FIRE RESCUE

January 2005 • U.S. $4/CAN $5

Rural Fire Command

by

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Installment 29 — April 2005

Fluid Motion, Part 7

Testing Intake Valves

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RURAL FIREFIGHTING INSTITUTE

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.

Fluid Motion — Part 7
Testing Intake Valves

First of all, I'd like to say that this series on drafting has generated more emails and phone calls than any other topic I've covered in this column. That's great! Drafting operations are a major staple of the rural firefighting menu, and yet in so many cases, we rush through drafting in pump operator training that people never have the opportunity to really understand how all of the goodies we add on the suction side of the pump impact the discharge of that pump.

This month, I want to talk about the performance of intake valves. Personally, I never thought much about the performance of intake valves until about 7 years ago when I came to Corpus Christi, Texas to help my brother Mark conduct a Pumps and Hydraulics Course for the Refinery Terminal Fire Company (RTFC) — a private, nonprofit, industrial fire department made up of about career 130 personnel.

While I had spent 27 years as a fire protection engineer working in industry, and 30 years in the fire service, I got to learn a lot about water supplies needed for refinery firefighting. I realized the first day I was in Corpus that I had not only found home, but had found a fire department that I really wanted to belong to. On the second day I was in Corpus, RTFC Fire Chief, Bob Andrews gave me a job description for a Staff Division Chief's position as Fleet Coordinator. The end result was that I came back for a month as a consultant to see how we fit and never left even though I now am a Vice President with GBW (Gotbigwater) Associates, LLC.

While most firefighters think about tank fires as being the big incidents, it is the process unit fire that really taxes resources and demands that between 8,000 and 10,000 gpm be delivered ASAP to cool processing unit columns and prevent collapse of the units.

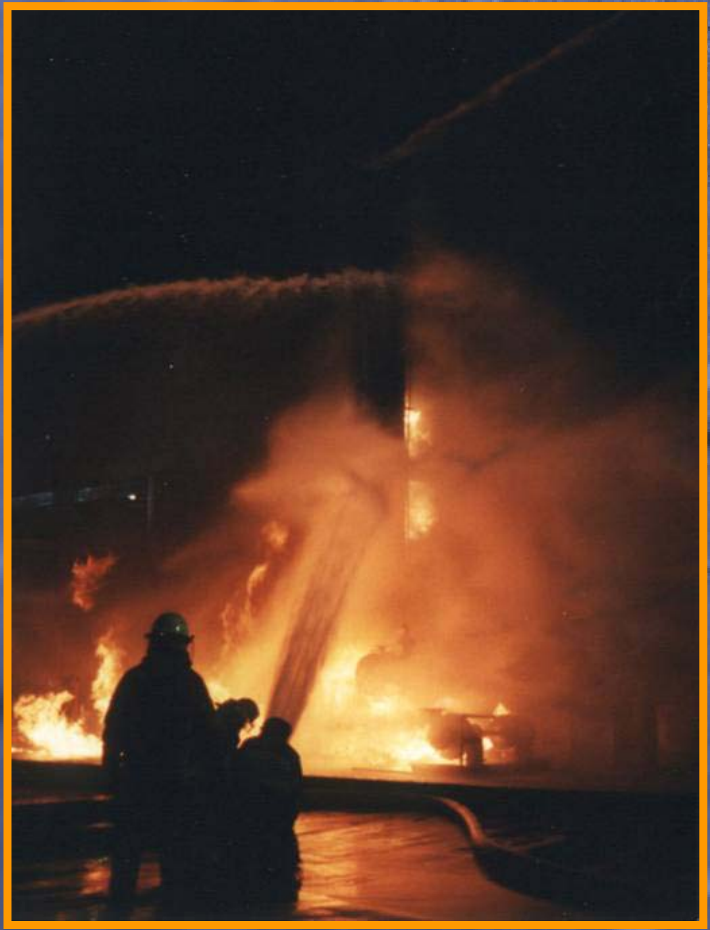


Figure 1. Refinery process unit firefighting requires the rapid application of 8,000-10,000 gpm. Just as in rural firefighting in which excessive intake losses can impact flow, if the water can't get into the pump, it can't reach firefighters who need it now!

To deliver flows of 8-10,000 with only 4 people, required some out of the box thinking. While RTFC had four foam pumpers at that point, the workhorse was Foam-5, a National Foam pumper equipped with a Hale 3000-gpm rear mounted pump, 1000 feet of 6” supply line, two 2,000-gpm deck guns, 1-3/4” and 2-1/2” preconnects, and two TFT 1250-gpm Crossfire portable monitors preconnected with 5” hose. Foam-5 carried 2000 gal of foam concentrate and 500 gal of water.

