Fire Protection

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Engineers and Sprinkler System Design

In the middle of August, I received a phone call from a client in Ohio regarding whether or not a fire pump was required for a sprinkler system installation in a three-story office building. The client indicated that the engineer for the project insisted a fire pump was necessary, while the sprinkler contractor indicated that the water supply at the site was adequate to design the system without a fire pump. The client said he would prefer not to have a fire pump installed for two reasons — the first was the cost of the pump and the second was the cost (and trouble) of maintaining the pump.

One of the client's concerns about the cost of the pump revolved around the fact that if an electric pump was installed, the State of Ohio would require that the pump be provided with standby power. So the cost of installing an electric fire pump involved not only the cost of the pump itself, but also the cost of providing a generator and transfer switch. The cost of providing standby power for an electric fire pump can be avoided by installing a diesel-driven fire pump, but a diesel-driven pump is more expensive than an electric pump and the maintenance costs are also higher.

Because I was already familiar with the water supply at the site, I knew that the static pressure at the site was around 50 psi. Based upon this, the answer to the question of whether a fire pump was required for the sprinkler system installation was obvious. The sprinkler contractor was correct — there was more than enough pressure to design the system without a fire pump.

How did I know that off the top of my head without doing any calculations? The answer to that question is simple — experience. Actually, it's a very simple sprinkler system hydraulics problem.

A rule of thumb is that you lose 5 psi for each building story. Because the building will be three stories in height, the pressure loss due to elevation will be approximately 15 psi. To be more precise, the pressure loss due to elevation is 0.433 psi per foot of elevation change. In this case, the elevation of the roof of the building will be 42 feet above the surrounding grade. Hence, the precise elevation pressure loss will be approximately 18.2 psi. (An estimate of 15 psi is close enough for this calculation.)

NFPA 13 requires that the minimum operating pressure at any sprinkler be 7 psi. The flow from a half-inch sprinkler at 7 psi is roughly 15 gpm. In an office building, the typical sprinkler spacing will be around 150 square feet per sprinkler (due to partitions), hence, a density of 0.10 gpm/SF can be achieved with the sprinklers operating at the minimum operating pressure required by NFPA 13.

Given this, the absolute minimum pressure required to operate sprinklers on the third story of the building will be 22 psi. Since the plumbing code in Ohio requires that a backflow preventer be provided for a sprinkler system, another 10 psi loss should be added to the minimum required pressure to account for the pressure drop in the backflow preventer. Hence, without considering any friction loss in the piping system, a minimum pressure of 32 psi would be required to operate the system.

Because a static pressure of 50 psi is available at the site, this means that somewhere between 8 and 18 psi is more than likely available to account for friction loss in the piping system. The sprinkler system designer simply sizes the pipe to limit the friction loss in the pipe to the pressure available for friction losses. The less pressure available for friction loss, the larger the piping system has to be.

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The above isn't hard if you know how to calculate elevation losses and are familiar with the design criteria contained in NFPA 13. The fact that the engineer on the project couldn't perform this simple (one minute) calculation is an indication that the engineer was not qualified to be involved in the design of the sprinkler system.

More disturbing findings

After this issue was resolved, the owner requested that I review the full set of contract drawings for the building for code compliance. What I found in the fire protection drawings was rather disturbing. After reviewing these drawings, there was little doubt the engineer who developed the sprin-

Continued on page 12

Fire Protection

Continued from page 10

kler drawings was practicing outside his area of expertise. Here are some of the errors found in the drawings:

1. Separate Domestic/Fire Protection Services. The building was designed with two separate water supply services, one for domestic water and one for fire protection water. While it was common for two separate services to be provided for a building protected by a sprinkler system in the 1960s, 30 years of experience has shown that combining domestic and fire protection water services does not have an adverse effect on the operation or reliability of the sprinkler protection.

Imagine the savings to a building owner who only has to pay for one tap into the municipal distribution system, only has to pay for one pipeline and only needs to maintain one pipeline, rather than two pipelines. On the downside, imagine the reduced revenues for the water company, the reduced amount of work for the plumbers installing the lines and reduced fees for the engineers.

