LET THE PUMP DO THE WORK

Hose & nozzle tests show how you can pump the same gpm with less strain on firefighters

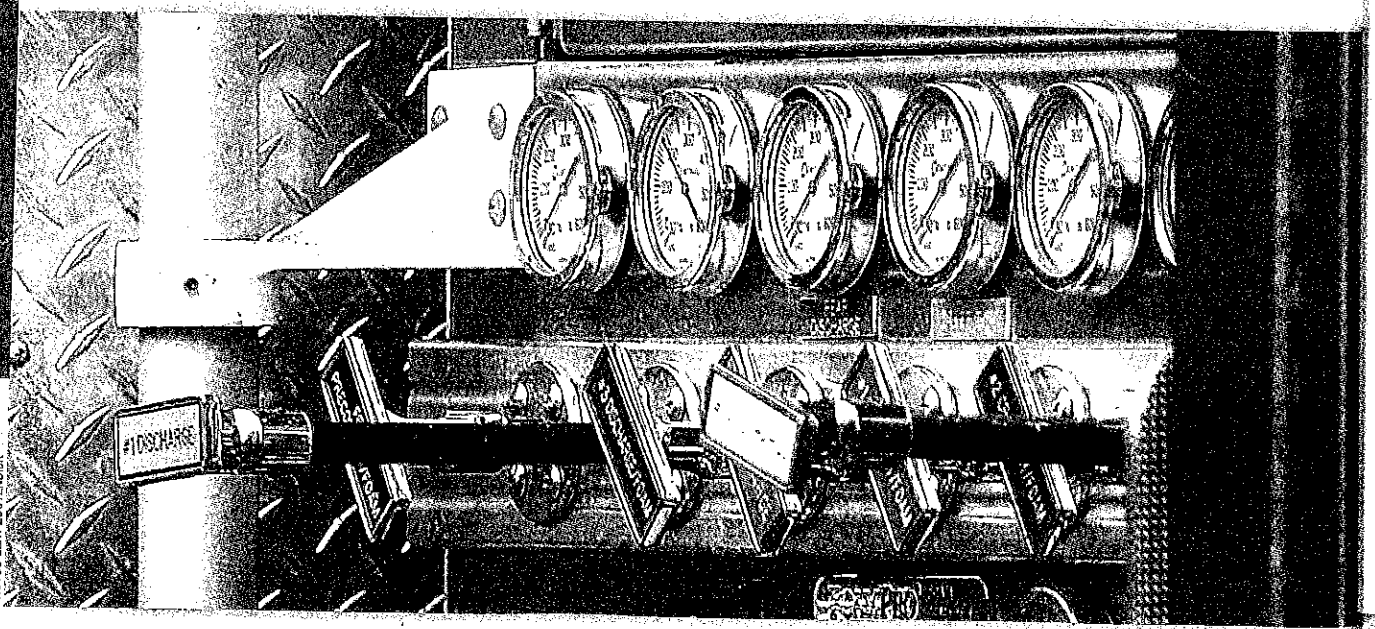
BY SKIP DORGAN

Few fire departments these days, regardless of whether they're career or volunteer, are staffed adequately for operations beyond routine incidents. What's *adequate* is up for discussion, certainly, but it's safe to say that very few departments are or will ever be staffed for the "big one." For the purposes of this article, we're going to consider a company consisting of less than four members as understaffed. We're also going to assume that the more water we can put on a fire, the better prepared we are for the big one.

With that in mind, how do we determine the gpm that we can realistically flow? To answer this question, we must address factors that affect water movement in handlines: the required hose size, hoseline length, friction loss, nozzle type, nozzle operating pressure and the corresponding nozzle reaction. We can't just rely on the gpm stats for a given nozzle.

And when determining what flow is realistic, we must look at nozzle reaction very carefully. If the line is too difficult to control, the first reaction the firefighter will have is to close the bale on the nozzle slightly to make the line easier to handle, which will reduce the amount of water coming out of the nozzle. Obviously, the problem here is that if we're not flowing what's required to extinguish the fire, the fire is going to kick our butts back out into the street—or much worse. When referring to nozzle reaction, *less* is desirable.