Figure 2. RTFC's Foam-5, a 3000-gpm pumper with rear-mounted pump and top-mount control panel.

One of my early experiences was at the RTFC Training Academy when the troops were doing quarterly training and fighting process unit fires at night. The standard evolution was the “quick attack evolution” in which a 6” supply line was laid into one of Foam 5’s three 6” intakes, the driver charged and directed one of the 2 remote-controlled 2000-gpm deck guns while a two-person crew stretched a preconnected Crossfire portable monitor to position it to cool the process unit.

Needless to say I was in awe as I nebbed around the operation. Being a big fan of big pumps and big hose, I was in my glory. As I walked around Foam-5, I heard the rear-mounted pump chattering as if it was cavitating. I climbed up to the top-mounted operator’s panel to see the intake pressure close to 0 psi. I then went back to the 6” supply line and stood on it — it was rock hard. What was apparent was that the piston intake valve was keeping the water needed from getting from the 6” hose into the pump.

Since RTFC was in the processing of specing out a new 3000-gpm foam pumper and a new 3000-gpm foam tower equipped with an 85 ft Schwing Firearm with an 8” waterway and a 4000-gpm TFT automatic nozzle, the subject of intake valves became very important. This led to a series of tests I conducted to get a handle on intake valve performance.

These tests then got me interested in exploring the performance (maximum flow and friction loss) of intake valves used in rural firefighting operations.

