Water Pressure and Volume of Water

Pressure Does Not Equal Volume

Captain Zach Polvino - August 2022

Water is essential to our success on the fire-ground. There are two sides to water, attack lines, and the supply side. Let's focus on the supply side. We know that without a supply of water, we cannot supply the attack lines.

Looking at supply and hydrant operations, there are two things at play - Hydrant Pressure and Water Volume. Let's define pressure and volume. The pressure in the water lines is the force used to move the water through the system and up through the hydrant. The volume of water is the amount of gallonage we can flow per minute. Pounds per square inch and gallons per minute are not the same.

To effectively fight fire, we need to balance both the volume of water needed and the pressures we pump at.

Engine Intakes

Traditionally, we have always used the 5" soft front suction on the front of the Engines to supply water from the hydrants to the pump. In Driver Training, we usually discuss other options such as the Officer Side and Driver Side Intakes, and the Auxiliary 2-1/2" Side Intakes. All of these flowing water into the pump, but not all are created equal. While the Front Intake is convenient for use, it has more Friction Loss than taking a feed directly into the pump from either side intake. The internal piping has numerous bends to make its way from the front bumper to the pump. Every inch of piping and every bend can reduce the pressure coming into the pump. Is it effective? Yes, but just keep in mind that there are other options. Part of being a good Engine Firefighter is the ability to think quickly and have Plan A, Plan B, and Plan C-Z, ready to go. Fluidity isn't just a term to describe water, it is the ability to think on the edges of the traditional box.

Engine Taking Multiple Feeds - 4" Side Intake and 2-1/2" Auxiliary Intake

Engine on the Hydrant with Front Suction Connected and 4" LDH connected from the 2-1/2" Outlet to the Side Intake

Hydrant Connection

There has been some discussion about this topic and adding the gate valve to the hydrant. There has also been some discussion about its value of it. My take is that I want it on the hydrant and an additional feed from it to the Pumper, again to capture as much water volume as possible, especially if it is a large fire and Master Streams are being utilized. Let's get as much water volume to the rigs as possible. At a recent driver training, we demonstrated that a single engine with multiple hookups on a hydrant was easily capable of flowing almost 1300 GPM.

Single Engine - High Flow GPM

On Wednesday, July 20, as part of the Engine Driver Training, we set up multiple feeds into the Engine. We had a 4" LDH from the hydrant to the Driver Side Intake, and a supplemental 2-1/2" Feed attached from the Hydrant to the Engine. We then flowed over 1300 Gallons Per Minute from the RAM Nozzle and the Deluge/Stang Nozzle. The RAM was flowing at approximately 502 GPM with the 1-3/8" Smooth Bore Tip, and the Stang flowing at approximately 813 GPM with the stacked tips removed to the 1-3/4" Smooth Bore Tip. We calculated the flow using the Elkhart Brass App Calculator factoring in the tip operating pressure and smooth bore orifice size opening. When measuring water flows, it is important to remember to read the pressure at the tip, or just before the appliance/nozzle. As a pump operator, the Pump Discharge Pressure will be higher due to the pressure needed to overcome the Friction Loss in the line.

So a few of the common questions asked about hydrant connections:

- Will adding an additional line from the hydrant to the Engine increase the intake pressure? No. Pressure is static. This tactic is about capturing more volume and directing more volume into the pump.

- Will adding an additional line to the Engine from the Hydrant rob pressure from yourself? No. Again the pressure is static. Opening additional outlets such as the 2-1/2" outlast on the hydrant in addition to the steamer, will not decrease the pressure.

Instead, adding additional lines will add the volume of water from the hydrant to the Engine Pump. While we read Pressure setting, not the pump discharges, we need the volume of water to supply attack lines and master streams. We can have a ton of pressure at the pump, but a little volume

of water which will not support many lines charged. Additionally, tremendous volume with no pressure will result in the same. A Motor Pump Operator needs to balance both pressure and volume to be efficient and effective.

Flowing Over 800 Plus GPM on the Stang Nozzle with 13/4" Tip — Pumped at 80 PSI, but Volume of Water Made the Stream Possible.

Water Supply for Master Stream Operations

Our Tower Ladder is equipped with dual-stacked tip master streams capable of flowing tremendous amounts of water. To achieve this, however, the Engine or Engines supplying it need to supply it with a tremendous volume of water. To achieve the volume needed, we need to supply the Truck with more than just a single 4" LDH connection. We have options here, as we can supply it with dual 4" LDH on both sides of the Truck, and additional supplemental 2-1/2" connections. The Truck's pump is capable of pumping adequate pressure up the tower, but it needs the volume. The volume of water is key, especially if we are going to remove some of the stacked tips to deliver massive amounts of water with reach and penetration.

