Fire Engineering

NOZZLES AND HANDLINES FOR INTERIOR OPERATIONS

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BY DAVID WOOD

The phrase "aggressive interior attack" is used frequently in the fire service, but what does it really mean? It implies that the first-due engine company`s primary function is to push a handline into the structure and control the fire. Separating the burning area from the uninvolved rooms that must be searched for occupants is the most vital function of the engine company. Putting water on the seat of the fire is the very heart of what we do. An old adage says that a properly placed hose stream will save more lives than any other action taken on the fireground. In these days of reduced staffing, it is all the more true. With today`s emphasis on technical rescue and EMS, basic engine company work is often overlooked and taken for granted. Do your engine companies truly have the ability to perform an aggressive interior attack? Establishing a minimum gallons-per-minute flow for interior handlines, flow testing the nozzles and hand-lines your engines are currently using, and assessing the actual handline practices your engine companies are employing must all be considered before you can answer this question.

MINIMUM GPM FOR INTERIOR HANDLINES

Has your department established a minimum gpm standard operating procedure (SOP) for interior handlines? If so, are you sure your firefighters are actually flowing it on the fireground? Is it based on experience and research and made after carefully considering the needs of engine companies operating inside burning structures? Is the gpm flow always available to the nozzleman, or does he have to turn a ring on the nozzle or call the pump operator for more water? Is the volume adequate to allow a nozzle team to rapidly advance through more than one burning room? Does it have a safety factor for those jobs where conditions deteriorate or when more fire than expected is encountered? If you cannot answer yes to all these questions, your engine companies may not be prepared for an interior attack on more than one room of fire. They may also be in danger.

Several formulas are used to calculate the minimum gpm required to extinguish a given volume of fire. The Iowa State formula (L 2 W 2 H / 100 4 gpm) has been taught to new firefighters since it was developed at Iowa State University in the 1950s. It calculates 13.44 gpm as the minimum required to control a fire in a 12- 2 14-foot room with eight-foot ceilings. Anyone who has responded to a fire at which a civilian with a garden hose has knocked down a room of fire through the window would most likely agree. Most firefighters, presuming they can crawl down the hall to the door of a burning room, would also agree that a 13-gpm stream would probably knock down the fire. While this may be technically correct, the formula does not provide a margin for error or a safety factor for the engine company using such a tactic from an interior position. Suppose that the engine company makes the door of the fire room just as an aerosol can full of a flammable propellant causes a BLEVE (boiling-liquid, expanding-vapor explosion). A window or sliding glass door that vents as the crew is advancing will allow the fire to quickly intensify. If the wind is blowing against the engine company, the results can be catastrophic. A fire presumed to involve only one room may have extended into the attic and is now roaring overhead, unknown to the firefighters below.

As more is learned about flashover, it becomes obvious that an engine crew armed with only a 13-gpm stream is in grave peril if the area in which they are located reaches flashover. A program about this phenomenon aired on educational TV graphically represents this. In just a few minutes, one small burning chair causes a room to flash over, and the fire quickly extends to adjacent areas. The prevalence of synthetic materials in our society makes the danger of flashover a real possibility at any fire to which we respond. Our engine companies must have enough water immediately available to protect themselves.

If we apply the Iowa State University formula to a fire scenario involving multiple rooms, the required minimum gpm will increase. A fire in the three bedrooms and hallway in my home would require a stream of 40 gpm to extinguish, according to the formula. This does not take into consideration the fact that a nozzle team would have to extinguish and cool the hall rapidly enough to crawl down its 20-foot length to reach the two rooms at the end. They would also have to knock down one room midway and then pass it as they pushed on.

To extinguish this fire, the nozzle team must have a stream with enough volume to cool the rooms quickly enough to occupy them and continue to advance the nozzle. They must be reasonably confident that the room they knocked down and passed will not light up behind them. In the real world in which engine companies operate, 40 gpm will not be effective or safe for extinguishing this fire.

