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Rural Fire Command

by

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Fluid Motion, Part 3

Dry Hydrants Are Really Pump Suction Extensions

RFI

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Training America's Rural Fire & Emergency Responders

A Message the Author, Larry Davis

In October 2002, I started writing the monthly "Rural Fire Command" column for *FireRescue Magazine*. Since that time, the RFC column has been carried in just about every subsequent issue of the magazine.

As time has passed, several readers have contacted me about obtaining back issues of the column. Some expressed an interest in acquiring the articles in Powerpoint format for use in training programs.

This led to, my adaptation of the RFC columns to the PowerPoint format. These PowerPoint programs are being made available through the combined efforts of *FireRescue Magazine* and the Rural Firefighting Institute.

Dry Hydrants Are Really Pump Suction Extensions

- The Fallacy of Dry Hydrants
- Dry-Hydrant Piping
- Pressure Losses & MUP
- A Real Life Application

Some Things to Consider

If a rural department insists on using a front or rear suction for drafting operations, firefighters must test the piping to determine what maximum flow it can deliver to the pumper, & realize that a second suction line will give them the biggest bang for their buck.

A dry hydrant is actually a permanently installed suction pipe, which is an extension of a fire pump's drafting system.

The piping & fittings in dry hydrants produce additional friction losses that impede a pump's ability to draft water.

Increasing the diameter & shortening the overall length of the pipe can greatly impact a dry hydrant's potential delivery rate.

In the November 2004 installment, I explained how friction losses in front and rear suction piping can significantly reduce a pumper's drafting capability. These piping arrangements, which cost about $6,000, seem convenient, but generally reduce a pump's capacity—especially with 1250-gpm and larger pumps.

If a rural department insists on using a front or rear suction for drafting operations, firefighters must test the piping to see what maximum flow and discharge pressure the suction can attain, and realize a second suction line will give them the biggest bang for their buck.

Figure 1 shows a pumper operating at a tanker fill site and using both its front suction and a side suction to maximize the fill rate.

Figure 1. To get the highest flow for a tanker fill operation, a front suction must be supplemented with a side suction. If a side intake valve is not provided, the side suction must be connected first to get the operation working. Once the side suction is operating, the valved front suction can then be used. A good driver/operator can then prime the front suction by opening the suction valve ever so slowly without ever having to hit the primer.

The Fallacy of Dry Hydrants

Installing piping arrangements, or dry hydrants, is one of the most popular methods of enhancing rural water supplies. The term ***dry hydrant*** is really a misnomer, but it's been around for so long, it's virtually impossible to change.

A dry hydrant is actually a ***permanently installed suction pipe***, which is an extension of a fire pump's suction system. From a performance standpoint, the piping and fittings in a dry hydrant incur additional friction losses that impede the pump's ability to draft water.

Depending on a dry hydrant's specific piping arrangement, the friction losses can run quite high. Figure 2 shows the friction loss values for various diameters of PVC pipe while Figure 3 shows the equivalent lengths of pipe for the various fittings commonly used in dry hydrants.

Friction Loss (psi/100 ft) of PVCPipe

Flow (gpm)	4"	6"	8"	10"
300	1.4	.3		
400	2.4	.4		
500	3.7	.6	.2	
600	5.2	.9	.2	
700	6.9	1.2	.3	
750	7.8	1.3	.4	
800	8.8	1.5	.4	.26
900	11.0	1.9	.5	.32
1000	13.3	2.3	.6	.39
1050	14.6	2.2	.7	.42
1100	15.9	2.7	.7	.46
1200		3.2	.9	.54
1250		3.5	.9	.59
1300		3.7	1.0	.63
1400		4.3	1.1	.72
1500		4.8	1.3	.82
2000		8.2	2.2	1.40

Figure 2. This table shows the friction loss per 100 feet of the various diameters of PVC pipe at various flows.

As can be seen, the friction loss is a function of:

- the flow
- the diameter of pipe
- the length of pipe

Equivalent Length (ft of pipe) of Fittings and Valves

	4"	6"	8"	10"
45° Elbow*	4	7	9	13
90° Standard Elbow*	10	14	18	27
90° Long-Turn Elbow*	6	9	13	18
Tee or Cross (flow at 90°)*	20	30	35	60
Swing Check Valve*	22	32	45	65
Dry Hydrant Strainer	5	5	5	5

*Source: *Fire Protection Handbook*, 18th ed.

