

## Do New York Nozzle Tests Prove Anything? by John D. Wiseman, Jr.

In a series of three articles published in *Fire Engineering* in February and September 2003 and in February 2004, Jerry Knapp, Tim Pillsworth, and either Sean White or Christopher Flatley reported on a number of nozzle tests at Rockland County Training Center in Pomona, N.Y. The three articles are titled: "Nozzle Tests Prove Fireground Realities". Reference to statements in these articles is made by article number and page number. For example, 1-72 indicates article 1, page 72.

The nozzle testing measured the air flow entrained by various types of nozzles that were held steady or moved in a certain way. This was done inside a compartment that was sealed to provide only one air intake and only one exhaust opening. It should be noted that none of these tests involved any fires or actual fire fighting. Also, while these tests did provide detailed information about various nozzles, none of the information obtained is really new. The fact that fog nozzles entrain more air than smooth bore nozzles has been known for a long, long time, as the authors recognize.

The authors cite William E. Clark's book, *Firefighting Principles and Practices*, originally published in 1974. In another article in the National Fire Protection *Handbook, Fifteenth Edition*, (1981), titled: "Theory of Fire and Explosion Control", Walter Haessler states that a fog nozzle at a 30° setting at 100 psi nozzle pressure induces 30 cfm into the water stream per gpm of flow. At 100 gpm that is 3,000 cfm. It is important to note that the amount of air entrained varies directly as the rate-of-flow. Haessler adds that this can be beneficial or harmful depending on its use. So you cannot assume that the fact that fog nozzles entrain more air automatically means that this is bad in any way.

First there is some data that is missing from these tests. With respect to fog nozzles, the authors state that data was collected from three separate fog nozzles. (1-74) A little later the article states that nozzles tested were "a low-pressure, constant gallonage fog tip and two automatic nozzles". These nozzles were flowing at designed pressures and volumes. It would be helpful to know what nozzles were used and what the flow rates were. What are the designed pressures and volumes? As you know automatic nozzles maintain a constant nozzle pressure with varying rates-of-flow. The data for the smooth bore nozzle was provided. This nozzle was a 15/16 inch tip operating at 50 psi nozzle pressure and flowing 180 gpm. The hose layout was 100 feet of 1.75 inch hose.

Airflow was measured by a velocity/volume meter. However, a major weakness of the nozzle tests is the fact that this meter had a maximum limit of 2,000 cfm. (1-74). Thus, the actual air flow produced by these fog nozzles is not known. The authors estimate that the actual flow is three to five times the measured flow of 2,000 cfm, that is, 6,000 to 10,000 cfm. This is only a guess that is probably too high. This is higher than Walter Haessler's data from the NFPA *Handbook, Fifteenth Edition*. Haessler's data produces 5,400 cfm for 180 gpm flow for a fog nozzle at 30° with 100 psi nozzle pressure. Lacking any further data from the N.Y. nozzle tests, we cannot say that these numbers apply to the fog nozzles used. So we simply do not know how much air is entrained by fog nozzles based upon the author's testing.

The main thrust of these articles is to highlight the differences between smooth bore nozzles and fog nozzles with respect to the amount of air entrained by each type nozzle. The authors did conclude that there was little difference between a smooth bore nozzle and a fog nozzle set on a straight stream. They quote Chief Andrew O'Donnell as saying: "The difference between smooth bore and straight stream in terms of direct attack effectiveness is negligible." (1-74) Air flow, however, from a fog nozzle set at 30° is characterized as "extreme".

The key to these nozzle tests is the rate-of-flow of 180 gpm. Here is where the author's make a fatal mistake. They assume that a safe and effective fog attack must be made with maximum flow from a fog nozzle. This is simply not true. The volume of the room used in the nozzle tests was 1,250 cubic feet. Let's calculate the amount of water needed to fill this room full of steam. Using the formula, Volume/200, this equals 1,250/200 or 6.25 gallons of water. For further calculations, let's use 6 gallons. This formula is

based upon the fact that one gallon of water expands to at least 200 cubic feet of steam at 212<sup>o</sup> F. This formula also assumes that at least 90% of the liquid water is changed to steam.

Six gallons can be distributed equally in a fire area by a flow of 30 gpm for 12 seconds. Now how much air is entrained by a flow of 30 gpm for 12 seconds? Using Walter Haessler's data of 5,400 cfm for 180 gpm flow from a fog nozzle at 30<sup>o</sup> with 100 psi nozzle pressure, dividing 5,400 by 6 to produce a rate of flow of 30 gpm, and dividing again by 5 to get 12 seconds (1/5 minute) produces 180 cubic feet of air. This number is well below the range of airflows produced by smooth bore nozzles. The authors do not provide the data on time, but presumably a flow of more than one minute is needed for smooth bore nozzles to be effective.

The conclusion is immediate. A fog nozzle used properly and effectively entrains less air than a smooth bore nozzle used properly and effectively. In other words, these nozzle tests are largely irrelevant as far as fire ground realities are concerned. The shorter time needed for an effective fog attack using little drops of water does not require the entrainment of massive amounts of air into the fire area. The little drops of water with a surface area as much as 1,000 times greater than the surface area of a solid slug of water from a smooth bore nozzle truly have a remarkable fire fighting power. This is the real reason for choosing fog nozzles over a smooth bore nozzle. No other nozzle can come close to matching the capability of a fog nozzle to absorb heat.

