Suction Elbow

Flow Performance Tests

Conducted by:

GBW Associates, LLC
And
Water Supply Innovations, LLC

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Hunterdon County, New Jersey

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Scope of Project

On September 30, 2017, GBW Associates, LLC in conjunction with Water Supply Innovations, LLC conducted a series of flow tests on a variety of fire service suction strainers. During the planning phase of that project, a few suction elbows became available for testing and the Project Team decided to conduct flow tests on those suction elbows in addition to the suction strainer flow tests. All of the flow tests were conducted at the Hunterdon County Emergency Services Training Center located in Hunterdon County, New Jersey.

Mark Davis, President of GBW Associates, LLC served as the project coordinator and data analyst. Alan Butsch of GBW Associates, LLC and Michael Guzy and Henry Lovett, Jr. of Water Supply Innovations, LLC served as assistant project coordinators: Alan Butsch oversaw all operations at the pump panel, Henry Lovett, Jr. collected all physical data on each suction elbow, and Michael Guzy oversaw all logistical support for the day. Chief Bryan Stevens and several members of the Glen Gardner Fire Company (New Jersey) provided a pumper and personnel to support the testing process. Andy Soccodato from the Charlottesville Fire Department (Virginia) assisted with data recordation.

The scope of the project was to evaluate the flow capability of 90-degree suction elbows with a specific interest in identifying any flow reduction when used on the side suction inlet of a mid-ship mounted fire pump.

Test Site

The test site was a manmade pond located on the property of the Hunterdon County Emergency Services Training Center. The primary purpose of the pond was to provide water supply for fire training exercises on the training grounds. The pond was also used as the water

source for fire pump service testing. A stream supplied the pond and plenty of clean water was impounded in the pond such that turbulence, aeration, and an increase in water temperature were not a concern during the course of the flow tests. All water taken from the pond during the flow tests was discharged back into the stream at locations remote from the pumper's intake suction point.

Figure 1: The pond provided a deep, clean water supply without worry about debris or vegetation.

Figure 2: Test strainers and elbows staged, numbered, and ready for full day of analysis.

Pumper Used

The pumper used during the suction elbow flow tests was Engine 1262, a 2,250 gpm pumper provided by the Glen Gardner Fire Company. Engine 1262 is a 2003 Pierce pumper equipped with a Hale Q-Max, single-stage pump rated at 2,250 gpm. A 515 hp Detroit diesel motor powered the pumper.

Engine 1262 was chosen for use in the project due to its "large-body" pump and the available horsepower of its diesel motor. The performance goal was not to "run out of pump capacity or motor horsepower" during any of the flow tests. The desire was to have a pumper that had a suction inlet capable of high flow intake and at the same time be able to discharge all of that available water in a usable manner. The 2,250 gpm Hale Qmax pump driven by the 515 hp diesel motor on Engine 1262 provided such capability.

Regarding pump performance certification, Glen Gardner Fire Company provided documentation verifying that Engine 1262 had passed an NFPA-compliant annual service test on April 17, 2017.

Figure 3: The Glen Gardner Fire Company supplied a pumper and crew for the project. Engine 1262 is a 2003 Pierce pumper outfitted with a 2,250 gpm Hale QMax pump and a 515 hp diesel motor.

Figure 4: Certification label from Engine 1262's April 2017 service test.

Test Gauges Used

All pressure gauges used for this project were either new gauges with factory calibration or recently calibrated existing gauges. GBW Associates, LLC and Water Supply Innovations, LLC provided all test gauges for the project. To help ensure accuracy, pressure gauges of various ranges (0-100, 0-200, 0-300, and 0-600 psi) were available for use. Gauges utilized during the testing were chosen based on the pressures expected to be read; this was done to ensure that the pressure readings measured fell within the mid-range of the gauge scales.