Figure 3. This table shows the equivalent length of pipe for fittings used in dry hydrant piping. For example, a standard 6” x 90° elbow has the same friction loss as 14 feet of 6” pipe.

Dry Hydrant Piping

Another component required in a dry hydrant installation is a strainer. One major strainer manufacturer for industrial installations figures friction loss in a strainer is equivalent to about 5 feet of the pipe used in the dry hydrant.

Historically, most dry hydrant standards have required that the minimum diameter of pipe used in a dry hydrant should be 6”. As is the case in many standards, the minimum requirement ends up becoming the maximum used.

Unfortunately, this minimum diameter doesn’t take into account the overall length of the pipe used in the dry hydrant. As far as I can tell, the 6” minimum diameter has been around forever and was originally predicated on a dry hydrant providing 500 gpm — since 500 gpm was better than nothing. This was also at the time when 500-gpm and 750-gpm pumpers were considered the norm for rural departments. Today, however, 1,500-gpm and even 2,000-gpm pumpers are not uncommon in rural departments.

If a department is going to go to all the time and trouble to get the required permits, and design and install a dry hydrant, it should design it to flow at least 1,000 gpm, and preferably 1,500 gpm.

If a department must pay to have a dry hydrant installed, the biggest cost will be for the backhoe and its operator to dig the ditch. Once the ditch is dug, it is wide enough to accommodate pipe much larger than 6”. And compared to the cost of the ditch, the cost difference between 6", 8" and 10" pipe is almost insignificant.

A dry hydrant installation should be designed to provide the maximum potential delivery rate and not on some minimum diameter arbitrarily decided upon by some group of people.

MUP & Pressures Losses Determine Delivery Rate

When drafting through a dry hydrant, we must remember that it is the *maximum usable pressure* (MUP) available and the pressure losses within a dry hydrant that determine the delivery rate (gpm) from the dry hydrant.

Figure 4 shows a sketch of a 6" PVC dry hydrant. The piping consists of:

- a strainer,
- 60 feet of 6" pipe,
- a 90-degree elbow,
- 15 feet of 6" pipe,
- a 90-degree elbow, and
- 2 feet of 6" pipe.

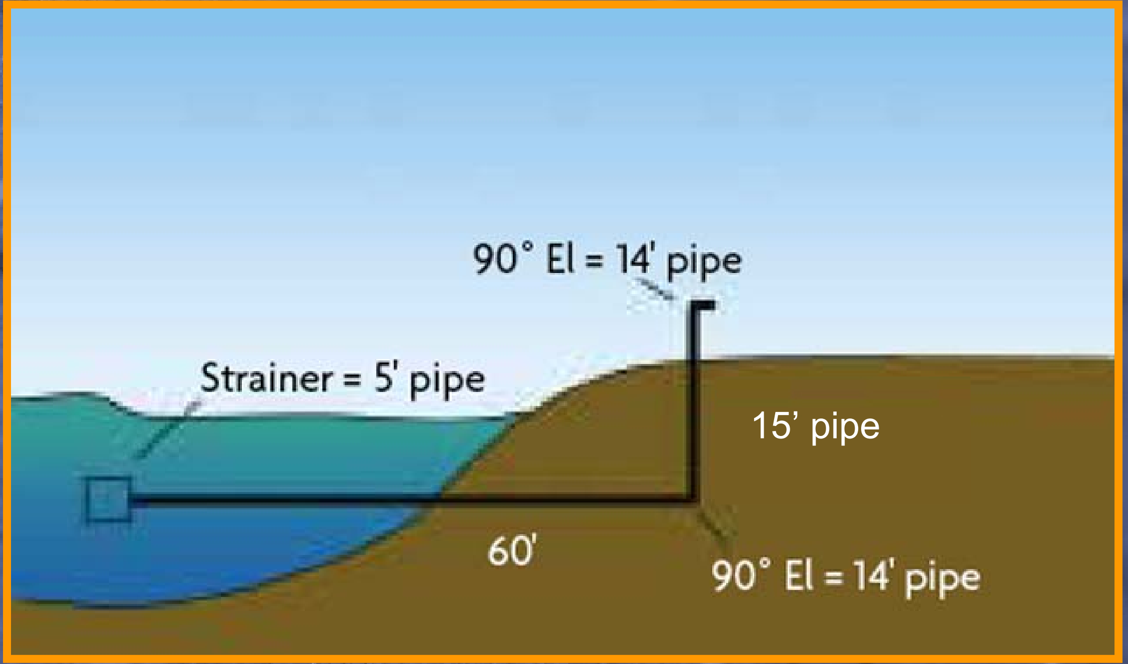


Figure 4.