We demonstrated this during Driver Training. We paired the Engine with Truck 6 and set up a massive water movement operation that included dual 4" feeds from the Engine to the Truck. This allowed us to flow both 2" Tips on the Tower Ladder. To support this operation, the Engine set up a Heavy Hydrant Hookup, with a 4" intake from the main hydrant steamer connection to the Side Intake, a 4" Connected front he 2-1/2" Outlet to the other Side Intake, and a supplemental 2-1/2" line to the auxiliary suction intake. We had about 50 PSI on the hydrant. Before the Truck was set up, we did flow from the Engine Stang Nozzle, pulling the tips off and flowing the 2" tip, delivering 1000 GPM with plenty of volume to give. Once the Truck was set up and feeds established we began flowing tremendous amounts of water. Because we offset the amount we flowed with a heavy hookup, we never dipped our residual intake pressure. At one point, we also opened the Stang which, with the added flow pushed us right to the limits of what the hydrant was capable of delivering. Again, this was flowing multiple master streams opened up all fully with 2" Tips opened. At 80 PSI, a 2" Tip is capable of delivering 1062 GPM. Factoring in Friction Loss for the elevation of the Tower Platform, we roughly estimated that we achieved flows of about 994 GPM per stream on the Tower. We estimated

that we had about 70 PSI at the tips. Per the flow charts and Elkhart calculator, we determined the flow rate, roughly giving us almost 2,000 GPM from the Truck.

Truck 6 Flowing both Master Streams with 2" Tips Delivering Massive GPM. Flows possible because of Multiple Intakes.

One other note about Tower Ladder Master Streams is that they need to be placed appropriately to d the most impact. Raising the tower above the roof line and raining down will not be as effective as positioning the Tower lower and aiming up allowing the stream to hit any ceiling structure and then rain down, covering a wider area of fire involvement. This has been shown effective in major cities with a ton of fire duty such as New York, and Boston.

Many view Master Streams as a Defensive tactic, which they are, however they can still be operated aggressively, meaning from a defensive posture we are still actively engaging and extinguishing the fire. The same holds for ground monitors such as the RAM.

Consider a store-front with heavy fire involvement, a quickly deployed RAM nozzle with adequate supply can knock down tremendous amounts of fire, while hand-lines are being stretched and a defensive posture is transitioned into an aggressive, offensive attack to knock out the rest of the fire. This is just another tactic we have at our disposal.

Chicago utilizes a similar method, with first due Engines knocking down fire blowing out the front with the Stang nozzle on tank water. A quick hit of 5-10 seconds knocks down the bulk of the fire, while a hydrant and feed are established, allowing the Engine Company to deploy landlines and make a push to knock down the rest of the fire.

Heavy Hookup - Dual 4" Feeds Going to the Engine Side Intakes, and additional 2-1/2" Feed

Tactical Application of Additional Feed

In the Summer of 2021, while operating at a large multi-company mutual aid commercial fire in Cheektowaga, FF Christopher and I assisted an Engine on a hydrant to get more volume of water by applying a supplemental 2-1/2" line from he hydrant to the pump. The Engine had the soft suction established and was straining to keep up with the demand. The hydrant was fortunately dressed with a ball valve on one of the 2-1/2" outlets. We ran the additional supply to the pumper and got them additional volume. Almost immediately after getting the additional volume of water into the pump you could hear the difference in the rig. This quick assist allowed the Engine operator to gain the additional water volume needed to supply what was being demanded. The hydrant pressure was good, but the Engine just did not have volume of water coming in needed to support the demand being placed on it by supplying a Master Stream atop a straight-stick and multiple hand-lines.

Final Thoughts

To deliver high volume water flows, we need high volume intakes. A large body of fire is only extinguished with high flow GPMs. Thinking and operating on the edges of our "Normal" operations can prove successful, and trining on these concepts can help build that muscle memory to be ready when we need to pull this trick out of our bags. We don't wish for luck, we make our own through hard work.

Engine Taking a Feed from he Hydrant and Supplying a 4" Feed off the Officer Side. In addition we utilized both 4" Intakes and the 4" Discharge off the Rear.

A few things to consider when sending and setting up a feed, especially with large, well-involved fires:

- Dressing the Hydrant - Take as many connections from the hydrant to the Engine, allowing us to get as much volume as we can.
- As the feeder pumper, consider dropping both the 4" line and a 2-1/2" to supply as much volume of water to the attack engine, or tower ladder as possible; for extended Tower Ladder operations, dual 4" feeds will give us a better advantage and greater volume of water.

It's better to drop a line and not need it, than to scramble to get another feed in place. The mark of a solid, high functioning company is preparation and preparedness, and taking initiative.