Keep in mind that a number of things, such as training, experience and teamwork,



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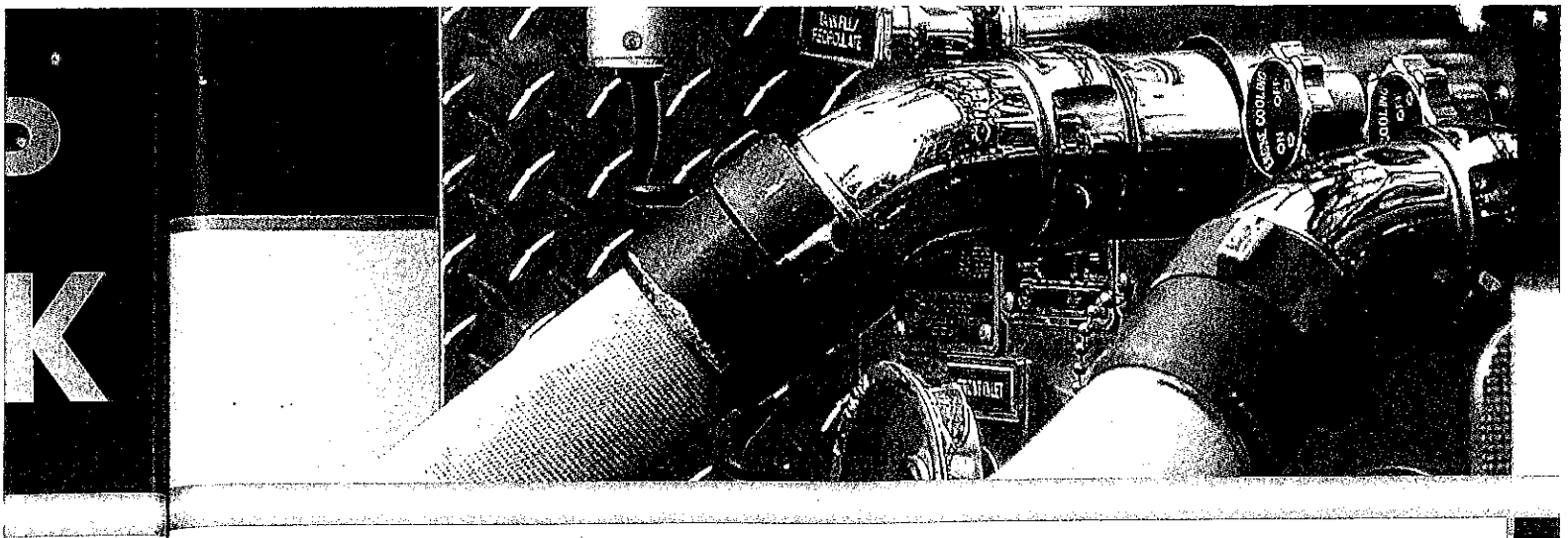


can also help overcome the effects of nozzle reaction. Some unscientific tests my department conducted have shown that a 1¾" handline equipped with a nozzle that had an operating pressure of 100 psi and flowed between 150 and 160 gpm (which, according to the Akron Brass Theoretical Dischaige and Reaction Chart for Fog Nozzles, puts the nozzle reaction at around 80 lbs.) was the upper end of what was considered optimum for a maneuverable handline by the firefighters involved in the testing.

With those thoughts in mind, in this article I'll demonstrate some hoseline comparisons and draw some recommendations about the right choice of line and nozzle for fire attack.

Note: We will assume that we have an officer and two firefighters available to do the required evolutions. For weight comparison, I used the same hose type and manufacturer (Ponn Conquest), chosen only because the needed information was easily obtainable.

The "conclusions" are strictly mine. Look at the information and see if you agree or disagree.

HOSE COMPARISON INFORMATION

1¾" hose contains 12.5 gallons of water per 100 feet of hose weighing 104.3 lbs.

- The weight of the water in 200 feet of hose is 208.6 lbs.
- 1¾" hose weighs 20 lbs. per 50 feet coupled
- The weight of the hose for a 200' line is approximately 80 lbs.
- Weight of the hose and water for 200 feet of 1¾" line is 288.6 lbs.

2" hose contains 16.3 gallons of water per 100 feet of hose weighing 135.9 lbs.

- The weight of the water in 200 feet of hose is 271.8 lbs.
- 2" hose weighs 22 lbs. per 50 feet coupled
- The weight of the hose for a 200' line is approximately 88 lbs.
- Weight of the hose and water for 200 feet of 2" line is 359.8 lbs.—approximately 25% heavier than the 1¾" line.

2½" hose contains 25.5 gallons of water per 100 feet of hose weighing 212.6 lbs.

- The weight of the water in 200 feet of hose is 425.2 lbs.
- 2½" hose weighs 31 lbs. per 50 feet coupled
- The weight of the hose for a 200' line is approximately 124 lbs.
- Weight of the hose and water for 200 feet of 2½" line is 549.2 lbs.—approximately 52% heavier than the 2" line and approximately 90% heavier than the 1¾" line.