Determining the Maximum Delivery Rate Possible

Let's use the example of the dry hydrant shown in Figure 4 to explore the process used to determine the delivery rate from a given dry hydrant under a given set of conditions that impact MUP. In this case, the target flow will be 500 gpm. The procedure for doing this is:

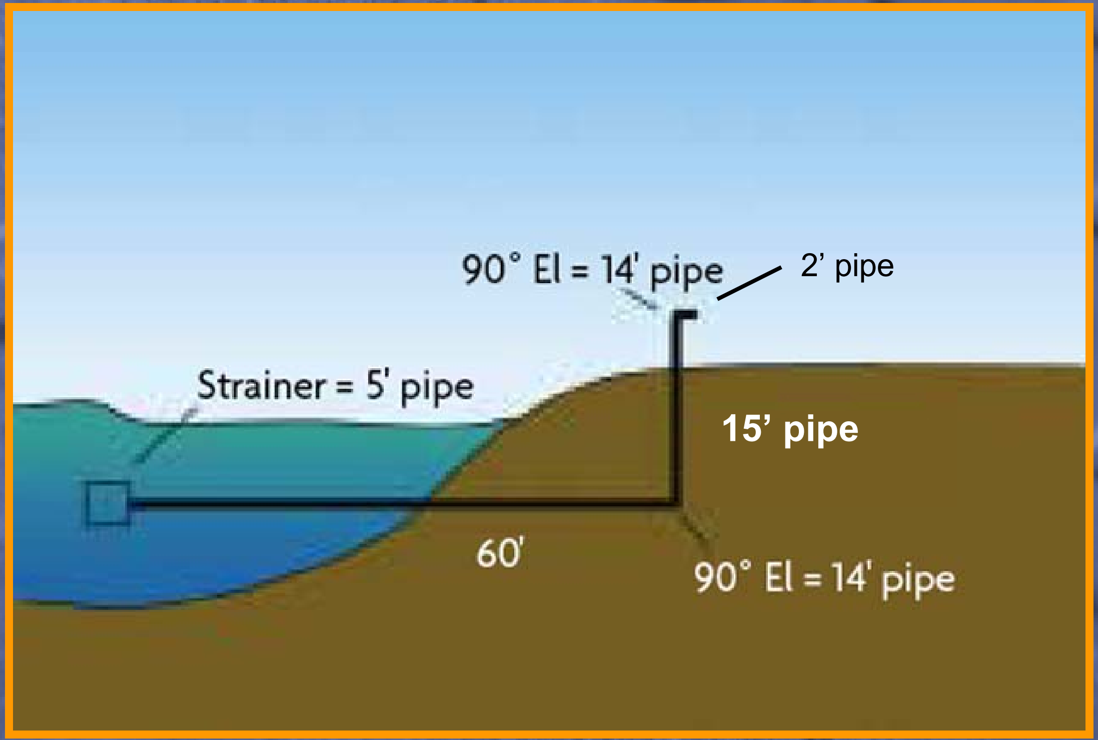
1. Calculate the total equivalent length of pipe in the dry hydrant pipe and fittings

2. Determine the MUP of the dry hydrant drafting conditions

3. Determine the friction losses in the dry hydrant and suction hose at the target flow (500 gpm).

4. Subtract the friction loss at the target flow from the MUP. If MUP is greater than 0, the target flow can be delivered; if not, the target flow cannot be delivered through the dry hydrant.