Another formula, developed at the National Fire Academy (NFA), states the minimum gpm required to extinguish a given fire can be determined by dividing the square feet of the fire area by 3 (L 2 W / 3 4 gpm). It calculates the minimum flow for the same one-bedroom fire as 56 gpm.

Although this is more than four times the volume of the Iowa State formula, it is barely above the flow from a one-inch booster line. It will certainly extinguish the fire in the room, but the safety factor is nonexistent. In the scenario involving three bedrooms and the hall, the NFA formula calls for 167 gpm. This is a safer, more realistic figure and may account for the extensive amount of synthetic materials that makes today`s fires hotter and quicker to flash over than fires 30 years ago. An experienced engine company should be able to advance a stream flowing 167 gpm down the hallway and extinguish three rooms without a great deal of difficulty.

This is the principle behind setting a minimum gpm SOP for interior handlines. The nozzle team should have enough water available at all times to extinguish multiple rooms of fire. For those fires involving just the mattress or a corner of the room, the nozzleman applies a short burst from the stream. If the burning area involves one room, the nozzleman opens the nozzle a little longer. If multiple rooms of fire are encountered, the nozzle team can flow enough gpm to allow them to occupy the space that was just burning and move forward. Always having enough water available at the nozzle for the multiple-room fire provides the engine company with a safety factor for the unexpected. It also puts the control in the brain and hands of the nozzleman. A small fire requires just a dash, while the full gpm is instantly available when needed.

Some departments use nozzles that allow the nozzleman to increase the gpm by turning a selector ring on the nozzle. These nozzles usually work well, and the theory is sound most of the time. This system requires coordination, though, and leaves a chance for error. What works well at company drills is not always practical under fire conditions. There is a huge difference between practicing in the parking lot vs. advancing a handline down a burning hall and extinguishing three rooms. There is a possibility that the nozzle flow selector may be set at or changed accidentally to an insufficient gpm. If it occurs before the engine advances down the hall, the nozzleman may recognize that something is wrong. If it occurs during the advance, as the crew is crawling and falling over everything that gets in their way at a tough job, it may be difficult to recognize and correct. Halfway down the hall under brutal conditions and zero visibility is not the time to have to try and change the gpm setting.

Some fire departments assume that the nozzle team can request a boost in gpm by radio if the line cannot be advanced: The engine officer simply calls the pump operator on the radio and requests more gpm. This may work if the radios are working and if the officer can get through the busy radio traffic. If by chance the pump operator happens to hear and understand the officer`s request, the nozzle team might get the desired gpm. The point is, too many things can go wrong. If engine companies always have sufficient gpm available at the nozzle, they will be able to operate more safely and efficiently from interior positions.

WHAT GPM IS ADEQUATE?

The question then is, What minimum gpm flow is adequate and safe for interior firefighting operations? The answer, to a degree, will vary according to your department`s needs. As a member of a Fire Department of New York (FDNY) engine company for four years, I learned the value of a stream with a minimum flow of 180 gpm. Although higher flows may sometimes be required, the FDNY minimum flow SOP provides the engine company with a fire stream with three vital characteristics.

First, it gives the nozzle team the punch to extinguish the majority of multiple-room fires. A properly applied stream flowing 180 gpm will control most fires involving as many as five rooms, barring unusual circumstances such as strong winds. Multiple rooms of fire are extinguished by controlling one area or room at a time and keeping the nozzle moving forward. A stream of 180 gpm should allow the nozzle team to cool a room and rapidly advance into it and gain control of it. The nozzle team must keep advancing to extinguish the remaining rooms. If a room must be darkened down and then passed, as when advancing down a hall, the volume applied must be enough to keep the room from lighting back up. It is important for one member to monitor a passed room so that the nozzle team can be warned if the fire in the room reintensifies.

Second, a stream flowing 180 gpm gives a good indication of the severity of the situation. It is a potent offensive weapon in experienced hands. If an engine company is unable to advance a nozzle it knows is flowing 180 gpm, a different tactic may be called for. As John Norman writes in his Fire Officer`s Handbook of Tactics, Second Edition (Fire Engineering, 1998), more water, more ventilation, or both, may be called for. If this doesn`t allow the nozzle to advance, a change of tactics--from offensive to defensive, for example--may be necessary.