Using this information, we'll do two comparisons.

- In the first example, we'll compare the operation of a 2" handline with that of a 2½" handline. The information for 1¾" hose is also provided because that's a hose size that most firefighters are familiar with handling, and that information can be used to compare the other two sizes of hose. In this example we'll look at flow and nozzle reaction using both smooth-bore and 100-psi operating pressure combination nozzles.
- In the second example, we'll compare 2½" hose with 3" for supplying a ground-mounted master stream, which is also applicable to fire department connections (FDCs) or other similar scenarios.

HOSE COMPARISON #1 (HIGH-FLOW HANDLINE)

1¾" Hose

- 1¾" hose, 200 feet long, pumped at 150 psi, with a combination nozzle, flows approximately 125 gpm with a nozzle reaction of 63 lbs.
- 1¾" hose, 200 feet long, pumped at 150 psi, with a smooth-bore 15/16" tip, flows approximately 185 gpm with a nozzle reaction of 70 lbs.

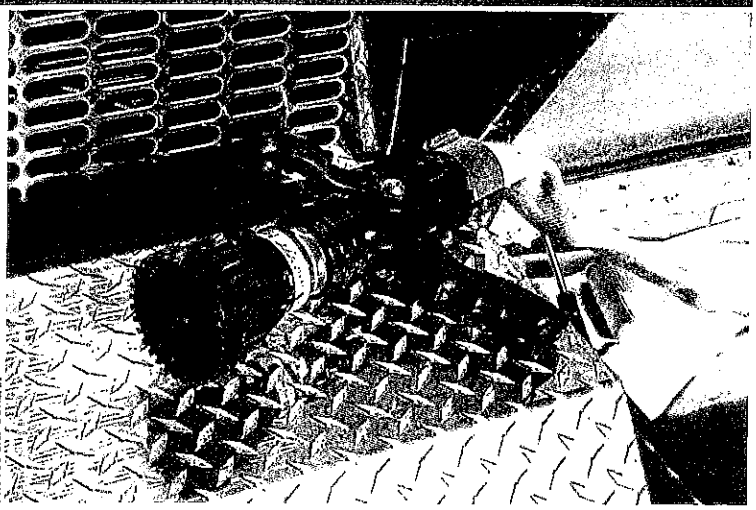
Observation:

- The smooth-bore flows 60 gpm more than the combination nozzle—or approximately 50% more water—with only approximately 11% more nozzle reaction.

2" Hose

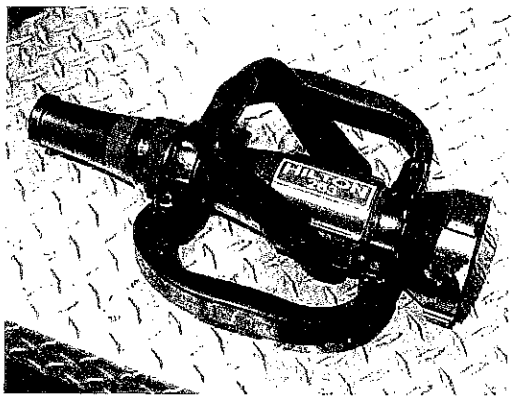
- 2" hose, 200 feet long, pumped at 160 psi, with a combination nozzle, flows approximately 185 gpm with a nozzle reaction of 93 lbs.
- 2" hose, 200 feet long, pumped at 160 psi, with a smooth-bore 1⅛" tip, flows approximately 265 gpm with a nozzle reaction of 99 lbs.

LET THE PUMP DO THE WORK



PHOTOS SKIP DORGAN

A 100-psi operating pressure automatic nozzle on a 1¾" handline (above), flowing between 150 and 160 gpm, is the upper end of what's considered maneuverable. The smooth-bore nozzle (right) can provide much greater flow with only a slight increase in handling difficulty. To simplify operations, smooth-bore nozzles should have one tip with the desired size.



Observations:

- The smooth-bore flows 80 gpm more than the combination nozzle—or approximately 44% more water—with only approximately 6% more nozzle reaction.
- Although it's about 25% heavier than the 1¾" hose, the 2" flows more than 40% more water when comparing smooth-bore tips.

2½" Hose

- 2½" hose, 200 feet long, pumped at 130 psi, with a combination nozzle, flows approximately 265 gpm with a nozzle reaction of 134 lbs.

Observations:

- The flow is approximately the same as the 2" hose with the smooth-bore and the nozzle reaction is 35 lbs. more—or approximately 35% more nozzle reaction.
- 2½" hose, 200 feet long, pumped at 80 psi, with a smooth-bore 1⅛" tip, flows approximately 265 gpm with a nozzle reaction of 99 lbs.