The test gauges were also "field" verified using Engine 1262's pump prior to the start of the suction elbow flow testing process. The test gauges were connected directly to pump discharge outlets and then the pump was engaged and pressurized. All gauges were then inspected for accuracy against each other and the pump panel gauges. All gauges passed this test.

Suction Hose Used

The Hunterdon County Emergency Services Training Center provided the suction hose used for the flow tests. One, 20 ft length of 6-inch lightweight suction hose was used. The hose was manufactured by Kochek and had 6-inch National Standard Thread couplings. The hose was inspected and found to be free of defects and in good working condition. The single length of suction hose was used for each flow test. No air leaks in the suction hose were found at any time during the flow test project.

Test Layout

The test layout involved Engine 1262 positioning near the pond and drafting through the single section of 20-ft suction hose that was connected to the pump's officer side suction inlet. Three discharge hose lines were used:

- A 50-ft long, 4-inch hose line supplied water to a Hose Monster flow diffuser equipped with a 2-1/2-inch orifice; and,
- Two, 3-inch hose lines (each 50 ft long) supplied water to a portable monitor equipped with an Akron flow test kit and 1-3/4-inch orifice.

The 4-inch hose line was connected to the pumper's officer side high-flow discharge. The 3-inch hose lines were connected to two, driver side 2-1/2-inch discharges.

Figure 5: Dual, 3-inch hose lines supplied water to a portable monitor. Each hose line was 50 feet in length.

Figure 6: A 4-inch hose line supplied water to a Hose Monster flow diffuser with fixed-pitot. The hose line was 50 feet in length.

Each of the three discharge hose lines had their respective flows measured using pressure gauges connected remotely to the flow measurement devices (Hose Monster and Akron flow test kit.) The gauges were assembled at a workstation table near the pump panel so that readings could be collected easily and in a time efficient manner.

Figure 7: The Hose Monster was outfitted with a 2-1/2-inch orifice. The portable monitor was outfitted with an Akron flow test kit and 1-3/4-inch orifice.

In addition to the remote gauges used to measure pressures at the flow orifices, remote test gauges were also used to measure pump intake and discharge pressures. A vacuum gauge (inches of Hg) was connected to the pump intake test gauge port. A pressure gauge (psi) was connected to the pump discharge test gauge port. Both gauges were positioned on the same workstation table as the flow orifice gauges.

Figure 8: Each test gauge was connected remotely to a pressure measure point while the actual gauge was displayed on a central workstation table. This arrangement allowed for easy and efficient data collection.

Test Controls and Variables

Next to accurately collecting test data from the flow devices, the use and oversight of test controls was the most important component of the entire project. In order to fairly compare like suction elbows, test controls had to be developed, implemented, and verified.

The test controls listed below were used for each suction elbow flow test:

- Engine 1262 was used for each flow test and did not change location for any of the suction elbow flow tests.
- The same person operated the pump for each flow test.
- The same 20-ft length of 6-inch Kochek suction hose was used for each flow test.
- The test location's altitude did not change (371 ft)
- A lift of 3.52 feet was used for each flow test.
- A Task Force Tip Low Level Strainer with Float Attachment (A03HNX-JET-F) was used as the suction strainer for each flow test. The Task Force Tips strainer was a top-performer in the strainer flow tests, thus it was chosen as the suction strainer for the suction elbow flow tests.
- Using the float attachment, the low level strainer's intake remained at a constant depth of 18-inches in the pond for each flow test.
- A 2-1/2-inch orifice was used at the Hose Monster for each flow test.
- A 1-3/4-inch orifice was used at the portable monitor for each flow test.
- Motor speed readings were obtained using the digital tachometer display on the pump operator's panel.

- Pond water temperature remained between 60^0 F and 70^0 F throughout the project.
- Air temperature remained between 60^0 F and 69^0 F throughout the project.
- The first flow test used no suction elbow on the suction hose: this was done to establish a base-line flow for the pumper's officer side suction inlet.
- The Project Team established a 5.0% margin of error for all test gauge readings and physical data collection: this margin of error was based on expected human error in the visual interpretation of gauge and measurement device readings.