Third, 180 gpm provide a safety factor for the nozzle team and any truck personnel in the nozzle`s vicinity. If more fire than anticipated is met or conditions deteriorate, the flow will be sufficient to extinguish the fire or at least protect the members as they retreat. In most cases, if the area flashes over, the power of the stream will allow the engine company to save themselves. In this age of energy-efficient buildings full of synthetic wall/floor coverings and furnishings, this factor can be critical.

FDNY Firefighter Andrew Fredericks has well documented the capabilities of a stream flowing 180 gpm in his article "The 212-Inch Handline" (Fire Engineering, December 1996). All departments should develop a gpm SOP based on actual fireground experience and their specific needs. It should provide all the qualities previously discussed. The FDNY SOP of 180 gpm may not be exactly right for your fire department, but it will not be far off. The goal is to set a standard minimum gpm based on analysis of your fire situation and make a conscious decision with the effectiveness and safety of your engine companies in mind.

A disturbing trend has developed in which many departments` engine companies assume that they are flowing enough water from their handlines but actually are not. Many firefighters have no idea of, and have never thought about, how much water they have available at the nozzle. Since most of our fires involve one room or less, we have become overconfident. We usually get away with relatively low flows, becoming victims of our own success. The times we are driven out of the building, we blame it on too much fire. Was it actually the volume of fire that drove us off the fire floor or the inability to advance the nozzle because of insufficient flow? To be able to answer this question accurately, you must not only establish a minimum gpm but also ensure that your companies are flowing it.

FLOW TESTING

To accomplish this objective, you must actually flow test the nozzles and handlines currently used in your department. It is the only way to accurately assess how much your engine crews are flowing. You can use an engine with onboard flow- meters or a portable flowmeter. The portable unit (several brands are available) allows more versatility in testing. You will need also a pitot gauge and a smooth-bore nozzle of a known flow at a given nozzle pressure. These devices will be used to calibrate the flowmeter and ensure that the readings are accurate. An in-line pressure gauge that can be inserted between the nozzle and the last coupling will give you an idea of the nozzle pressure, but it is not essential.

To use the portable flowmeter, connect a supply line directly to a hydrant and into the inlet end of the meter`s flow tube. Connect another line from the outlet end of the flow tube into the auxiliary inlet on the pump. Attach the wire that transmits the flow reading between the flow tube and the flowmeter. Once the supply line from the hydrant is charged and the flowmeter is calibrated, the gpm flow of any handline off the engine can be easily determined. With this arrangement, multiple lines can be quickly flowed and tested. Every handline on the apparatus can be stretched. As long as only one line at a time is flowing, the gpm reading will be for that individual nozzle and hoseline. The gpm of water entering the pump will equal the volume flowing from the nozzle. This also allows rapid comparison between streams from different nozzles without disconnecting each time.

Another advantage of connecting the flowmeter on the inlet side of the pump is that it allows you to observe the correct pump discharge pressure needed to supply your target gpm to a specific nozzle/hoseline combination. Since the flow tube is on the inlet side of the pump, no additional friction loss occurs from a test device in the handline being flow tested. The alternative is to place the flow tube on a pump discharge. This will also work, but it allows testing of only the nozzle and line connected directly to the flow tube. Different nozzles and hoses must be disconnected and reconnected each time.

Once the flowmeter is in place, charge the supply line from the hydrant to the pump, and connect a handline with a smooth-bore nozzle to a discharge. A smooth bore is required for calibrating the meter, since a fog nozzle can`t be accurately measured with a pitot gauge. The gpm flow of the smooth bore at a given nozzle pressure must be known. For our purposes, a 1516-inch tip is connected to 134-inch hose. Have the pump operator start water in the handline and throttle up to a pump discharge pressure that will approximate 180 gpm (the flow of a 1516-inch tip at 50 psi). With the nozzle wide open, insert the pitot tube into the stream, and take a reading. Adjust the pump discharge pressure until the pitot gauge reads 50 psi. Now, without shutting down the nozzle or changing the pump discharge pressure, adjust the flowmeter until it reads 180 gpm. This calibrates the flowmeter and verifies that the flow reading is correct. If we were using a 78-inch tip, the flowmeter would be set at 160 gpm (the flow of a 78-inch tip at 50 psi). Once the meter has been calibrated to a smooth-bore nozzle, the flow from any nozzle and handline combination connected to the pump will be accurately displayed on the flowmeter.

