Suction Strainer Flow Performance Tests

Conducted by:

GBW Associates, LLC
And
Water Supply Innovations, LLC

September 30, 2017
Hunterdon County, New Jersey

Contents

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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 hose strainers. The 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 strainer, 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 barrel, box, basket, floating, and low-level style fire service suction strainers with a specific interest in identifying significant flow variances in similar style devices.

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 staged, numbered, and ready for full day of analysis.

Pumper Used

The pumper used during the suction strainer 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 powers 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 <u>not</u> 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 strainer 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. 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 strainers, test controls had to be developed, implemented, and verified.

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

- Engine 1262 was used for each flow test and did not change location for any of the suction strainer 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.
- Each barrel, basket, box, and low-level suction strainer was positioned 25-inches below the surface of the water.
- There was more than 2-feet of water below each suction strainer during 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 strainer on the suction hose: this was done to establish a base-line flow for the pumper's 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.

Figure 9: With the exception of the floating strainer tests, each strainer was deployed to a depth of 25-inches – meaning the top of the strainer was 25-inches below the surface of the water. A yardstick was used for measurement verification each time a strainer was deployed.

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 strainer flow test was the same: connect the suction strainer to the suction hose; deploy the suction hose and strainer in the pond; verify suction strainer depth control measurement; establish a draft; and discharge water to the point where an increase in throttle produced no further increase in pump output.

Figure 10: (Left) Strainer and suction hose assembly deployment. (Right) Data collection and recordation in progress at the remote gauge workstation.

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. 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 strainer 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 strainers. That is why the “more throttle produces no more pump output” data collection point was chosen.

Suction Strainers Tested

A total of 30 suction strainers were flow tested: 8 low level strainers, 7 floating strainers, 2 box strainers, 2 basket strainers, 10 barrel strainers, and one ice strainer. All strainers were designed for use on 6-inch suction hose. The strainers were acquired from a number of sources including fire departments, training centers, private collections, and product distributors. All strainers were acquired with the understanding that all testing would be done independent and without bias to any one product. Many of the low level strainers had built in jet siphon features; none of the flow tests involved the use of the jet siphon features.

Figure 11: Task Force Tips Low Level Strainer with 1.5-inch Jet Siphon (A03HNX-JET-F). This strainer came with a float attachment that was removed for the "low level" suction strainer test. The strainer had a cast housing; no tubing was used in the design.

Figure 12: Kochek Low Level Strainer with 1.5-inch jet siphon (LL60). This strainer used a 6-inch tube.

Figure 13: Harrington Low Level Strainer with 1.5-inch jet siphon (HTLLS-60NHLH). This strainer used a 6-inch tube.

Figure 14: Kochek Big Water Low Level Strainer with 1.5-inch jet siphon (LL602). This strainer used an 8-inch tube.

Figure 15: Ziamatic Low Level Strainer (QD-600-NST). The strainer had a cast housing; no tubing was used in the design.

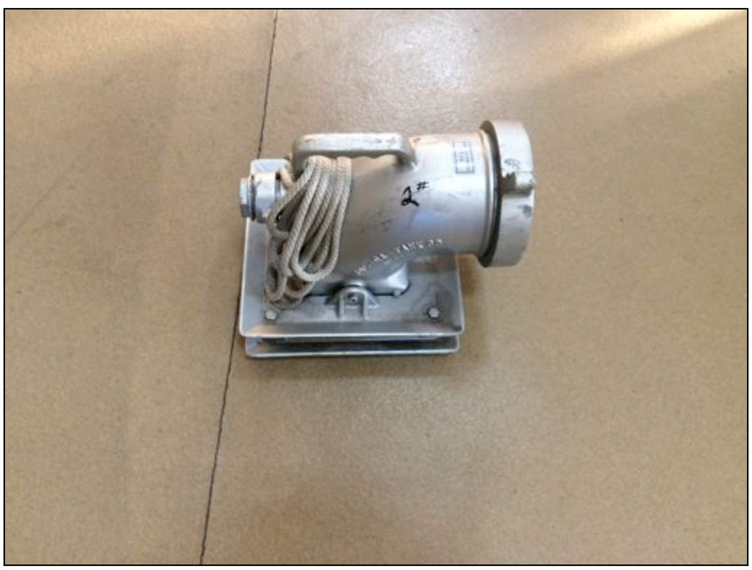


Figure 16: Fol-Da-Tank Low Flow Strainer (LFS6). This strainer had a fitting for a jet siphon connection, but no jet siphon pipe inside the strainer. The strainer had a cast housing; no tubing was used in the design.

Figure 17: Fol-Da-Tank Low Flow Strainer with Jet Boost (LFS6). This strainer had a fitting for a jet siphon connection and also had a jet siphon pipe inside the strainer. The strainer had a cast housing; no tubing was used in the design.

Figure 18: Firovac Low Level Strainer with 1.5-inch jet siphon (HVLL). The strainer had a cast housing; no tubing was used in the design.