2. Fire Department Location. The drawings showed that the fire department connection would be installed on an exterior wall in close proximity to the location where the underground supply line would enter the building, rather than on the address side of the building. Not a major deficiency, but locating the fire department connection on the address side of the building makes it easier for the fire department to find the fire department connection on a cold snowy night in January or just a dark night in July. Why not make it easier for fire fighters to find the fire department connection?

The obvious reason why not is that the engineer has never had to find a fire department connection at 2 o'clock in the morning. The difference between a good engineer and an average engineer is that the good engineer puts himself in the shoes of the people who have to use the equipment, while the average engineer just doesn't care.

3. Fire Department Connection Size. The drawings for the sprinkler installation indicated that the piping in the fire department connection was required to be 6 inch. NFPA 13 indicates that the pipe in a fire department connection is required to be a minimum of 4 inch. Will providing 6-inch piping in the fire department connection really improve the performance of the sprinkler system?

While a fire department connection larger than the minimum required by NFPA 13 might be justified for a storage building, it is doubtful that a 6-inch fire department connection would really be of any use in a building which is predominantly light hazard. Studies of operating sprinkler systems in New York City some 30 years ago indicate that 100 percent of fires in sprinklered office buildings are controlled by the operation of four or fewer sprinklers. You certainly don't need 6-inch pipe to supply four operating sprinklers.

4. Flow Test Data. Water supply information was provided on the fire protection drawings (as it should be). The water supply data provided indicated the following:

Static Pressure:	48 psi
Residual Pressure:	41 psi
Flow:	955.20 gpm
Date:	6/27/00
Time:	11 p.m.

There's a lot to talk about here. First off, given the method of determining the flow rate in a flow test, it simply is impossible to determine the rate of flow to the hundredth of a gpm. Indicating the flow rate to the hundredth of a gpm is an indication that the engineer who produced the drawings is not familiar with how a water supply test is conducted. At best, using a pitot tube and gage to determine the velocity pressure of a water stream issuing from a hydrant is just an estimate. Hence, reporting the flow rate from a hydrant to the hundredth of a gpm implies an accuracy to the measurement which doesn't exist.

Secondly, the water supply information provided indicates that the test was conducted in late June at 11 p.m. The appendix material contained in NFPA 13 indicates that the water supply available from a municipal distribution system fluctuates based upon the season of the year and the time of the day. The appendix material further states that the results of a water supply test should be adjusted for these fluctuations. Conducting a water supply test at 11 p.m. in late June is more than likely not representative of the water supply that would exist in the early evening in August when everyone is watering their lawns.

A flow test only measures the water supply available at the time the test is conducted. In other words, the results of a flow test are just raw data. These data need to be

Continued on page 14

Fire Protection

Continued from page 12

adjusted to account for the fluctuations in pressure in the system.

5. Floor Control Valve Location. The system shown on the drawings was a combined sprinkler and standpipe system. Given this, control valves were required to be provided at each sprinkler connection to the standpipe risers. The drawings indicated that these floor control valves were to be installed above the ceilings just outside of the exit stair enclosures.

While installing the control valves above the ceiling may be acceptable from a maintenance standpoint, installing the valves above the ceiling certainly doesn't make any sense from a fire fighting standpoint. The reason that NFPA 13 requires that floor control valves be provided in a combined sprinkler/ standpipe system is to allow the fire department to shut down a portion of the sprinkler system in case sprinkler piping breaks during a fire or in case the sprinkler system fails to control the fire. The control valves allow the fire department to shut down the portion of the sprinkler system which is not functional (because it is wasting water) and still maintain the standpipe system in operation.

