

FIRE PROTECTION HISTORY-PART 122: 1958 (SPRINKLER SYSTEM HYDRAULICS/WILBUR STUMP)

By Richard Schulte

The sixty-second Annual Meeting of the National Fire Protection Association (NFPA) was held at the Palmer House (Hotel) in Chicago in May 1958. Among the committees with reports at this meeting was the Committee on Automatic Sprinklers. The chairman of the Automatic Sprinkler Committee, Gordon F. Price, presented the report. Following Chairman Price's presentation, an interesting and lengthy discussion of the hydraulics of the pipe schedule ensued. The following is an excerpt of the discussion:

Mr. W. D. Storm (U. S. Navy): Gentlemen, those of you who have been attending the NFPA conventions regularly know that I have long been somewhat at variance with the theory of design of automatic sprinkler systems and I have reviewed this present revision with a great deal of disappointment to find that we are still adhering to unrealistic requirements and requirements that do not produce what we think they do. Actually they are producing tables and not protection.

*I would like to refer you to page 138, Table 302. There we find a tabulation of Guides to Water Supply Requirements for Sprinkler Systems and we find the various Occupancy Classifications listed and we find the water supplies and residual pressures and total flows that are required for a water supply shown in the table. **The minimum residual pressure is still held to 15 pounds on the sprinkler on the top head.** Then on Light Hazards we find the figures 500 to 750 gallons per minute with the notation to see Note 3, "The requirement may be reduced to 250 gallons per minute if building is limited in area or if building, including roof, is noncombustible construction."*

There is no place that I find in here where there are any changes made in the sizes of the pipe which is supplying the sprinkler in the Light Hazard system regardless of whether the building is fire resistant for [or] noncombustible or if it is of wood construction. We have never changed the occupancy.

I would like to inquire, first off, by what strange manner you can flow 750 gallons per minute through the same pipe that you were only putting 250 gallons a minute through with a possible pressure loss in the overhead piping of perhaps 7 pounds. It is absolutely out of the question to deliver 250 gallons per minute out of a Light Hazard distribution piping system at the most extreme point, possibly at the roof and end of line, with anything like a 7 pound residual value for pressure drop in the pipe.

Now we come down to a similar condition in Ordinary Hazard (Group 1). *Fifteen psi is still held for residual pressure for the top level but we find that the flows required go over the same area 500 to 1,000 gallons per minute.*

Now I had occasion to calculate the hydraulics on systems that were laid out or designed on the basis of your standard pipe schedule or layout and I believe it is basically impossible to deliver 1,000 gallons per minute from such a system at the worst point—that is at the end of the line and at the top level—again with only 7 pounds drop in pressure available to you. Now that 7 pounds basically is derived from the pressure required at the base of the riser and it shall be the residual pressure required under the roof plus the pressure required to reach this elevation. That is all you have available as a minimum residual figure.

Now if this weren't bad enough we come to Ordinary Hazard (Group 2). We have exactly the same conditions for determining the minimum water supply and instead of stopping at 1,000 gallons per minute we are now going to drive 1,500 gallons per minute through the same type of pipe distribution system and design.

It seems to me that this is basically impossible. It is not good engineering and it merely leaves us with the position of saying, "Okay, we are putting a sprinkler system in here. It is designed in accordance with Pamphlet 13 and because its occupancy follows in Ordinary Hazard (Group 2) we are going to demand a 1,500 flow capacity in the city main. This we will test and we will have this residual pressure of 15 plus the hydraulic head to the top line, and you can put your label on the building that this is protected by automatic sprinklers."

In my opinion I think it is a misleading approach because we as, shall we say, experts know we cannot deliver 1,500 gallons per minute out of that system. We are merely depending on the fact that our past fire record or experience with automatic sprinklers is so darn good that we can supply enough sprinklers to take care of approximately 75% of all the fires we have had. The other 25% we hope we won't get. But when you do you have a total loss or an enormous loss because the fire department has had to supplement the sprinklers with heavy streams and the man who has paid out his money for a proper sprinkler system, thinking he was getting proper fire protection, has been cheated. I think this is not the proper thing to do. I feel that we should recognize the limitation of water flow through certain size pipes and either tell the man that he can't deliver that much water or not demand it of him because you demand this water supply out on the street where it does not play on fire but it is only the water that you distribute in the building that makes any difference. So why demand these high minimum flows when you are not delivering or using them?

Mr. Price: Mr. Stump, would you propose a revision of the pipe schedule?

Mr. Stump: At least that it be considered for hydraulic design. That is the only way you can be sure you can deliver the water in the way you say you need it.

Mr. Price: This Section deals with water supplies, of course, and not pipe.

Mr. Stump: But it relates to all the rest of it in design. This is the primary point where you have to design.

Mr. Price: Have you noticed it is 15 psi in Light Hazard and in the others it is 15 psi or higher? Over on page 137 if you are fearful that it might get into the hands of unauthorized individuals you notice that it says, "The table is to be used only with experienced judgment."

