprinklers in each small compartment making sure to stagger them so that no sprinklers is closer than 6 ft to another sprinkler.
2. Get the owner to raise the partition to the ceiling so that you can install sprinklers in each compartment without worrying about whether they are within 6 ft of each other.
3. Get the owner to lower the partition so that there is 18 inches of clearance from the top of the partition to the sprinkler deflector. Depending on where you install the sprinklers, this would require the partitions to be 19 inches or more from the ceiling. This would permit you to use standard spray or extended coverage sprinklers in the space without regard to partition wall location.
4. Get the owner to do some variation of option 3 with very open chicken wire or mesh forming the top 18 inches of the partition. There is no definition for exactly how open this would need to be, but the AHJ would need to be consulted on this option since it is an equivalent design that would need to be evaluated under section 1.5 or 1.6 of NFPA 13, so they AHJ could rule on the opening of the wire or mesh during this discussion.

**Question 12 – CPVC in Ordinary Hazard Rooms of NFPA 13R Occupancies**

Can CPVC pipe be used to provide water to sprinklers in an ordinary hazard space larger than 400 sq ft that is outside the dwelling unit in an NFPA 13R system?

Answer: Yes. The listing for CPVC pipe allows it to be used throughout residential occupancies that are protected with NFPA 13R system. The listing does not limit the use of the pipe to dwelling units within residential occupancies. Instead, the listing allows the pipe to be used throughout the occupancy. NFPA 13R recognizes that the occupancy is going to have ancillary spaces that are outside the dwelling unit that have a slightly higher hazard than those spaces within the dwelling units, but are essential to the general use of the building as a residential occupancy (such as a kitchen, storage room, electrical room, mechanical room, etc.). As long as you follow the listing of the CPVC pipe (protecting the pipe or following the exposed protection rules) you are allowed to use CPVC pipe throughout the building that is being protected using NFPA 13R.

## Did You Know??

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