A newer type of portable flowmeter, controlled by a computer chip, has made calibration easier. The unit can be calibrated by programming it for the size of the flow tube without flowing water. To use this type of meter, hook it up as described above. Increase the flow to the 1516-inch smooth bore until the flowmeter reads 180 gpm. At this point, the stream from the nozzle should be measured with a pitot gauge to verify the flow reading. The pitot gauge should indicate 50 psi nozzle pressure if the flowmeter has been correctly calibrated. If it does not, consult the operator`s manual, and make the necessary adjustments.

A good place to begin assessing your current handline practices is to give an engine company a fire scenario. With a flowmeter in place, have the members stretch a handline and flow water. To be as realistic and informative as possible, ask them to duplicate what they would actually do under fireground conditions. Repeat the test with several engine companies, and analyze the results. Is every unit meeting, or at least close to, the gpm flow established as the department required minimum? If so, you have verified that you are operating as the department has stipulated. All that is left to do is to make sure that all your engine companies continue to follow the SOP when operating. This can be accomplished through training and implementing a formal policy for interior handline operations.

If your engine companies are not flowing the desired gpm, you must investigate further. There may be several reasons for this. It may simply be a matter of education and training. Engine companies may be using low gpm flows based on the success they have had with one-room fires. Explain the need for having an adequate flow available immediately, as discussed earlier. Another reason may be that they simply don`t know what they are flowing. Since they usually get away with a low gpm, they have not considered the need for more. A more common reason may be the handling characteristics (i.gif>., nozzle reaction and maneuverability of the line) of the nozzle at flows sufficient to extinguish multiple rooms of fire.

HANDLING CHARACTERISTICS

Nozzle Reaction

Nozzle reaction is measured in pounds of force and determines how difficult a stream is to control. The higher the nozzle reaction, the harder the stream is to control. The lower the nozzle reaction, the easier the stream is to control. Nozzle reaction depends on the gpm flowing and the nozzle pressure at which it is flowed. It is roughly the same for a smooth-bore and a fog nozzle in the straight-stream position, if both the flow and nozzle pressure are the same. For our discussion, let`s assume that interior operations will be conducted with a solid-stream or fog nozzle in the straight-stream position.

There are different formulas to calculate nozzle reaction for smooth-bore and fog nozzles. All we need to know is that at a given flow (180 gpm in this case), the nozzle reaction will vary directly with the nozzle pressure. If the flow in gpm is held constant while the nozzle pressure is lowered, the nozzle reaction will be less, and the stream will be easier to control. The more the nozzle pressure is reduced at a given flow, the easier the stream will be to handle. As long as the stream has adequate reach and shape, the lower the nozzle pressure, the better. Fog nozzles that operate at low pressures also produce a straight stream with larger droplets than nozzles that operate at 100 psi. This allows a tighter straight-stream pattern that approaches the quality of a smooth bore in some low-pressure nozzles.

The other factor that must be considered is the pump discharge pressure needed to supply our target flow at the correct nozzle pressure. Simply put, nozzles that operate at 100 psi require higher pump discharge pressures. This means the hose will be stiffer and less maneuverable and the nozzle reaction at our target flow will be higher. Nozzles that operate at pressures lower than 100 psi require lower pump discharge pressures. The hose will be more maneuverable, and the nozzle reaction at our target flow will be less. The more we lower the pressure at which the nozzle operates, the more maneuverable the line and the lower the nozzle reaction. Kinks can be a problem, though, and must be managed.