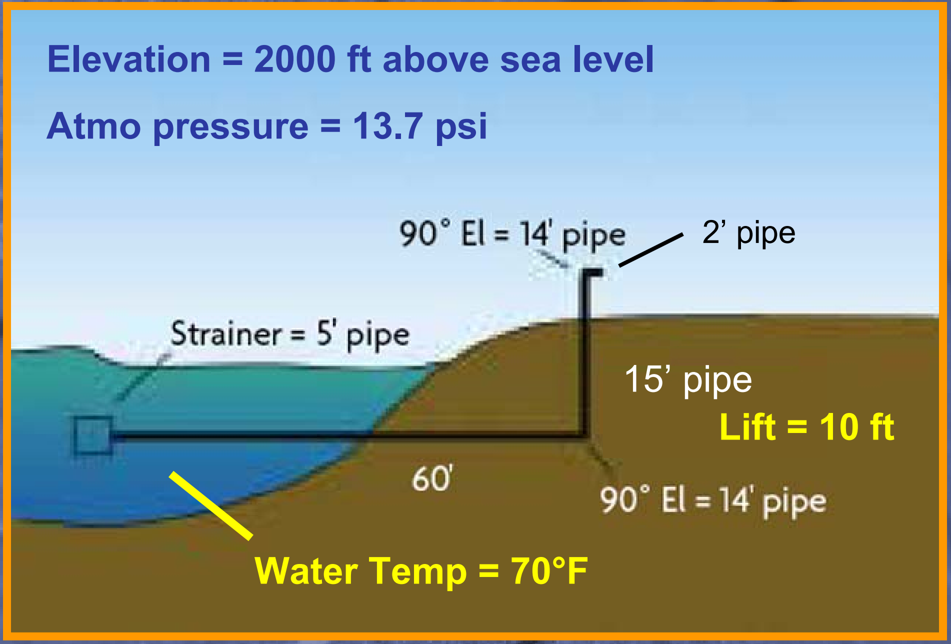
Step 1: Total Equivalent Length of 6” Pipe



- Total length of 6” pipe = 60 ft + 15 ft + 2 ft = 77 ft
- Two 90° elbows = 2 x 14 ft = 28 ft
- Strainer = 5 ft

Total equivalent length of dry hydrant piping = 110 ft

Conditions at Dry Hydrant Drafting Site



- Elevation = 2000 ft above sea level
- Atmospheric pressure (AP) at this elevation = 13.7 psi
- Water temperature = 70°F
- Static lift = 10 ft

Step 2: Determining Maximum Usable Pressure

MUP = atmo psi - vapor pressure loss - static lift loss - 5

MUP at this site = 13.7 - .36 - 4.3 - 5 = 4.04 psi

The MUP at this draft site based on ambient conditions is 4.04 psi. This is the maximum pressure that can be lost to friction in the dry hydrant piping and the suction hosed used to hook-up to the dry hydrant.

Note: The factors that influence MUP and the method to determine MUP at a given draft site were explain in Installment 23 — October 2004.

Step 3: Calculating Friction Loss at 500 gpm Flow

1. Using Fig. 2, the FL in 100 ft of 6” pipe at 500 gpm = 0.6 psi/100 ft
2. The FL in 110 ft of pipe is then 110 ft/100 ft x 6 psi/100 ft = 0.66 psi
3. The FL in 10 ft of 6” suction at 500 gpm = 0.1 psi
4. The total FL at 500 gpm = 0.63 psi + 0.1 psi = .67 psi

Step 4: Subtract FL from MUP

1. MUP - FL = 4.04 psi - 0.67 psi = 3.37 psi

Since MUP exceeds the FL by 3.37 psi, the 500-gpm delivery rate can be delivered through the dry hydrant piping and the 10-ft length of 6” suction hose under these set of conditions.

The next question is whether or not 1000 gpm can be delivered from the dry hydrant. To answer this question, the same process is used.

Calculating Friction Loss at 1000 gpm Flow

1. Using Fig. 2, the FL in 100 ft of 6” pipe at 1000 gpm = 2.3 psi/100 ft
2. The FL in 110 ft of pipe is then 110 ft/100 ft x 2.3 psi/100 ft = 2.53 psi
3. The FL in 10 ft of 6” suction at 1000 gpm = 0.3 psi
4. The total FL at 1000 gpm = 2.53 psi + 0.3 psi = 2.83 psi

Subtract FL from MUP

1. MUP - FL = 4.04 psi - 2.83 psi = 1.21 psi

Since MUP exceeds the FL by 1.21 psi, the 1000-gpm delivery rate can be delivered through the dry hydrant piping and the 10-ft length of 6” suction hose under these set of conditions.

The next question is whether or not 1500 gpm can be delivered from the dry hydrant. To answer this question, the same process is used.