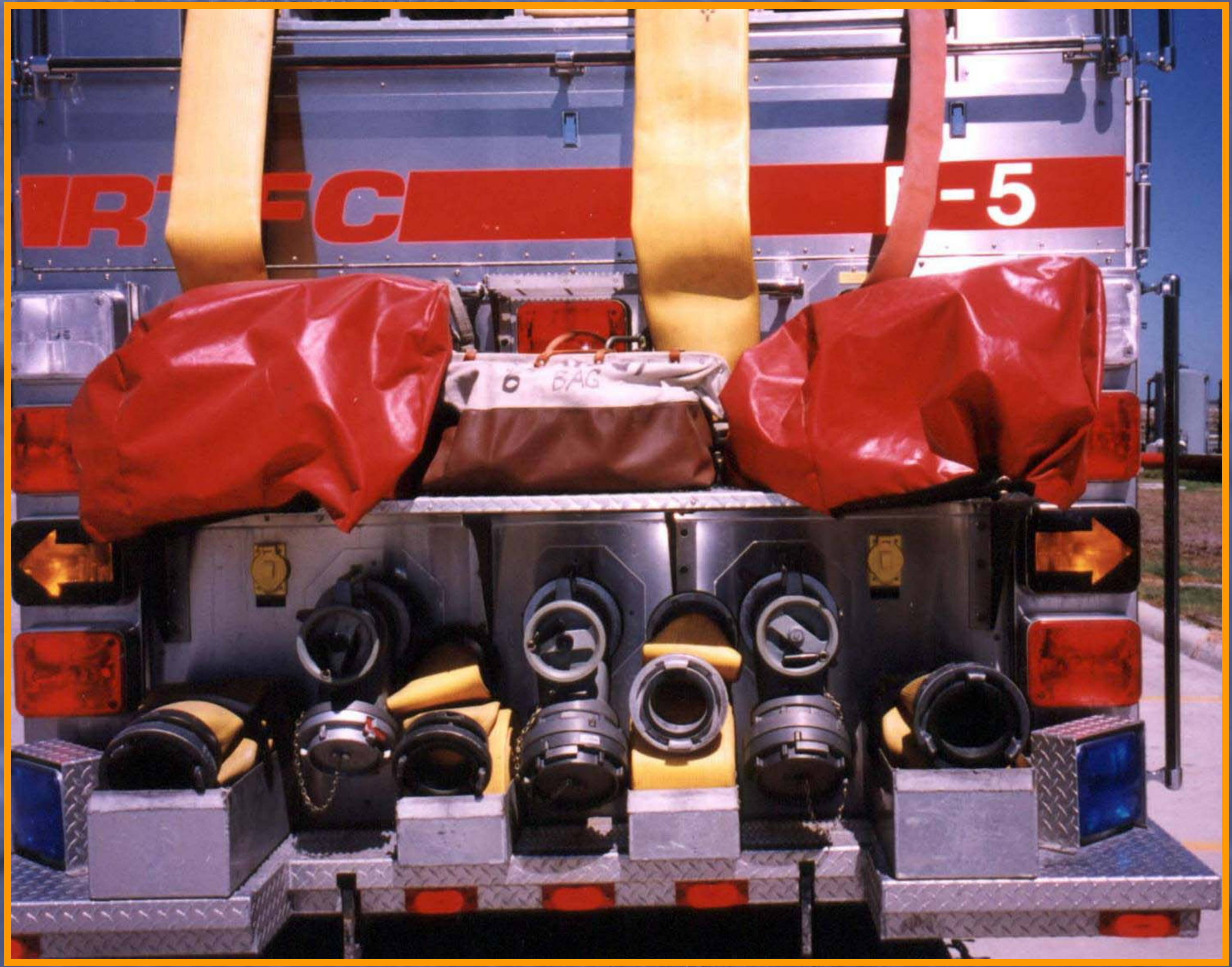


Figure 3. The three 6” pump intake with the original piston-intake valves. The red covers cover preconnected 1250-gpm TFT Crossfire portable monitors.

The RTFC Intake Valve Tests

As a result of the intake valve limitations, we set up a series of intake valve tests using Foam 5. The site used was the RTFC Training Academy because it has a has a water supply fed by two 3000 gpm @ 150 psi fire pumps fed by a above grade suction tank.

The Kochek Company worked with me to fabricate in-line gauge adapters with both for 6” threaded and 6” Storz connections.

In each test, the pump discharge pressure was increased until the pump bordered on cavitation.