Specific Nozzles

The smooth-bore, automatic-fog, and low-pressure fog nozzles are commonly used by engine companies. For our purposes, we will assume the following for each of these types of nozzles: a minimum flow of 180 gpm for all nozzles (if the desired gpm flow is different, adjust your testing and research accordingly; the principles em-ployed will be the same), and the nozzles will be used on 134-inch hose, which will allow flows of 180 gpm at relatively low pump discharge pressures.

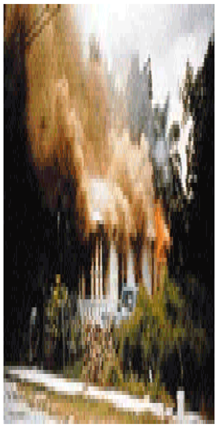
The smooth-bore nozzle. This nozzle type has been around for many years. It is still a popular choice because of its ability to deliver high gpm with low nozzle reaction at 50 psi nozzle pressure. A 1516-inch smooth bore delivers 180 gpm at 50 psi. The nozzle reaction is 69 pounds. In Fire Stream Management Handbook (Fire Engineering, 1991), David Fornell states that one firefighter can safely and comfortably control approximately 70 pounds of nozzle reaction. The 1516-inch smooth bore on 134-inch hose is a popular combination in many departments for this reason. It delivers 180 gpm with manageable nozzle reaction at relatively low pump discharge pressures. A 78-inch tip is another popular choice of smooth-bore advocates, delivering 161 gpm at 50 psi nozzle pressure with 60 pounds of nozzle reaction.

Automatic fog nozzles. Also used widely in departments, this type of nozzle operates through a range of gpms. A typical automatic for handlines may have a range of from 60 to 200 gpm. The nozzle has a large spring inside the barrel, which helps to shape the stream. At the upper end of the gpm range, the spring is compressed, allowing the deflector stem to move out. This increases the nozzle orifice and allows more water to flow from the nozzle. At the lower end of the nozzle`s gpm range, the spring is not compressed. This keeps the deflector stem in close, reducing the nozzle orifice and giving the stream good reach at low flows. This is exactly what the nozzle is designed to do. It is widely believed that automatic fog nozzles "automatically" maintain 100 psi nozzle pressure. This is not entirely true. The data sheet provided with the automatic nozzles used by my department shows that they operate through a range of nozzle pressures as well. At 60 gpm, these automatics have 65 psi of nozzle pressure and 24 pounds of nozzle reaction. At our target flow of 180 gpm, these automatics have 95 psi nozzle pressure and approximately 95 pounds of nozzle reaction. This is well above the 70-pound reaction that is readily controlled by one firefighter.

Engine companies must be aware of how automatic fog nozzles work to avoid the possibility of unknowingly flowing a dangerously low gpm. The nozzle reaction at 180 gpm is substantial and difficult to control. Firefighters are ingenious and quickly learn that lowering the pump discharge pressure still gives an adequate stream (or so they think) and one that is now manageable. They are being deceived into thinking that a low flow stream is adequate, because of the spring in the barrel of the nozzle, which provides a stream with good reach at 60 gpm. An analogy would be placing your thumb over the end of a garden hose. The stream will have good reach, but you still have a garden hose. This situation occurred in my own department. It was determined through flow testing that our engine companies were operating in interior positions with as little as 60 to 80 gpm. In talking with Fornell, who has done nozzle consulting all over the country, I learned that this is a common occurrence.

The key to operating an automatic nozzle at 180 gpm is to relieve the nozzle reaction from the nozzleman. In the FDNY Training Academy, I was taught that at least two firefighters are needed to control the nozzle reaction from an automatic at 180 gpm. We were taught that, as a rule of thumb, if one firefighter can easily control the nozzle, the flow is inadequate. At the time, I was not fully aware of the implications. The FDNY solution to absorb the nozzle reaction is the two-firefighter method, or nozzle-team concept. The backup firefighter must be on the same side of the hose as the nozzleman and must maintain physical contact with him. He turns his arms backward, clamping his hands on the hose and pulling against the nozzle reaction. He leans into the nozzleman with his body weight, which relieves almost all the reaction from the nozzleman. The backup man must be careful not to push the nozzleman faster than he wants to go. They must truly work together as a team. If the nozzleman moves left, around a corner, the backup man moves right. When the nozzleman directs the stream up, the backup man must keep the hose low. The technique works so well that it is also used with the smooth-bore nozzle. Although the smooth-bore reaction is considerably less than that of an automatic at the same flow, 180 gpm is a potent stream. The two-firefighter method is preferred with flows of 180 gpm, regardless of the type of nozzle used.

