Big Water 101

Blackwood Fire Company
Engine Company Training

Engine Work

The job of the engine is to get water on the fire. Plain and simple. Accomplishing that can be a problem depending on the circumstances. We deliver the water in a number of ways, from simple to complicated.

- Portable Fire Extinguisher
- Pre-connected hand lines and tank water
- Un-pumped (cold water) supply line with like size lines or single lines
- Pumped supply lines with multiple lines and master streams.
- Relay pumped supply lines with multiple lines and master streams.

Big Water

Big fires are a rare occurrence and being creatures of habit, we have a tendency to employ the same tactics we use on the smaller, more run of the mill fire. Our tactics for dwelling and smaller apartment fires are sound and obviously effective, but our operations on the "Big One" need some work. The need for multiple streams flowing from 250 to 1000 GPM requires some changes and understanding of water supply.

Well, how much water do we really need?

Fire Flows

A simple method for determining the required fire flow is used by the National Fire Academy. Simply estimate the square footage of the building (length x width) and divide by 3 or, FF = LxW/3. Adjust for multiple floors of involvement by multiplying result times involved floors. Adjust for less than fully involved by dividing result by percentage of structure involved. The pre-fire plans carried in the engines and command vehicle supply building dimensions and should be used for this purpose.

College Plaza is "L" shaped, but approximately 60' deep x 118' long on one side and 120' on another or about 11,000 square feet. To find the required fire flow for this building divide the total area by 3, or 3600 GPM. That is the number if the building is 100% or fully involved. Further multiply by the ACTUAL involved percentage to find out what we needed to flow on arrival. For instance, if 25% of the building were involved upon arrival the fire flow would be 900 GPM. That is the flow we have to shoot for!

How Much Water Are We Flowing?

Hose	Nozzle	Nozzle Pressure	Flow	Tank Duration	NFA FF
1 ¾”	15/16” SB	50	185 GPM	4 minutes	555 sq. ft.
1 ¾”	TFT	100	180 GPM	4 minutes	555 sq. ft.
3 2 1/2"	1 1 ¼” SB	50	325 GPM	2:20	975 sq. ft. 45
Deck Gun	Fog Tip	100	1000 GPM	45 sec.	3000 sq. ft.
Deck Gun	2” SB	80	1000 GPM	45 sec.	3000 sq. ft.
Deck Gun	1 ¾” SB	80	800 GPM	56 sec.	2400 sq. ft.
Deck Gun	1 ½” SB	80	600 GPM	1:15	1800 sq. ft.
Deck Gun	1 3/8” SB	80	500 GPM	1:30	1500 sq. ft.

Just How Fast Can We Get a 5” Laid and Water Supply Established?

Types of Hose Lays

Straight Lay – The engine stops on the way in, wraps the hydrant and lays into the scene. If necessary, a second engine responds to and pumps the hydrant. The advantage here is that the work is done prior to arrival and it is the fastest *sustained* water supply. The disadvantage is that the second engine may have its crew and all equipment quite a distance from the fire.

Reverse Lay – Starting at the scene, an engine lays to the hydrant and pumps the line. The advantage here is that the crew and equipment on the engine can be deployed before it starts its lay. The disadvantage is trying to get into the fire scene and maneuver back to the hydrant with additional apparatus responding in.

Split Lay – The first engine lays in partially (courts, driveways, parking lots) and the second engine either performs a reverse or straight lay to make up to the partial lay.

Water Supply

It becomes obvious that establishing the water supply *rapidly* is the TOP priority at the BIG fire. Although not the least bit glamorous it is essential that the first engine begin to establish a water supply of at least the required fire flow or their rated capacity, which ever is smaller and the next arriving engines support that effort and begin to develop additional water supplies. Concentrate on getting one good supply and build on it. Throughout this discussion we will concentrate on getting 1500 GPM to the fire, which is well within the abilities of our engines, hose and water supply system.

How much 5" can we lay and still pump 1500 GPM without an engine on the hydrant?

Not Much. Assuming we have 60 psi on the hydrant and we need 20 psi residual at the fire, friction loss will overcome the hydrant discharge pressure at lays over 200'. An engine must be placed on the hydrant and set up to take advantage of all the water available by utilizing all of the hydrants discharges. 2 stage pumps must be in "Volume" and the largest discharges utilized. Engines should NOT pump through hydrant valves when high flows are desired.

Fire Flows and Hose Lays With no Engine on Hydrant

Assuming 60 psi on Hydrant

750 GPM – 800'
1000 GPM – 500'
1250 GPM – 300'
1500 GPM – 200'

How much 5" can we lay with a pump on the hydrant and maintain 1500 GPM?

About 800'. This allows for a pump discharge pressure of 175 psi minus 150 psi for friction loss, leaving 25 psi residual at the intake of the fire ground engine.

Why 175 psi?

The maximum pressure for large diameter hose is 185 psi. This simply gives us a cushion and allows some flexibility if additional water is needed**.**

What if we have to go farther than 800'?

Then we need to add additional engines and start a relay pump operation. We need to place an engine in-line at each 800' interval until the lay is complete. For instance, if we had a 2000' lay, we would use one engine at the hydrant, one engine at 800', one engine at 1600' and one engine at 2000', which would be the fire. This would total 4 engines. When in a relay, the hydrant engine and the fire ground engines are the only 2 to require communications. The relay engines, whether there be 1, 2 or 20 need only to monitor their radio and their intake gauge. Anticipate increases or decreases in flow and maintain residual pressure at 20 psi.