Test 1 — Existing Piston Intake Valve

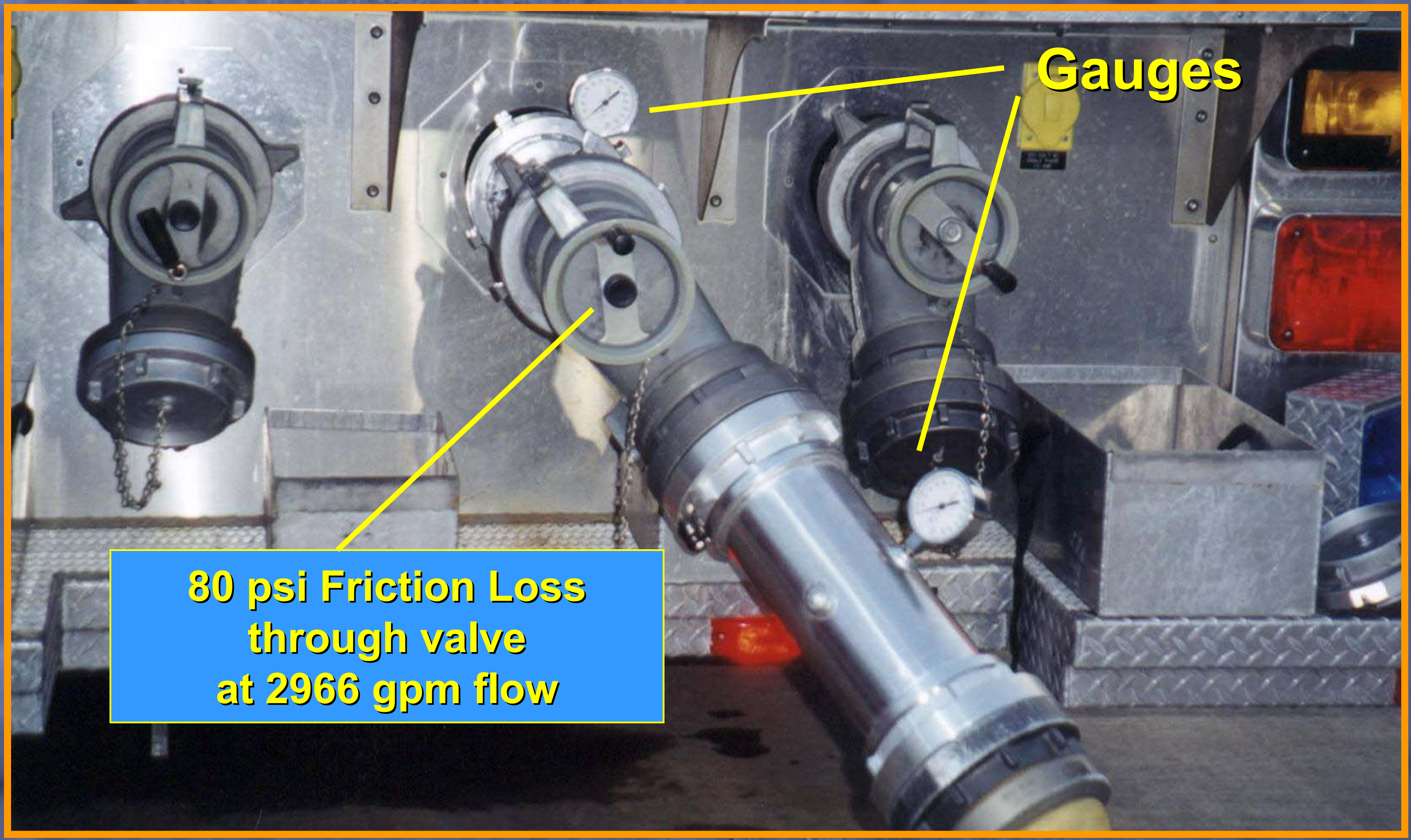


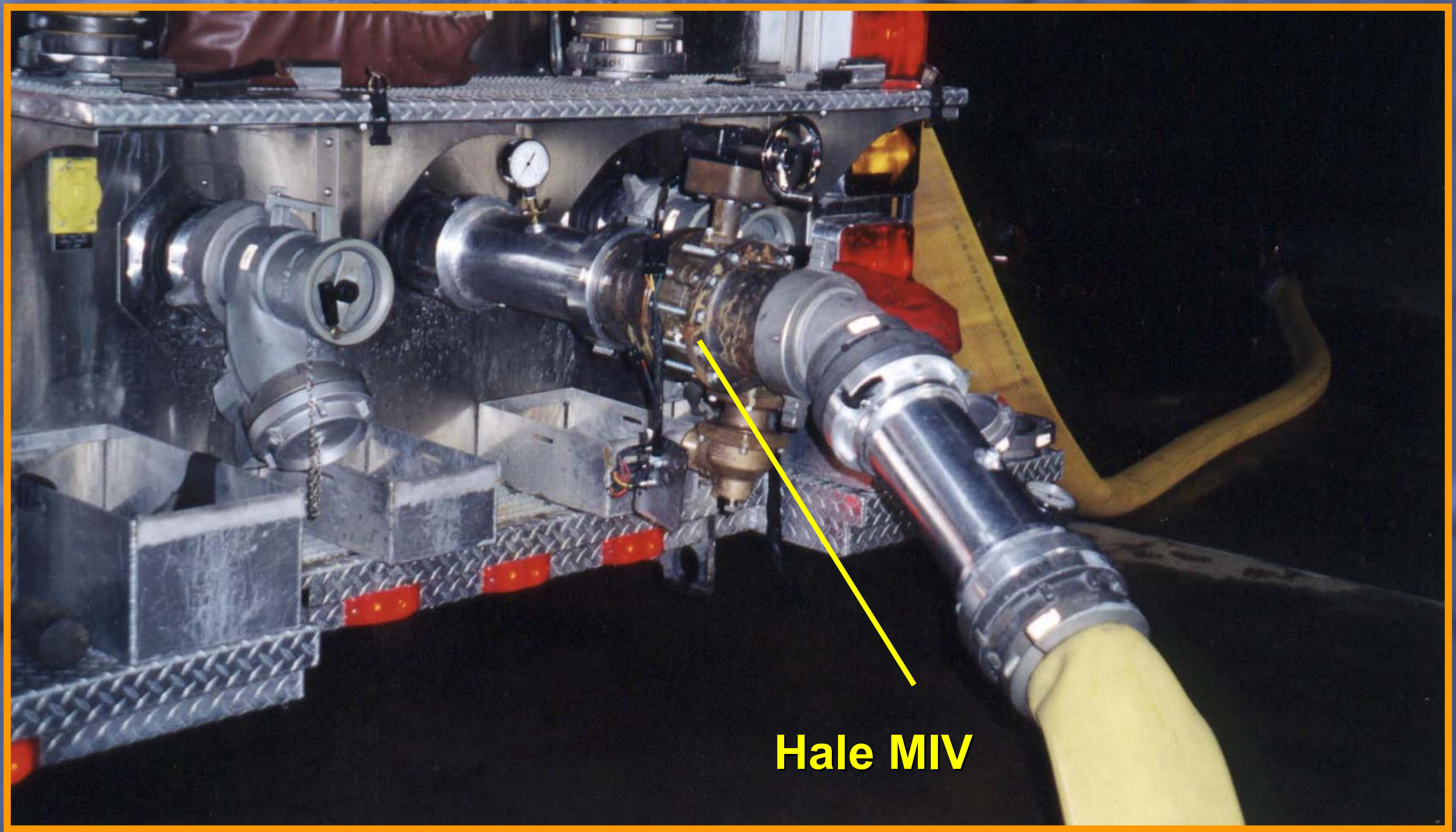
Figure 4. The first test was conducted on the existing intake valve. In-line gauges can be seen on each side of valve. The friction loss was 80 psi with a flow of 2966 gpm.

Test Set-up

Figure 5. In the RTFC intake valve tests, two deck guns and 2 portable monitors with smoothbore nozzles were used so pressures could be measured with a pitot tube.