Mr. Stump: Yes, this is a pious, fine opinion but, believe me, when these become documented, and this is particularly true in the Government, when this becomes the governing document you get the minimum that is here. You do not get the maximum. You do not get anything above minimum. You can't enforce anything above minimum actually. It leaves your engineer or your sprinkler control organization or body, or what have you, the regulating body, it leaves them with a broken sword. You have some blade left and it is sharp and if you can get close enough to the man you can use it but you don't have a sword any more. You have taken away from him his power to assure that the poor owner of the property, who is paying his money out, is getting true fire protection. He has been sold on the need and he is trying to get it but he is not going to get it.

Vice President Thomas: Mr. Stump, I believe your remark is that you have no objection to the quantity of water recommended but you feel it is not obtained in the pipes provided. The residual you know can rise. The minimum is 15 [psi, plus elevation].

Mr. Stump: But basically you are talking in terms of minimums here and your minimum water flow, for example, is not realistic because it will not be applied on the fire; it cannot be.

Vice President Thomas: You maintain that the table cannot be complied with as far as water is concerned.

Mr. Price: You mean that the quantity called for is that the piping distribution system according to the schedule in the Standard would not permit it to flow into the system? If pressure is supplied at the base would it not flow in?

Mr. Stump: You will not get the quantity flow because it will not flow to the head. You will have nothing left.

Mr. Price: Hydraulically if you have sufficient pressure there I can't see why it can't flow in.

Mr. Stump: Suppose you used all your 15 pounds you have required for the head, how much more than that will flow?

Mr. Price: Is your objection here to the quantity of the water or your particular contention that the water cannot reach?

Vice President Thomas: I think, Mr. Price, that Mr. Stump's remark is that the recommended water supply can not be obtained through the piping.

Mr. Stump: It can't be used through the piping. In other words, you are asking for minimum requirements here in the street that you can't use.

Mr. Price: Well, what do you think of these supplies? Do you think they are too large or not large enough? Do you have any complaint on the supply as mentioned? This is a guide also. It is noted in the heading of the table that it is a guide. That is another caution in addition to the caption I read.

*Mr. Stump: Basically, sir, I would say in general terms that Ordinary Hazard (Groups 1 and 2) Occupancy, are proper and I don't agree that they are in here but if they are proper then I would say this quantity of water you have will satisfactorily take care of those occupancies. When you get into the more hazardous classifications, such as Group 3 and Wood-Workers and Extra Hazard, you are going to determine the quantity of water you need anyhow, which is not in the table at all, and you determine it properly. But I do think that assuming that the occupancies as listed in Groups 1 and 2 if they are proper, which is not the point at this time, I think those have a range of flow which is satisfactory. **The matter is pipe schedule in size.***

Mr. Price: Might the Committee then have a recommendation from you—and I assure you it will be given careful study—that the pipe scheduling should be gone into?

Mr. Stump: I certainly do. As a matter of fact, I have advocated it for a number of years. In our Navy publication we require hydraulic design on many of the occupancies on Groups 1 through Extra Hazard. Of course, our occupancies are restricted to those things that apply to Navy operations and it isn't as broad as are listed here but we do require hydraulic design or systems in much the same manner as you would design a deluge system except we use a maximum flow requirement for the head system rather than for all heads.

Vice President Thomas: Mr. Price, I think certainly the opinion has been considered by the Committee that the tables you have recommended are realistic. I would suggest with your permission, Mr. Price, that Mr. Stump's ideas be considered and if you put them on paper, Mr. Stump, the Committee will consider them. Is that all right?

Mr. Price: Yes, the Committee would appreciate it. (Applause.)

If you know a little about hydraulics and do a hydraulic analysis of the pipe schedule, you will see that Wilbur Stump's comments are correct. With just a few operating (one-half inch) sprinklers at the end of a branch line (with the end sprinkler operating at a pressure of 7 psi), the required pressure at the top of the sprinkler riser will far exceed 15 psi required by the water supply requirements for pipe schedule system. From a hydraulics standpoint, supplying the end two sprinklers with one inch pipe just doesn't work. And that was the point the Mr. Stump was trying to make.

Although Mr. Stump comments about the hydraulics were correct, what the discussion above failed to recognize was that the flow required by the water supply table for pipe schedule system includes an allowance for the use of fire department streams. Hence, it was not expected that the flow demand for the sprinklers would be 500 gpm, 750 gpm or 1,000 gpm. What is now called the hose stream allowance was (and still is) included in the water supply for sprinkler systems so that the fire department does not deplete the water supply for the operating sprinklers.

It took another 15 years or so before hydraulic design criteria was included in NFPA 13. I guess we could say that Mr. Stump was ahead of his time.

* * * * *

Source: "*Proceedings of the Sixty-second Annual [NFPA] Meeting*", Chicago, Illinois, 1958.