Figure 19: Kochek Big Water Self-Leveling Floating Strainer (FBS602). The strainer used an 8-inch barrel with more than one thousand, 3/8-inch holes.

Figure 20: Kochek Self-Leveling Floating Strainer (FBS60). The strainer used a 6-inch barrel with nine hundred and fifty, 3/8-inch holes.

Figure 21: Fol-Da-Tank Float Dock floating strainer (FDS6). The strainer had a removable float that allows the strainer to be used as a box strainer. The strainer had approximately 90 square inches of open space in the expanded metal mesh.

Figure 22: Ziamatic Floating Strainer (FDS-600-NST). The strainer had a removable float that allows the strainer to be used as a box strainer. The strainer had approximately 127 square inches of open space in the wire mesh.

Figure 23: Harrington Floating Barrel Strainer (HTFBS-60NHLH). The strainer used 6-inch tubing and a wire mesh intake screen.

Figure 24: Kochek Floating Strainer (original model). The strainer used 6-inch tubing with approximately four hundred forty-four, ½-inch holes.

Figure 25: Task Force Tips Floating Low Level Strainer Jet Siphon (A03HNX-JET-F). This is the same strainer as used in the low level strainer flow test. The strainer had a cast housing; no tubing was used in the design.

Figure 26: Kochek Box Strainer (BX60). The strainer used a welded-sheet metal housing and had approximately 114 square inches of open space in the expanded metal mesh screen.

Figure 27: Kochek Big Water Barrel Bottom Guard Strainer (BS602BG). The strainer used an 8-inch barrel with more than one thousand 3/8-inch holes. This is the same barrel as was used on the Big Water Self-Leveling Strainer.

Figure 28: Red Head Style 139 Basket Strainer. The strainer used ¼-inch wire mesh. Due to the design of the basket, there was limited uniformity in the mesh's hole size. The base of the screen had a 22-1/4-inch circumference.

Figure 29: Basket Strainer (Unknown Manufacturer). The maker of this strainer was unknown, although the design resembles an Akron basket strainer. The strainer used ¼-inch wire mesh. Due to the design of the basket, there was limited uniformity in the mesh's hole size. The base of the screen had a 29-inch circumference.

Figure 30: Kochek Big Water Barrel Strainer (BS60-2). The strainer used an 8-inch diameter tube with approximately twelve hundred sixteen, 5/16-inch holes – some of which were in the closed end of the strainer. The holes all had sharp edges.

Figure 31: Akron Barrel Strainer Style 340. The strainer used a short, 8-inch diameter tube with approximately six hundred twenty-eight, 3/8-inch holes – some of which were in the closed end of the strainer. The holes all had sharp edges.

Figure 32: Harrington Barrel Strainer (HTBS-60NH). The strainer used 6-inch diameter tubing with approximately six hundred forty, 3/8-inch holes – some of which were in the end of the strainer. The holes all had sharp edges.

Figure 33: Barrel Strainer (Manufacturer and Model unknown – possible American LaFrance). The strainer came from a 1960's era American LaFrance pumper and had approximately seven hundred sixty, 3/8-inch holes. There were no holes in the end of the strainer. The holes all had sharp edges.

Figure 34: Kochek Barrel Strainer (BS60). The strainer used 6-inch tubing with approximately seven hundred ninety-eight, 3/8-inch holes. There were no holes in the end of the strainer. The holes all had sharp edges.

Figure 35: Barrel Strainer (Manufacturer and model unknown – possible Seagrave). The strainer came from a 1959 Seagrave pumper and had approximately three hundred sixty, ½-inch holes. There were no holes in the end of the strainer. The holes all had smooth edges.

Figure 36: Elkhart Barrel Strainer (Model 315). The strainer had approximately seven hundred sixty, 7/16-inch holes. There were no holes in the end of the strainer. The holes all had smooth edges.

Figure 37: Powhatan Barrel Strainer (Model unknown). The strainer had approximately three hundred ninety-two, 3/8-inch holes. There were no holes in the end of the strainer. The holes had sharp edges and were not uniform in distribution.

Figure 38: Barrel Strainer (Manufacturer and model unknown). The strainer had an outside diameter slightly greater than 7-inches and had approximately nine hundred sixty-eight, 5/16-inch holes. There were no holes on the end of the strainer. The holes all had sharp edges.

Figure 39: Barrel Strainer (Manufacturer and model unknown – possible Seagrave). The strainer came from a 1959 Seagrave pumper and had approximately three hundred ninety-two, ½-inch holes – some of those holes were in the end of the strainer. The holes all had smooth edges.

Figure 40: Kochek Ice Strainer (IS60). The strainer used 6-inch tubing and had approximately nine hundred fifty, 3/8-inch holes.

Test Results

The flow test results for each style of suction strainer 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 strainer 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 41: Henry Lovett, Jr. (left) collects physical data on a suction device while Alan Butsch and Andy Soccodato (right) record flow data.