Calculating Friction Loss at 1500 gpm Flow

1. Using Fig. 2, the FL in 100 ft of 6” pipe at 1500 gpm = 4.8 psi/100 ft
2. The FL in 110 ft of pipe is then 110 ft/100 ft x 4.8 psi/100 ft = 5.28 psi
3. The FL in 10 ft of 6” suction at 1500 gpm = 0.6 psi
4. The total FL at 1500 gpm = 5.28 psi + 0.6 psi = 5.88 psi

Subtract FL from MUP

1. MUP - FL = 4.04 psi - 5.88 psi = -1.84 psi

Since FL exceeds the MUP by 1.84 psi, the 1500-gpm delivery rate cannot be delivered through the dry hydrant piping and the 10-ft length of 6” suction hose under these set of conditions.

Let's look at what we could do to improve the flow from the dry hydrant if we break with tradition and tweak its design a bit.

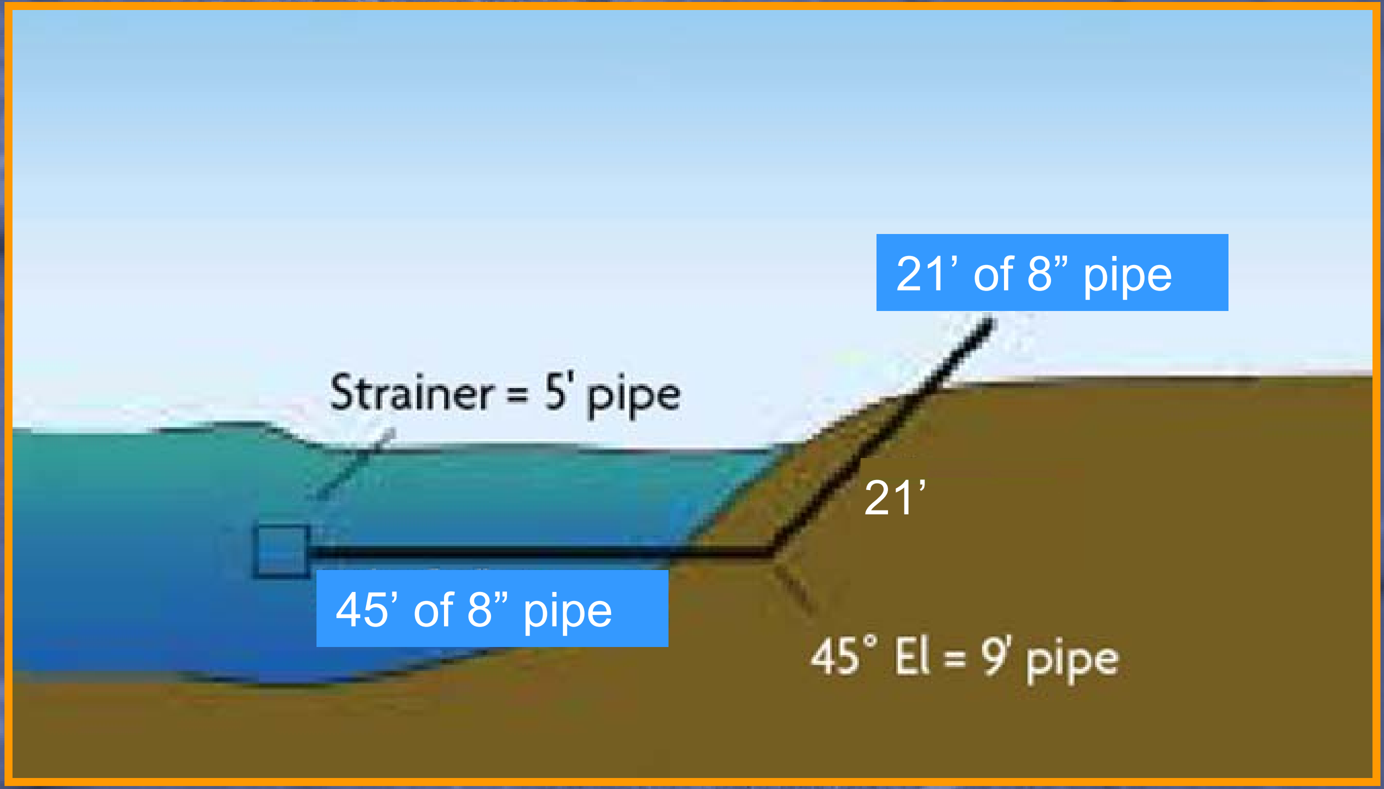
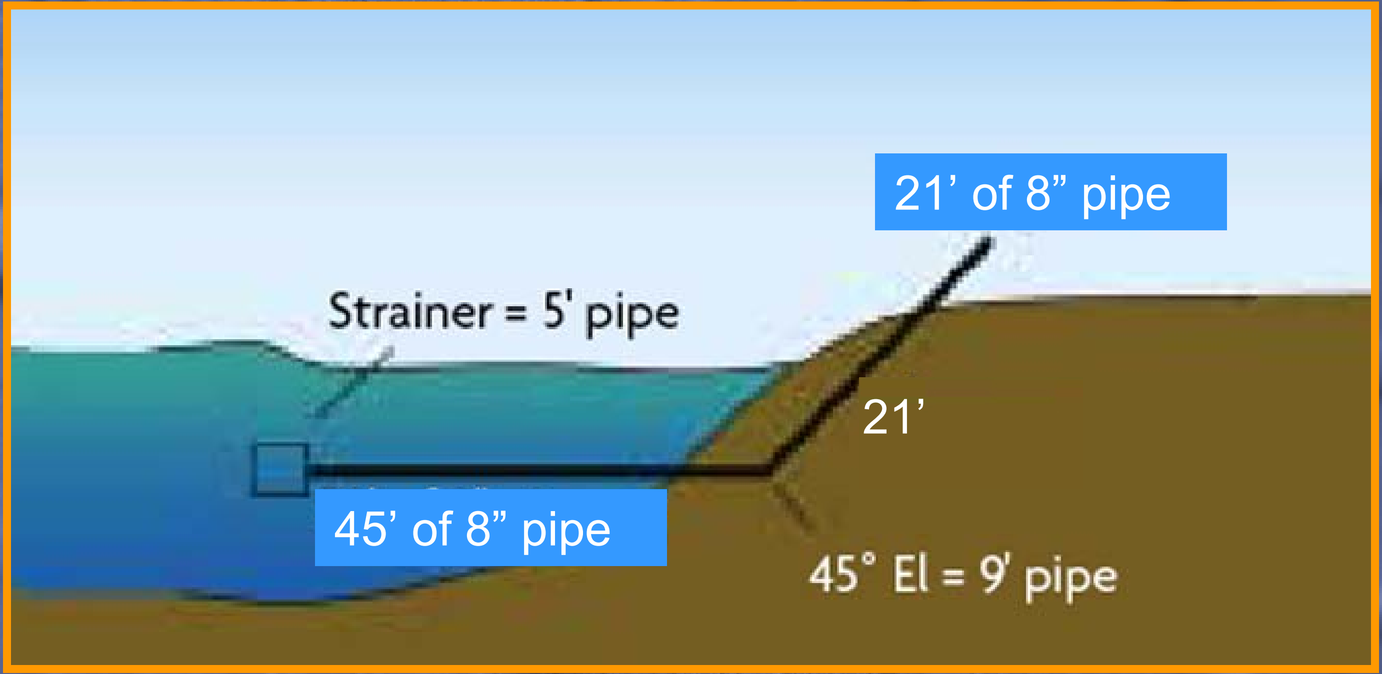


Figure 5. This sketch shows an improved dry hydrant piping arrangement. It replaces 6" pipe with 8" pipe, and the two 90° elbows with one 45° elbow.

Total Equivalent Length of 8" Pipe



• Total length of 8" pipe = 45 ft + 21 ft	=	66 ft
• One 45° elbow	=	9 ft
• Strainer	=	5 ft
Total equivalent length of dry hydrant piping	=	80 ft

Can the 8” Dry Hydrant Flow 1500 gpm?