Test 2 — Hale Master Intake Valve

In Test 2, a Hale Master Intake Valve (MIV) modified for installation on the outboard side of the pump was used.



Test 2 — Hale Master Intake Valve

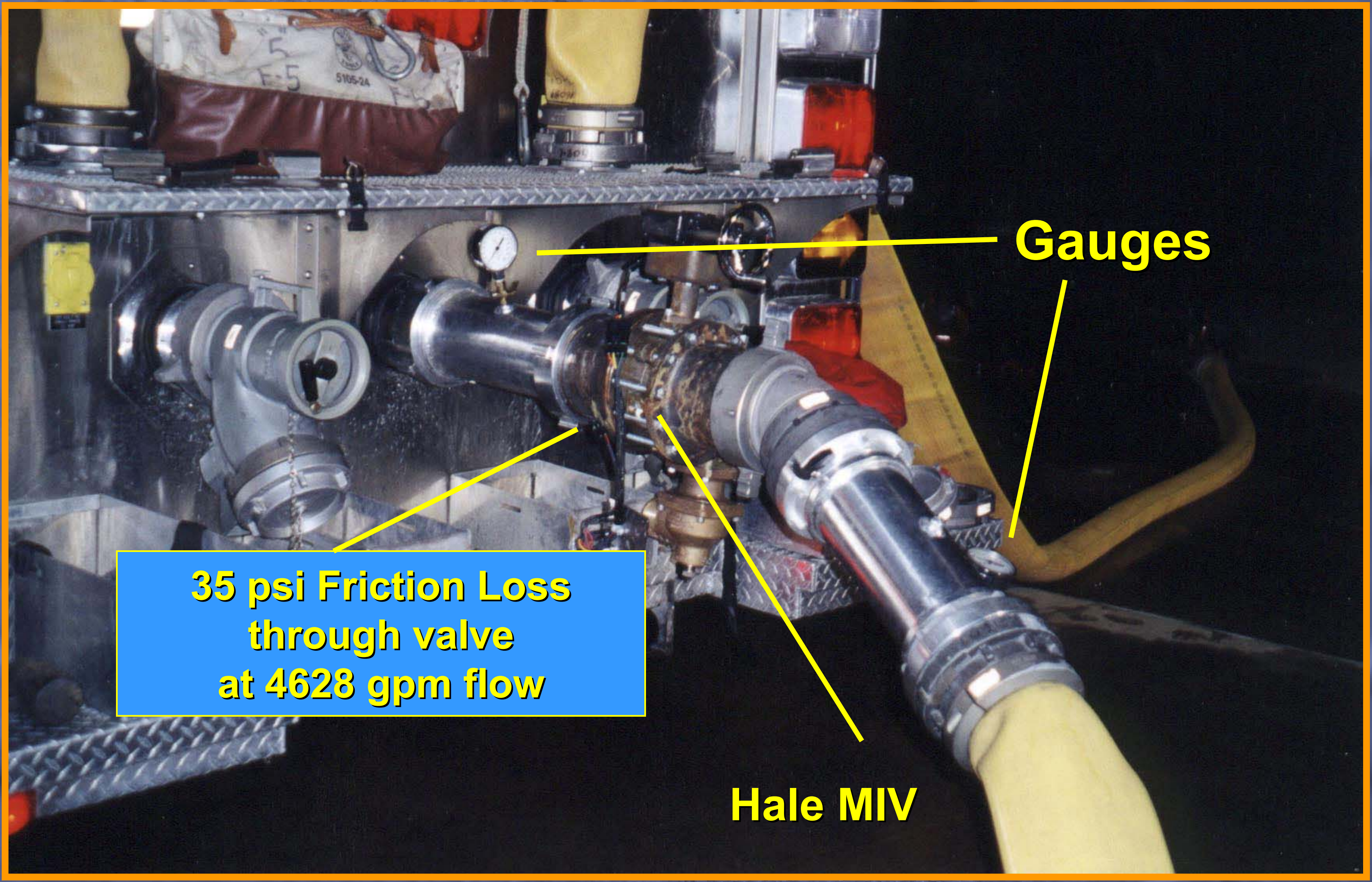
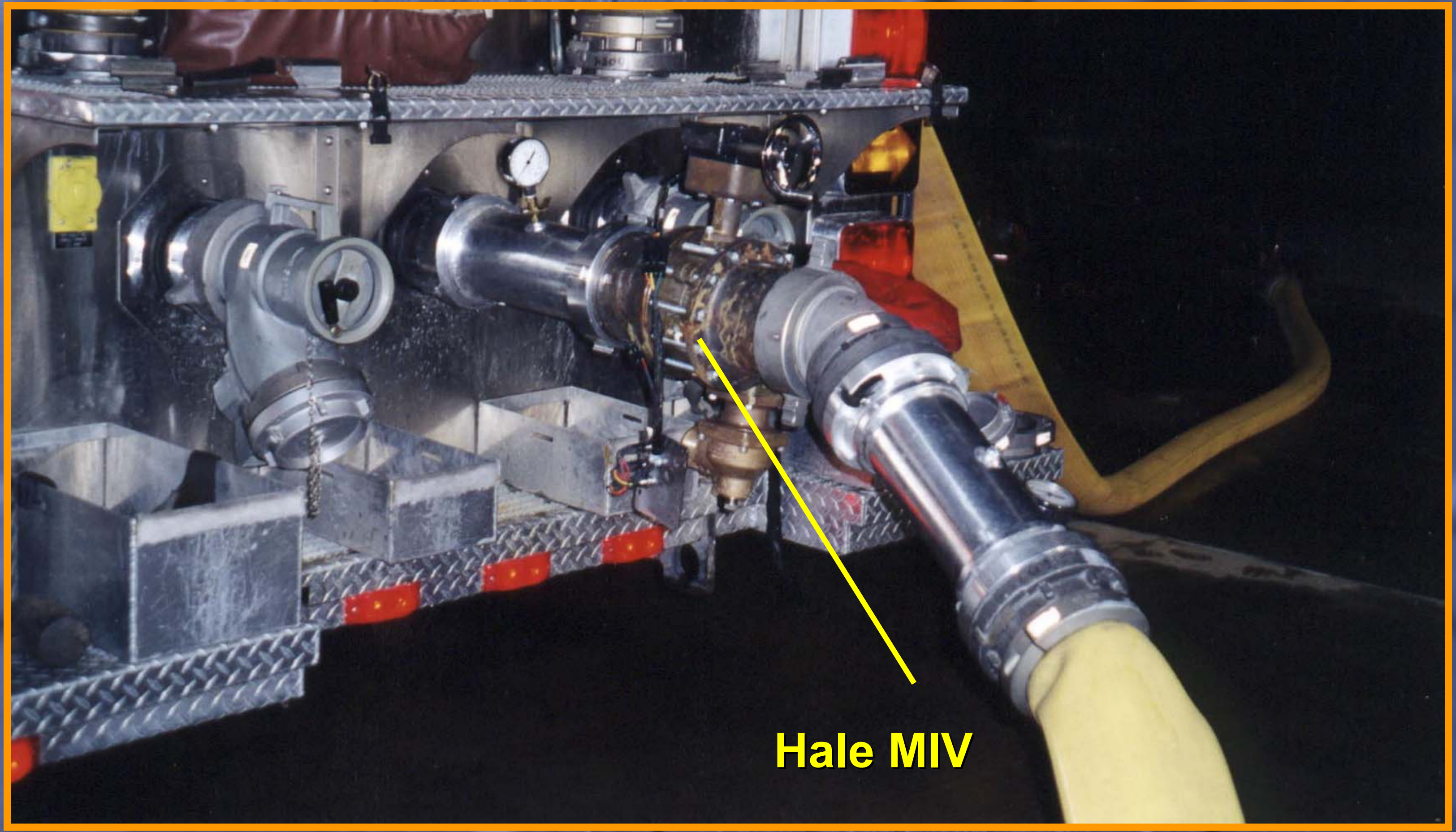