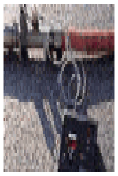
The low-pressure fog nozzle. If a standard fog nozzle operates at 100 psi, a low-pressure nozzle operates at pressures below 100 psi. As previously discussed, the lower we can get the nozzle pressure while maintaining gpm, the lower the nozzle reaction will be. As long as the stream has adequate reach and shape, the lower the pressure at which the nozzle



operates, the better it will be for the nozzle team. Consider three nozzles. Each flows 180 gpm at 100 psi, 75 psi, and 50 psi, respectively. The nozzle that flows 180 gpm at 50-psi nozzle pressure will be the easiest to control.

Low-pressure fog nozzles have been around for many years and are becoming very popular. Fire departments reluctant to switch to smooth-bore nozzles are learning that they can have the same easy handling characteristics for which the smooth bore is known, but with fog capability. Many different flow/ pressure combinations are available. The following rated nozzles are common and are growing in use by many good fire departments: 150 gpm at 75 psi (stated as 150@75), 175@75, and 200@75. Other low-pressure nozzles are also available.

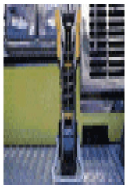
Quite by accident, while talking to a nozzle vendor, I came across the low-pressure nozzle to which my department is switch- ing. It is rated as a 250@100 psi nozzle. If it is rated at 100 psi, you may ask, how is it a low-pressure nozzle? The answer is that we "underpump" the nozzle to deliver 180 gpm at 50 psi nozzle pressure. Do those numbers sound familiar? They are the same as those of a 1516-inch smooth-bore nozzle with fog capability. The straight-stream pattern, which we use for most of our interior firefighting, is the closest to a smooth-bore stream I have ever seen. A vendor that sells nozzles to the Memphis Fire Department tells me that it is doing something very similar. It is underpumping a 200@75 to deliver 160@50. The concept is the same, only the target gpm is lower. The Memphis Fire Department has recognized the need to select a minimum standard gpm and reduce the nozzle pressure at which it is flowed.



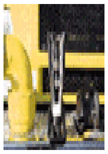
At ratings above 175 gpm, the different manufacturers increase the size of the nozzle body to accommodate the higher flows. At first glance, these nozzles look quite large and unwieldy. Nozzles should be purchased based on how they perform, not on how they look.

The initial impression of the awkward appearance of the 250@100 nozzles disappears the moment you flow 180 gpm through one of the nozzles. I believe it is the large barrel size that produces the excellent streams it delivers. Without a doubt, it produces a 180-gpm stream that is superior to any fog nozzle I have ever tested. The heavy droplets produced by the low nozzle pressure deliver a straight-stream pattern that rivals any smooth bore, with almost identical handling characteristics. The deflector stem is easily changed to convert a 250@100 to a 200@75.

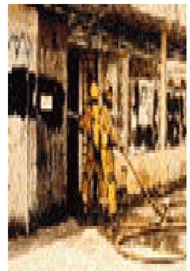
We have discussed the characteristics of a fire stream that will allow our engine companies to extinguish multiple rooms of fire from interior positions. Adequate volume and reach are vital for allowing the engine to push a handline into the seat of the fire. Using the two-firefighter nozzle-team concept, a stream that is adequate and safe for interior operations can be delivered by a smooth-bore, automatic-fog, or low-pressure fog nozzle. Nozzles that flow a given gpm at a lower nozzle pressure are easier to handle. Keep this in mind as you evaluate the way your engine companies are operating and consider new equipment purchases. For fire departments that do not have the luxury of six-firefighter ladder companies, the engine company`s ability to get a handline inside the structure and control the fire may be their only chance to save lives.