Note: A few manufacturers provided products for use during the flow test project. As a control measure, no product manufacturer factory representatives were allowed to participate in the project on test day. Many thanks are given to those manufacturers for the willingness to provide products to support the project.

Testing Procedure

The procedure for each suction elbow flow test was the same: connect the TFT low-level floating suction strainer to the suction hose; connect the suction hose to a suction elbow; connect the suction elbow to the officer side suction inlet on Engine 1262; deploy the suction hose and strainer in the pond; establish a draft; and discharge water to the point where an increase in throttle produced no further increase in pump output.

The members of the Project Team from GBW Associates, LLC and Water Supply Innovations, LLC considered a few different flow test data collection points and chose the "more throttle produces no more pump output" data collection point. This was the same data collection point as used in the suction strainer flow test project. Data collection points considered included: using the same motor rpm for each flow test, using

the same pump discharge pressure for each flow test, and using the same net pump pressure for each flow test.

The decision to use the "more throttle produces no more pump output" data collection point was based upon the notion that in an emergency incident, the average pump operator would most likely deploy the suction hose and elbow arrangement, obtain a draft, discharge water through all attached supply hose lines, and increase the throttle until pump output stopped increasing.

It was the general consensus of the Project Team that net pump pressure and factors affecting pump capacity are not fully-understood by many of today's pump operators. All members of the Project Team have witnessed such knowledge deficiencies in both the training and emergency scene arenas over the last ten years. Therefore, Project Team members felt that the data collection point chosen should simulate the "real world" use of the suction elbows. That is why the "more throttle produces no more pump output" data collection point was chosen.

Suction Elbows Tested

Three suction elbows were flow tested: two, Fol-Da-Tank models and one, Kochek model. Two of the elbows were acquired from product distributors with the understanding that all testing would be done independent and without bias to any one product. The third elbow was acquired from a fire department in Maryland.

		
Fol-Da-Tank 90-degree Suction Elbow ELB-6.0 Casted "Red"	Fol-Da-Tank 90-degree Suction Elbow ELB-6.0 Casted – Unpainted	Kochek 90-degree Suction Elbow KEP6L6-C90 Welded
		
Task Force Tips Low Level Strainer w/Float A03HNX-JET-F)	90-Degree Suction Elbow In Use Turtle, Wisconsin	90-Degree Suction Elbow In Use Whitewater, Wisconsin

Figure 9: Two, Fol-Da-Tank suction elbows and one Kochek suction elbow were flow tested. A Task Force Tips Low Level Strainer w/Float was the suction strainer used for all of the flow tests. Suction elbows are popular with departments that have moved to the Single Lane Tank™ dump tank arrangement.

Test Results

The flow test results for each style of suction elbow are presented below along with relevant physical data collected by the Project Team. Mr. Henry Lovett, Jr. of Water Supply Innovations, LLC was instrumental in the collection of physical data – his work was tedious and thorough and only completed by him in order to ensure data collection consistency. Mr. Alan Butsch's work overseeing elbow deployment and pump operations was critical to the consistency of the pump intake and output processes. Finally, Mr. Andy Soccodato's work reading the test gauges and recording flow data was critical to the consistency of data recordation.


Figure 10: Henry Lovett, Jr. (left) collects physical data on a suction device while Alan Butsch and Andy Soccodato (right) record flow data.

As noted earlier, three different suction elbows were flow tested. The first flow test did not use a suction elbow. The purpose of the first flow test was to obtain a base flow to which the subsequent flow tests could be compared. The Project Team's hypothesis was that each of the suction elbows would restrict suction inlet flow. Thus the first flow test – without a suction elbow – was critical to the evaluation of the hypothesis.