Figure 6. The test of the Hale MIV resulted in a friction loss of 35 psi at a flow of 4628 gpm.

Test 2 — Hale Master Intake Valve

As a result of Tests 1 and 2, the center piston intake valve was removed — to become a boat anchor — and replaced by the modified Hale MIV.



Hale MIV

The Reason for the Difference in Performance

The reason for the difference in these tests was that the piston intake valve had a waterway of only about3" in diameter, even though it was equipped with 6" connections.

The Hale MIV, even though it is called a 6" valve, actually has a diameter of 6-1/2" so that when the area (3-1/4 sq in) of the 1/2" x 6-1/2" butterfly is subtracted from the 33.8 sq in area of the valve opening, the waterway is that of a full 6-in valve.

These tests resulted in the specifications of the new appartus be modified to require the center pump intakes to be equipped with 8-in air-operated butterfly valves and the two outboard intakes to be equipped with Hale MIVs with manual control at the valves.

How These Tests Relate to Rural Firefighters

How do these tests relate to rural firefighters and drafting operations? Simple, they show how the design of an intake valve can impact flow from draft.

While rural firefighters aren't generally interesting in flows of 3000+ gpm from a pumper, these tests show the the true capabilities of the valves under high flow conditions. They also show how obstructions within the valves can affect flow.