Overall Comparisons

- The flow and nozzle reaction are the same in the 2½" and the 2" hose.
- 2½" hose is approximately 52% heavier than the 2" line.
- 2" line would have to be pumped at 160 psi vs. the 2½" at 80 psi. ▶

PHOTO FIREGROUND 360

When setting up a master stream away from the engine, consider 3" hose. To flow 800 gpm 200 feet from the pumper, you'll need to stretch two 2½" lines, a total of 248 lbs. of hose, which will likely take twice the amount of time to stretch as one 3" line that weighs 152 lbs.

Using the 1⅛" tip flowing 265 gpm with a nozzle reaction of 99 lbs. as the comparison figures, we can conclude:

- 200 feet of charged 2" hose flowing 265 gpm with a nozzle reaction of 99 lbs. weighs approximately 359.8 lbs.
- 200 feet of charged 2½" hose flowing 265 gpm with a nozzle reaction of 99 lbs. weighs approximately 549.2 lbs.

Recommendations:

- Let the pump do the work, not the firefighters. The 2½" line weighs approximately 52% more than the 2" flowing the same amount of water with the same nozzle reaction. The 2" line would need to be pumped at 160 psi vs. the 80 psi for the 2½" line.
- The 2" hose, which has an operational weight that's 25% more than the 1¾", should probably not replace the 1¾" hose, which has proven to be effective for the majority of incidents, but it should be considered as an alternative to the 2½" handline in situations where a higher flowing, mobile line is required. The reason? It has the same flow characteristics, yet is approximately 34% lighter than a 2½" line.

HOSE COMPARISON #2 (MASTER STREAM REMOTE FROM THE APPARATUS)

We want to position a ground-mounted master stream 200 feet from the pumper and pump a 1¾" tip flowing 800 gpm.

2½" Hose

- One 200' section of 2½" hose flowing 800 gpm would need to be pumped at approximately 335 psi (obviously not a practical working pressure).
- Two 200' sections of 2½" hose flowing a total of 800 gpm would need to be pumped at approximately 145 psi.

3" Hose

- One 200' section of 3" line flowing 800 gpm would need to be pumped at approximately 185 psi.

Recommendations:

- Let the pump do the work, not the firefighters. To flow 800 gpm 200 feet from the pumper, we need to stretch two 2½" lines, a total of 248 lbs. of hose, which will likely take twice ▶

PHOTO GERT ZOUTENDIJK

Staffing is a problem at many departments, and when staffing is limited, carrying hose can be an issue. Spend some time testing what hoseline size and nozzle type works best for your department in different situations.

the amount of time to stretch as one 3" line that weighs 152 lbs. The two 2½" lines would be pumped at 145 psi vs. 185 psi required for the one 3" line.

MATCH THE HOSE TO THE SITUATION

Although the 1¾" hose should probably remain our primary fire attack tool based on its proven track record (particularly for fires inside of buildings) the smooth-bore tip's much greater flow at only a slight increase in handling difficulty would be worth looking at.

There are those who don't advocate smooth-bore tips. Reportedly one of the reasons is that they have problems with the hose kinking. Our experience says that this is more a problem with the hose than the type of nozzle.

For situations that require a greater flow from a handline that must still be mobile, the 2" hose looks like a better alternative than the 2½". The 2" is more than one-third lighter, yet it flows the same gpm with the same nozzle reaction as the much heavier 2½" hose.

For situations that require a greater flow for master stream operations, a single 3" line, while nearly 40% heavier than the 2½" hose, will flow twice as much—so only half as much hose needs to be deployed, potentially making for a faster and more efficient operation.

The flow and friction loss information provided for the various hose sizes was gathered from industry accepted sources. I suggest that you run actual water flow evolutions with the hose used by your department to see if the data comes out the same. Different hose has varying flow characteristics depending on the brand, manufacturer and age. After you've gathered the needed information, evaluate it and see if you agree or disagree with my conclusions.

Regardless, it makes for both great discussions and good training.

Skip Dorgan has served 33 years in the fire service, including 27 years as a career firefighter with the Kodak Fire Department in Rochester, N.Y., where he's presently a battalion chief. Previously, he was chief of a volunteer fire department. Dorgan holds an associate's degree in fire protection technology and is a nationally certified NFPA Level II Fire Instructor and Level II Fire Officer, and a New York State Fire Instructor.

A Weighty Issue

For more comparisons detailing how much weight each firefighter must carry when advancing handlines, and how that relates to gpm with different nozzles, go to http://tinyurl.com/hoseweight.