What about 4" hose?

As we saw in the 1997 fire, 4" hose is a lot less similar to 5" than you may have thought. First, 4" is much better suited to flow 1000 gpm rather than 1500 gpm as the 5" does. The 800' interval we discussed above with an engine on the hydrant to obtain 1500 gpm now becomes a 750' lay to obtain 1000 gpm. Let's look at the evolution in 1997 where we attempted to supply 844 with a 4" line being pumped 600' by a 2000 gpm engine on the hydrant.

Needed flow: 1000 gpm (rated flow for the snorkel platform)

Friction loss in 600' of 4" hose: 120 psi.

Elevation: 37 psi (.434 psi per foot x 85')

Nozzle Pressure: 80 psi.

To successfully complete this evolution, the supply engine would have had to pump at over 250 psi (including loss for appliances). That is 65 psi over the service pressure for the 4" hose and at the upper limits of the fire pump.

What if we had used 5"?

Needed flow: 1000 gpm

Friction loss for 600' of 5" hose: 48 psi.

Elevation: 37 psi.

Nozzle Pressure: 80 psi.

This evolution would require approximately 175 psi at the pump, or 10 psi <u>under</u> the service pressure of the 5" hose.

How about if we put 844's pump into the equation?

Using the 1997 example, just using 844 as a relay pump solves a lot of the problems. We still need 1000 gpm and we still have 120 psi friction loss for the hydrant pumper to make up. When you add in the residual of 20 psi at the snorkel pump intake, you have a pump pressure of 140 psi for the hydrant engine. Very manageable and it leaves us with a margin to supply more water if necessary. What happened to the elevation and nozzle pressure? They are 844's problem. As long as the hose brings the flow (1000 gpm) to 844's pump, it is up to 844's pump to supply the 80 psi for the nozzle and 37 psi for the elevation in addition to loss for appliances. This requires 844 also to pump at well under 150 psi, again, very manageable.

How much can that hydrant flow?

2 key terms should be understood here. Residual pressure and static pressure. Static pressure is the reading we get on the pump suction gauge with the hydrant charged, intake valve opened and no water flowing. Residual is the pressure remaining after we have started flowing water. Residual pressure should be maintained at no less than 20 psi in most cases. 20 psi protects the water system from a negative pressure situation which could allow contaminates in and it protects the fire pump from cavitation. The pump operator should open the hydrant with no pump discharges open and make a mental note of the static pressure reading. Once water flow is started and stabilized, check the residual pressure. The percentage that the pressure dropped is the key to determining how much more water is available.

Additional Water Available at a Hydrant

Percent Decrease of Pumper Intake Pressure	Additional Water Available
0 – 10 %	3 times the amount flowing.
11 – 15%	2 times the amount flowing.
16 – 25%	Same amount as is flowing.
>25%	More water may be available, but not as much as is flowing.

For example, E-841 hooks up to a hydrant to supply E-842. The hydrant is connected and opened and the pump operator notes a static pressure of 70 psi. The pump operator opens the discharge and begins pumping to E-842, when flow is stabilized, the intake gauge indicates a residual pressure of 63 psi. If E-841 is pumping 750 GPM, how much more water is available from this hydrant?

Use this formula:

$$\text{Percent Drop} = \frac{(\text{Static-Residual})100}{\text{Static}}$$

$$\text{Percent Drop} = \frac{(70-63)100}{70}$$

$$\text{Percent Drop} = \frac{700}{70}$$

Percent Drop = 10% = 3 times more water or 2250 GPM.

How do we get the most out of the hydrant?

- Kinks are major flow killers for LDH. Make sure all bends are smooth and the line is not kinked. Taking the time to do this pays off on the other end. If necessary, notify command and shut down lines to resolve major kinks.
- Take advantage of all hydrant ports. Install gate valves on both 2 ½" ports for using all available water. Use 5" for these supplies where possible.
- Discharge through the largest discharge ports on the engine.
- Ensure all valves are FULLY open and then lock them in place.
- Maintain desired pressure (do not exceed 185 psi discharge pressure on LDH)
- Use 2 ½ x 5" adapters for 2 barrel hydrants.

The hydrant engine is at full flow and still has a high residual!

A number of our hydrants can flow more than one engine or 5" LDH can move. If we have additional available water, there are a number of ways to take advantage of it.

- Lay another LDH to the hydrant and let the same engine pump it.
- Dual pump the hydrant with another LDH. If the available water at the hydrant is more than the combined rated capacity of the 2 engines being supplied, dual pumping can be used. For instance, E-841 is pumping 1500 gpm through one 5" line and the residual pressure indicates that at least another 1500 is available. E-842 would be connected to E-841, intake to intake and would pump a second LDH from the same hydrant.

Some Basics

- The IC must determine where the priority for placing lines into service will be and work to put water at those points. You can't cover everything at once.
- Establishing big water WILL NOT be as quick as attacking with tank water, but it will be long lasting. Don't lose sight of this!
- Remember that 5" has limitations. Lay additional lines early and often. Consider the fact that EACH elevated or master stream may warrant an additional line for effective flow.
- Unless immediate exposure protection or support of search is indicated, do NOT deploy 1 ¾" hose lines. Concentrate available water into high flow streams.
- Assign resources to get one line in service at a time. If it takes the first 3 engines to properly set up a relay, this needs to be done. Call for help.