Figures 7 and 8 were sent to me by a reader whose department has a pumper which is having trouble passing its annual service test.

Figure 7 shows the inside diameter of the internal valve while Figure 8 shows the waterway of the valve when the buttefly is in the open position.

Figure 7. The opening from the pump suction into the intake valve is 6”.

Figure 8. An interesting view! First of all, you can see the space the butterfly takes up. Secondly, you would think the installer would have positioned the butterfly in the vertical position to minimize turbulence within the pump entry. This 6” valve does not have the area of a true 6” waterway.

Most people who have the responsibility for developing specifications for a pumper don’t think much about valves. Of course, manufacturers and sales people care even less.

I’ve given up on trying to help people who really don’t want to be helped. I recently had discussions with a department about how they could maximize their flow through pump intakes. I made some suggestions about the type of valving they should specify.

When it was all said and done, the salesman convinced them that the valve his company used was just as good as any other intake valve.

The good thing is that whether you use an intake valve that has low pressure loss or not, eventually the fire will burn down to the point where the flow through any intake valve will be adequate.

The Jaffrey Intake Valve Tests

I also had the opportunity to test a Jaffrey jumbo gate valve on Equistar's Foam Tower 1 in Corpus Christi. FT-1 is a 3000-gpm pumper equipped with an 85 ft Schwing boom with a 6" waterway.

The Jaffrey piston intake valve performed very well. This is because of the large waterway through the valve. While this valve was great, it is no longer available since Jaffrey has gone out of business.

The Jaffrey Intake Valve Tests

Figure 9. Equistar's Foam Tower 1

The Jaffrey Intake Valve Test Set-up

Figure 10. Equistar’s Foam Tower 1 flowing through both deck guns for tests.

Figure 11. Test 1 was done with no valve installed. The friction loss was measured between the in-line shown and a master intake test gauge at the pump. In this test the friction loss was 35 psi at a flow of 4142 gpm.

Figure 12. Test 2 used the Jaffrey jumbo piston intake valve. The test results were 35 psi friction loss at a flow of 4000 gpm. This resulted in a friction loss just slightly higher than Test 1 when no valve was installed.

Kochek Ball Intake Valve Tests

In the summer of 2004, we had the opportunity to test a Kochek ball intake valve at the RTFC Training Academy.

From what I have seen, this valve has the largest intake of any ball valve on the market.

The test setup was utilized Williams Fire and Hazard Control’s 7-1/4” hose with 6” Storz couplings. Flow was through RTFC’s Foam Tower 2.

Kochek Ball Intake Valve Test Set-up

Figure 13. The deck guns on FT-2 were equipped with 3” smoothbore nozzles to measure flow. The supply line is 7-1/4” Williams hose.