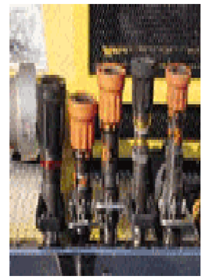


Don`t assume that your handline practices are effective or safe just because you are good at one-room fires. Every fire department should set a minimum gpm SOP for interior handlines and ensure that the engine companies are meeting it. This SOP should be based on experience and analysis, not on the basis of "because we`ve always done it that way." The standard should be established by conscious decision and not be allowed to just happen. The only way to know for sure is to perform actual flow tests and train. Engine companies must know exactly what their handlines are flowing to be effective and safe while operating inside burning buildings.



Frame house with fire and heavy smoke showing. The benchmark of a good engine company is the ability to advance a handline and extinguish multiple-room fires from interior positions. If presented with this fire, would your first-due engine company have the ability to perform an aggressive interior attack? (Photo by Jack Swerdloff.)





(Top left) Flowmeter in-line setup. A portable flowmeter placed in the supply line allows more versatility in testing. Multiple handlines may be stretched off the pump. After calibrating the meter, flowing any one handline at a time will give a gpm reading for that line. (Top right) Flowmeter calibration. Adjust the pump throttle until the nozzle pressure on a 1516-inch smooth-bore nozzle reads 50 psi on the pitot gauge. While still flowing water, adjust the flowmeter to read 180 gpm. The meter is now calibrated, and any type of nozzle can be flow tested. (Bottom right) Closeup of flowmeter with reading. A new type of flowmeter is controlled by a computer chip. It can be calibrated without flowing water and displays a digital readout. (Photos by author.)

(Above) Three fire streams from a distance. From right to left, a 1516-inch smooth-bore, 60-200 automatic, and 250@100 "low-pressure" nozzle. All nozzles are flowing 180 gpm. All three streams are adequate and safe for interior operations. (Right) From front to back, acceptable streams from smooth-bore, automatic, and 250@100 "low-pressure" nozzles. Note how the "heavy" straight stream from the 250@100 "low-pressure" nozzle matches the quality of the smooth bore. (Photos by author.)

This cutaway view of an automatic fog nozzle shows the heavy, internal spring. At high gpm, it compresses and lets the deflector stem move outward. At low gpm, it keeps the deflector stem in close and gives the stream reach. (Photo by author.)

This cutaway view of a 250@100 "low-pressure" also shows an internal spring, which is part of the flush feature of the nozzle and does not influence the reach of the stream. ThIs nozzle delivers 180 gpm at 50 psi nozzle pressure. (Photo by author.)

(Top left) Ineffective backup technique. Several firefighters are advancing the hoseline. Fire is showing from the doorway and heavy smoke from the eaves. Many firefighters are taught to back up the nozzleman from a position three feet back. This does very little to relieve the nozzle reaction. At higher nozzle flows, the hose will kink between them, and the nozzle will rear up like a cobra. (Photo by Al Griffin.) (Top right) Two-firefighter backup technique, kneeling. The backup firefighter clamps onto the hose and leans into the nozzleman. To advance, once the nozzleman shuts down, both firefighters crawl forward and quickly assume their positions. This method takes the reaction off the nozzleman. This automatic nozzle is flowing 180 gpm. (Photo by author.) (Bottom right) Two-firefighter backup technique, standing. This method also works in a standing position. The firefighters must work as a team. If the nozzleman goes left, the backup man goes right. If the nozzleman directs the stream up, the backup man keeps the line low. (Photo by author.)

There are many flow/pressure combinations available for "low-pressure" nozzles. On the right are two 175 gpm@75 psi, two-piece nozzles with integral 1516-inch smooth bore. The three nozzles on the left are 250 gpm@100 psi "low-pressure" nozzles. They deliver 180 gpm @50 psi. (Photo by author.)

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