Calculating FL:

1. Using Fig. 2, the FL in 100 ft of 8” pipe at 1500 gpm = 1.3 psi/100 ft
2. The FL in 80 ft of pipe is then 80 ft/100 ft x 1.3 psi/100 ft = 1.04 psi
3. The FL in 10 ft of 6” suction at 1500 gpm = 0.6 psi
4. The total FL at 1500 gpm = 1.04 psi + 0.6 psi = 1.64 psi

Subtracting FL from MUP:

MUP - FL = 4.04 psi - 1.64 psi = 2.4 psi

Since MUP exceeds the FL by 2.4 psi, the 1500-gpm delivery rate can be delivered through the dry hydrant piping and the 10-ft length of 6” suction hose under these set of conditions.

Can the 8" Dry Hydrant Flow 2000 gpm?

Calculating FL:

1. Using Fig. 2, the FL in 100 ft of 8" pipe at 2000 gpm = 2.2 psi/100 ft
2. The FL in 80 ft of pipe is then 80 ft/100 ft x 2.2 psi/100 ft = 1.76 psi
3. The FL in 10 ft of 6" suction at 2000 gpm = 1.0 psi
4. The total FL at 2000 gpm = 1.76 psi + 1.0 psi = 2.76 psi

Subtracting FL from MUP:

MUP - FL = 4.04 psi - 2.76 psi = 1.28 psi

Since MUP exceeds the FL by 1.28 psi, the 2000-gpm delivery rate can be delivered through the dry hydrant piping and the 10-ft length of 6" suction hose under these set of conditions.

The Benefits of Larger Pipe and 45° Elbows

As you can see, increasing the diameter and shortening the overall length of the pipe used in a dry hydrant can greatly impact the potential delivery rate from a dry hydrant. Understanding the role of friction loss in dry hydrant piping is extremely critical to designing one based on output and not what it looks like.

Even if a department doesn't have a 1500-gpm or 2000-gpm pumper now, the dry hydrant should be around for a long time, and who knows what capacity pumper the department will have in the future.

Another Option

Another option to increase the delivery rate from a dry hydrant piped with 8” or larger hose is to install 2 suction connections on the dry hydrant so two pumpers could draft through it at the same time. This way, if the department doesn’t have a pumper with a large enough capacity to use the delivery rate the dry hydrant can supply, two smaller pumpers could be used.

A Real Life Application

Figures 6 through 8 show a tanker fill site at a water-on-wheels course I conducted in New York State. The water source for the fill site was the Hudson River.

Because a dry hydrant had been installed, the fill pumper initially hooked up to it with 10 ft of 6" suction hose. Understanding how the losses in dry hydrant piping could impact the tanker fill rate, and seeing the drafting site, I had the fill pumper disconnect from the dry hydrant and set up to draft from the river.

Figure 6. The 1000-gpm pumper originally hooked up with a 10-ft length of 6" suction to the dry hydrant. While this was convenient, much of the pump's energy was going to be lost due to friction loss in the dry hydrant piping. This would result in a tanker fill rate much less than it could be.

The pumper was then nosed up to the river so a 6” suction could be run from each side intake to maximize the flow into and out of the pumper to maximize the fill rate and minimize fill time. This allowed the pumper to deliver between 1500 and 2000 gpm, and reduced tanker fill times significantly.

Figure 7. The pumper was nosed up to the water source with dual 6” suctions equipped with floating strainers used to minimize losses and maximize the delivery rate.

Figure 8. An overview of the fill site. With the pumper using dual suctions, it delivered between 1500 and 2000 gpm, and reduced tanker fill time significantly.

With these examples, you can see the impact that friction loss in these permanent suction pipes can have on drafting operations.

If you really want a shock in how piping impacts drafting performance, use the same example we've been using, and add to it the friction loss in the front suction we discussed in the November 2004 installment.

In the next installment, we'll take a look at other options for improving drafting operations.

Until then, stay safe!

For Questions or comments on this or any of the Rural Fire Command articles, contact the author at ldavis@RFI411.org

About the Author

Larry Davis is a full member of the Society of Fire Protection Engineers, a Certified Fire Protection Specialist, and a Certified Fire Service Instructor II with more than 30 years experience as a fire service instructor. He is Vice President of GBW Associates, and Chairman of the Rural Firefighting Institute.

Davis has conducted more than 400 Rural Firefighting Tactics and Rural Water Supply Operations seminars throughout the United States and Canada. In addition, he has written numerous fire service texts, including *Rural Firefighting Operations*, books I, II, and III. Most recently, Davis co-wrote the *Rural Firefighting Handbook* and *Foam Firefighting Operations*, book I with Dominic Colletti.

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