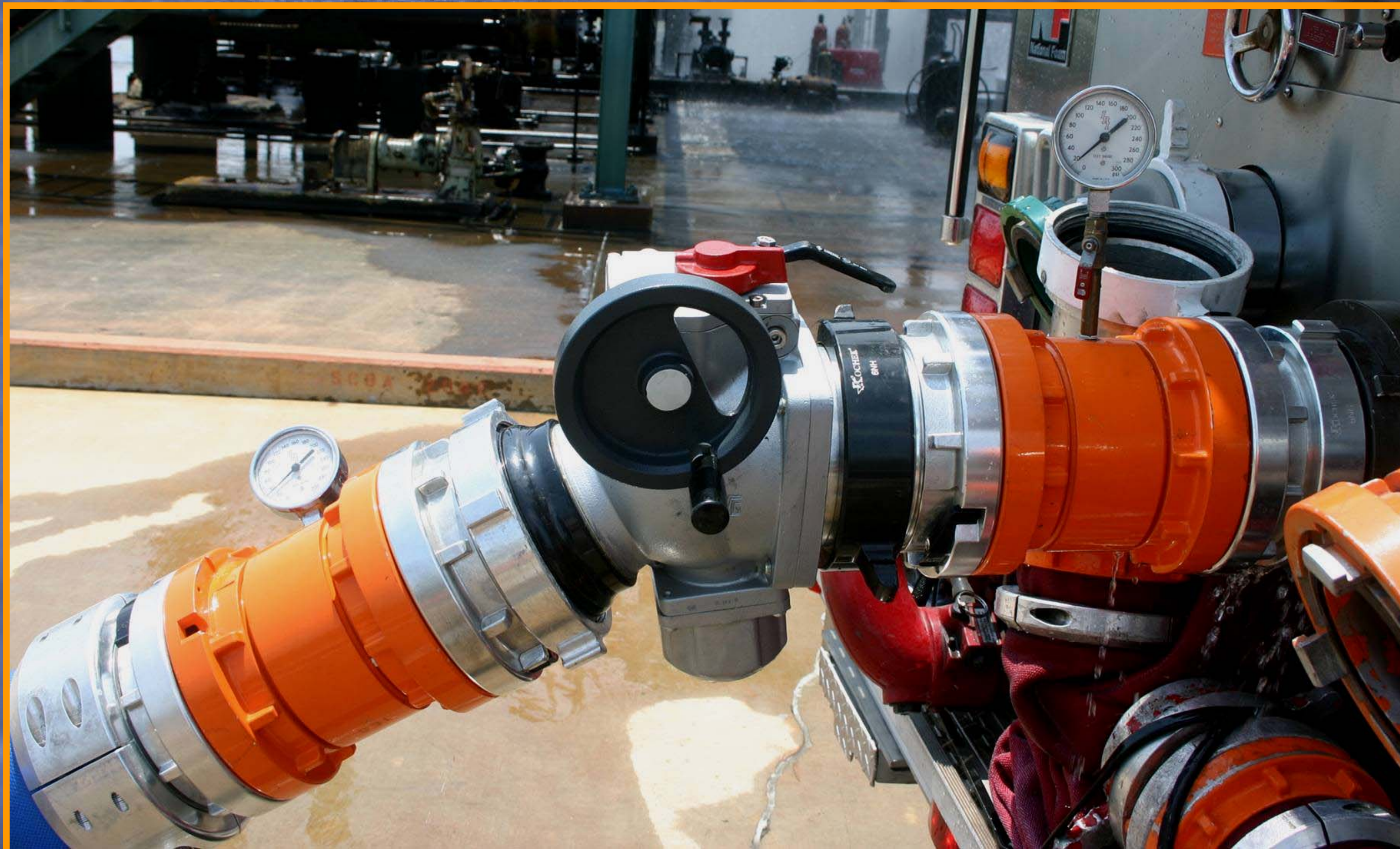


Figure 14. The Kochek ball intake valve showing in-line pressure gauges on each side. The test results were a friction loss of 15 psi at 3000 gpm. I should point out that we could have flowed more water but the hydrant we were using and the length of 7-1/4” hose limited the flow to 3000 gpm.

Testing Intake Valves Under Draft Conditions

I find it best to test intake valves using a pressurized water supply that can deliver high flows. While valves can be tested under draft conditions, there are numerous variables that come into play and, as a result, make replicating the tests in other locales difficult.

In testing intake valves from draft, set up a draft site with the highest capacity pump available and conduct the first test with no valve. In this type of test, you must remember that all of the factors that influence a drafting set-up will impact the flow through the valve. Besides lift and geographic conditions (altitude, water temperature), the length and diameter of suctin hose and the strainer used will impact flow.

Testing Intake Valves Under Draft Conditions

In the first test (with no valve) the pump should be maxed out. At that point, measure the flow, and record the master pump discharge pressure, and speed (rpm).

Then install the intake valve and repeat the test. Run the pump speed up until it borders cavitation and then measure the flow, and record pump discharge pressure and pump speed. The difference between the tests will show the impact that the valve has on the performance of the specific pump under the specific set of conditions that exist.

Testing Kochek's Ball and Gate Intake Valves

Kochek has a 5-1/4" gate intake valve available. We conducted a test of this valve and the Kochek Ball Intake Valve under draft conditions using a 2000-gpm pumper, a single 6" suction line 20 ft long equipped with an 8" floating strainer, and a 4 ft lift. In both tests, the engine speed was increased until cavitation was approached.

The test of the ball intake valve produced a flow of 1491 gpm, a pump discharge pressure of 130 psi, and 1500 rpm (the maximum speed attainable).

The test of the gate valve produced a flow of 2062 gpm, a pump discharge pressure of 200 psi, and 1635 rpm.

When these test results are compared, the gate valve, because of its larger waterway outperformed the ball valve by a great measure. The gate valve delivered 571 gpm more flow at 70 psi higher discharge pressure at a 144-rpm higher speed.

Figure 15. The test of the Kochek ball intake valve produced a flow of 1491 gpm and a pump discharge pressure of 130 psi, at 1500 rpm (the maximum speed attainable).

Figure 16. The test of the Kochek 5-1/4" Gate Intake Valve produced a flow of 2062 gpm, and a pump discharge pressure of 200 psi at a speed of 1635 rpm.

In Conclusion

As you can see, the design and the area of the waterway through an intake valve can be critical to the output of a pump. This is especially so in drafting operations.

To see what effect your intake valves have on pump performance, set up tests such as these and test the pump under the exact same conditions both with and without the valve.

Next Month

In the next installment, we'll cover a subject that has generated much discussion and emails — suction strainers.

Til 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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