A 1,250 cubic foot room is a small room. The authors make a rather unusual statement with respect to one room fires. They say

Almost anything works for a one room fire! (1-76)

The only incident cited to justify this statement is an incident observed by the authors where a one room fully involved kitchen fire was extinguished by a fire fighter using a booster line from outside the kitchen. I have never heard or read a statement anywhere or anytime that even remotely resembles the author's statement. Remember that we are talking about the most frequent type of fire encountered by fire departments in the United States. The NFPA reports that 75% of all structure fires occur in one or two family detached dwellings, and that almost 75% of all structure fires are extinguished with a single attack line that confines the fire to the room of origin.

I must respectfully disagree with the author's statement. Fire fighters can mess up even a one room fire if they do not know how to properly use their nozzles. This includes fog nozzles as well as smooth bore nozzles. It is easy enough to do this by using entirely too much water. In other words, excessive amounts of water applied to a confined fire produce thermal imbalance that hinders further operations. It is not massive amounts of air, but massive amounts of water that is the culprit.

I have always been impressed by a statement made by Floyd W. (Bill) Nelson in his book *Qualitative Fire Behavior*. He said:

In principle fire fighting is very simple. All one needs to do is put the right amount of water in the right place, and the fire is controlled.

I consider this to be the most profound statement that has ever been made about fighting fires. The key to this statement is "the right amount of water". Too little water, or too much water, will not work. In other words, almost anything does not work for a one room fire, or for any size fire. You must use the right amount of water.

The authors conducted a second series of nozzle tests this time with the nozzles located six to ten feet outside the compartment but inside the container with water being projected through a vent opening. Various ventilation situations were provided in the simulated fire room, from no ventilation to a window opening or a door opening opposite the vent opening. (2-72) No measurements were obtained in any of this testing. Vinyl tape or twine was used to show the direction of airflow into or out from the simulated fire room. The same results were obtained as in the first series of nozzle testing. (2-74)

I consider this second series of tests to be completely irrelevant, because no fog nozzle should ever be used outside a structure with the fire fighter standing six to ten feet away. The only exception would be using a straight stream and then only if safety considerations prevent a closer approach to the building. This constitutes “outstanding” fire fighting and is the least efficient and least effective method of fighting fires. No matter what the air flow involved, it should not be done. I will leave it to the authors to state whether “outstanding” fire fighting is appropriate or suitable for smooth bore nozzles.

There is one interesting section in article 1 concerning nozzle movement in which the authors cite the Fire Department of New York 1989 engine company operations manual. (1-72) This manual advocates rotating the nozzle in a clockwise manner and details the results obtained. The five statements, including the exact wording, are almost identical to statements made by Keith Royer, Director of the Fire Service Institute at Iowa State University, Ames, Iowa. This statement appeared in the Iowa State University Bulletin, No.18, in the 1950s. Keith Royer and Bill Nelson created the combination attack with the clockwise rotation of the fog nozzle. Incidentally the combination attack is not “outstanding” fire fighting, since the nozzle must be rotated inside the fire room with the nozzle person outside the window or door to the room.

The end of article 1 has a discussion of the contributions made by Chief Lloyd Layman during World War II. The authors claim that there has been a misinterpretation of indirect method of attack as developed by Chief Layman. There are several errors in the author’s presentation. First, there was only one test conducted with cotton bales in the hold of a ship. This was done in California at the end of Chief Layman’s service as Commandant of the Coast Guard Fire School. Prior to this, Chief Layman conducted dozens of tests on board at Liberty ship at Ft. McHenry in Baltimore, MD, extinguishing fuel oil fires below the deck plates in the engine room of this ship. Second, the authors claim that Chief Layman never suggested using fog nozzles inside a building. (1-78) However, three paragraphs later, Chief Layman is quoted as saying that it “may be possible and practical” to attack from an interior stairway below the involved floor. Third, the authors, like many others who have read Layman’s book, failed to recognize, or even mention, that Chief Layman spent three years from 1947 to 1950 as Chief of the Parkersburg, W.V. Fire Department perfecting the use of fog nozzles to fight Class A structure fires in Parkersburg. This was the first time in history in any town anywhere that fog nozzles were used for this purpose.

Unfortunately, there is one crucial bit of information about Chief Layman’s tactics in using fog nozzles in Parkersburg. In the ship testing water was injected into the engine room 25 to 30 feet above the deck plates. This was truly an indirect attack. However, the ceiling height in Parkersburg was only 8 feet high. Chief Layman instructed his fire fighters to distribute the water throughout the fire area, and he added that it took some skill to do this properly. What his instructions were, we simply do not know. Thus a truly indirect attack may not have been used. The only thing that we do know is that Chief Layman’s tactic was only 50% efficient in converting liquid water to steam.

Finally, the authors ask a question. Given all the fact presented above, why is anyone still using fog stream inside a fire building? I will tell you why.

- A fog nozzle is used to make a direct attack just as effectively as any other type nozzle. (straight stream)
- A fog nozzle is used to make a combination attack (direct and indirect attack) from an inside door into a room fully involved with fire.(30° pattern)
- A fog nozzle is used to make a 3D gas cooling pulse attack to stop rollover and prevent a flashover or backdraft from occurring.( 60° pattern)

The latter method of attack has already saved fire fighter’s lives, and this method of attack can only be done with a fog nozzle .These three methods of attack prove what the realities actually are for a safe and effective fog attack on the fire ground.