The base line flow test without a suction elbow resulted in a peak flow of 1,738 gpm. When inserting the various suction elbows, flow test results ranged from a low of 1,565 gpm to a high of 1586 gpm. All three suction elbows performed within the 5% margin of error that was allocated for all test readings. Thus, all three suction elbows were considered equivalent in flow capability.

Table 1
90-Degree Suction Elbow Flow Test Results
Motor Speed and Vacuum Reading

Device	Flow Achieved (gpm)	Motor Speed (rpm)	Vacuum Reading ("Hg)
No suction elbow (Baseline Test)	1738 gpm	1150 rpm	16.5 in
Fol-Da-Tank – ELB-6.0 Casted/Red	1565 gpm	1025 rpm	18.0 in
Fol-Da-Tank – ELB-6.0 Unpainted	1582 gpm	1125 rpm	18.0 in
Kochek – KEP6L6-C90 (Welded)	1586 gpm	1125 rpm	18.5 in

Table 2
90-Degree Suction Elbow Flow Test Results
Discharge Pressure and Net Pump Pressure

Device	Flow Achieved (gpm)	Discharge Pressure (psi)	Net Pump Pressure (psi)
No suction elbow (Baseline Test)	1738 gpm	68 psi	76 psi
Fol-Da-Tank – ELB-6.0 Casted/Red	1565 gpm	60 psi	69 psi
Fol-Da-Tank – ELB-6.0 Unpainted	1582 gpm	72 psi	81 psi
Kochek – KEP6L6-C90 (Welded)	1586 gpm	70 psi	79 psi

Regarding physical data findings and the suction elbow flow tests, there was little performance difference between the casted or welded tube designs. Of the two, Fol-Da-Tank model suction elbows, the only difference was that the "red" painted one had a better female swivel coupling which made connecting and disconnecting the elbow much easier.

Final Thoughts and Considerations

The suction elbow flow test project was born over the last four years as members of the Project Team encountered more use of suction elbows during rural water supply training events. As with any addition to the suction inlet configuration that differs from the factory certification pump test configuration, the possibility for flow restriction occurs. The Project Team's desire was to try and quantify the flow restriction created by suction elbow use.

The results of the suction elbow flow test project surprised the Project Team a bit in terms of the performance levels achieved; the Team was expecting more restriction than what was found. It was good to see that a 1,500 gpm flow could be achieved using any of the three, suction elbows tested. This flow achievement means that these suction elbows

(the ones tested) generally exceed the flow capabilities of many front suction inlets often found on mid-ship mounted fire pumps. Hence, a suction elbow is a relatively inexpensive way to draft from a water source in front of, or to the rear of a pumper - without paying for a piped intake.

One very important item to note however, is the choice of suction strainer used during the suction elbow flow tests. As clearly learned during the suction strainer flow test project, the type of suction strainer used during a drafting operation affects the flow output of the fire pump. During the suction elbow flow tests, the Task Force Tips low-level/floating strainer was used because it was a top performer in the suction strainer flow tests. The strainer was also chosen because suction elbows are often used during dump tank operations – and low-level strainers are commonly used with those dump tank operations. (Fol-Da-Tank's Single Lane Tank™ concept)

Finally, it is clear that suction elbows are a somewhat new "tool for the toolbox" in terms of drafting operations. Owners and potential buyers of suction elbows are encouraged to flow test each suction elbow during annual pump service testing so that definitive flow measurements are obtained for each elbow and suction strainer combination.

Project Support

The members of the Project Team wish to thank the following organizations and businesses that provided support to the GBW Associates, LLC and Water Supply Innovations, LLC project:

Hunterdon County Emergency Services Training Center (New Jersey)
Glen Gardner Fire Company (New Jersey)
Takoma Park Volunteer Fire Department (Maryland)

Wolfsville Volunteer Fire Company (Maryland)

Fol-Da-Tank Company (Illinois)

Kochek Company, LLC (Connecticut)

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