Once you understand the intended function of the sprinkler floor control valves, then it's easy to understand why locating the floor control valves in the ceiling outside of the stair enclosure doesn't make any sense. Imagine a fire in the building where the sprinkler system fails for some reason. Now imagine you are a fire fighter who has to find a control valve in the ceiling under fire conditions. You can't see more than one foot in front of your face and the temperature at the ceiling is between 1,000 and 2,000 F. If you were a fire fighter, wouldn't you really rather have the control valve located within the exit stair enclosure where you can safely operate the valve from within a 1- or 2-hour fire-rated enclosure?

Again, the difference between a good engineer and an average engineer is that the good engineer thinks about the fire fighters who will have to use the valve under fire conditions, while the average engineer simply complies with NFPA 13 requirements without regard to whether or not the control valves will actually be useable under fire conditions.

6. The Term "Sprinkler Head." The specifications for the sprinkler installation used the terms "sprinkler heads" and "heads" when referring to sprinklers. The term "sprinkler head" is slang for the term "sprinkler." Nowhere in NFPA 13 will you see the term "sprinkler head" used. Those familiar with the proper use of the English language don't use the word "ain't." Similarly, fire protection professionals don't use the terms "sprinkler heads" or "heads" to refer to sprinklers.

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7. Insurance Carrier Requirements. The specifications for the sprinkler installation indicated that the sprinkler contractor was responsible for determining who the owner's property insurer was and made the contractor responsible for complying with the insurance carrier's requirements for sprinkler installations. Obviously, from the standpoint of bidding the job, it makes more sense to have the engineer inquire who the owner's insurer is, rather than have a number of sprinkler contractors contact the owner to ask the same question.

Aside from the logistics, it would seem that a good engineer would want to contact the owner's insurer to determine any special sprinkler installation requirements so that these special requirements could be included in the engineer's drawings. Again, the difference between a good engineer and an average engineer is that a good engineer would have taken the time to identify the insurer and contact that insurer regarding their requirements for sprinkler installations, while an average engineer simply pushes off the work to the contractor. If the function of an engineer is to push off all of the engineer's work to the contractor, why do we need engineers?

8. Approval Stamps. The specification for the sprin-

Continued on page 16

Continued from page 14

kler installation requires that the sprinkler contractor obtain all of the approvals from the various authorities having jurisdiction prior to submitting the drawings and hydraulic calculations to the engineer for approval by the engineer. Whenever I see this requirement in the specs for a sprinkler system, I smile.

The purpose of this requirement is to make sure that the engineer doesn't approve the shop drawings if there are deficiencies in the drawings that have been identified by the approval authorities. (That would be embarrassing.) In other words, if the drawings are approved by the enforcing authorities, then the engineer just approves the drawings without doing an independent review of the drawings.

Even if the enforcing authorities have already approved the drawings and hydraulic calculations, the engineer-of-record should still do a thorough review of the drawings to verify compliance with fire protection standards. Why, you ask? Simply because the drawings are approved by an enforcing authority doesn't mean that the drawings have actually been reviewed. Most building department and fire department don't have anyone on staff with the expertise to review sprinkler system shop drawings and most insurers wouldn't bother to spend the time reviewing shop drawings for a building with such a relatively low value. Given this, it is likely that the only review of the drawing for compliance with NFPA 13 will be conducted by the engineer, unless, of course, the engineer thinks that somebody else has already reviewed the drawings so there is no reason to review the drawings again. More than likely, the engineer doesn't have the expertise to do a review the shop drawings either.

There were many more deficiencies in the fire protection drawings and specifications for this building which I could discuss, but there are limits to the available space. Suffice it to say that the sprinkler drawings and specifications for this building were less than a professional job. It seems obvious to me that the engineer firm who produced these drawings was practicing outside its field of expertise. Should their engineering license be revoked? In my opinion, the answer to this question is yes, definitely. After all, if no action is taken against the engineers, these engineers will simply continue producing unprofessional drawings. The only way to improve the level of professionalism in the fire protection field is to discipline engineers who practice unprofessionally. □

Looking for a review of fire protection basics?

The first nine installments of Richard Schulte's "Nuts and Bolts of Fire Sprinkler Installations" are now available for downloading (as PDF files) from the *Plumbing Engineer* Web site.

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