Low-Level Suction Strainer Results

Eight different low-level suction strainers were flow tested. The flow test results ranged from a low of 924 gpm (Harrington) to a high of 1864 gpm (Firovac). The Task Force Tips low-level strainer had a flow test result of 1800 gpm, which is within the 5% margin of error that was allocated for all test readings and thus considered equivalent to the Firovac low-level strainer. The Firovac and Task Force Tips Strainers were clearly the top performers as evident in their 1800+ gpm flows and the low vacuum readings at the pump when those strainers were in use. In fact, both the Firovac and Task Force Tips low-level strainers could have flowed more water had the Hale QMax pump been able to take in more water through the single, side suction inlet. However, the pump had reached its suction inlet limit.

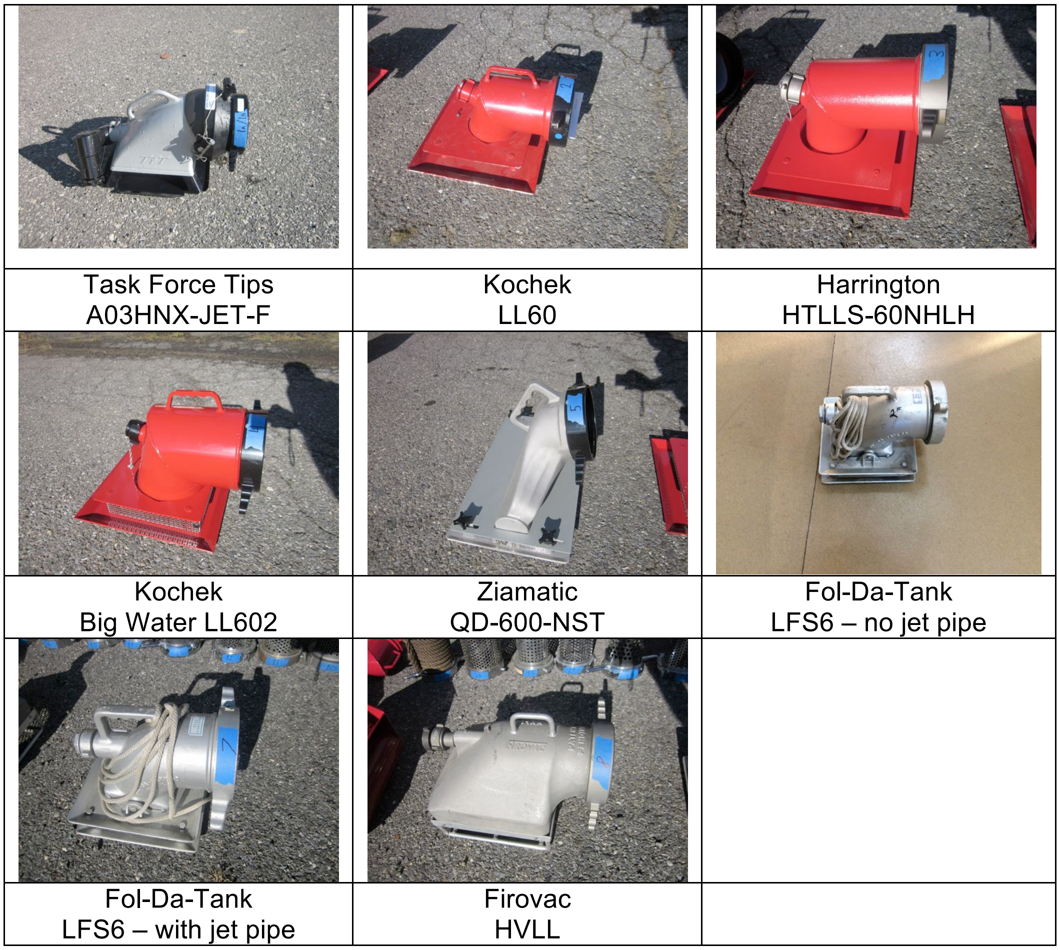


Figure 42: Eight low-level suction strainers were flow tested.

Table 1
Low-Level Suction Strainer Flow Test Results – Motor Speed and Vacuum Reading

Device	Flow Achieved (gpm)	Motor Speed (rpm)	Vacuum Reading ("Hg)
No strainer (Baseline Test)*	1800 gpm	1225 rpm	17.0 in
Task Force Tips (A03HNX-JET-F)	1800 gpm	1125 rpm	16.5 in
Kochek (LL60)	1040 gpm	925 rpm	24.0 in
Harrington (HTLLS-60NHLH)	924 gpm	978 rpm	24.0 in
Kochek Big Water (LL602)	1284 gpm	1050 rpm	22.0 in
Ziamatic (QD-600-NST)	1666 gpm	1025 rpm	17.5 in
Fol-Da-Tank (LFS6) [no jet pipe]	1594 gpm	1000 rpm	19.5 in
Fol-Da-Tank (LFS6) [with jet pipe]	1590 gpm	950 rpm	19.0 in
Firovac (HVLL)	1864 gpm	1125 rpm	14.5 in

Table 2 **Low-Level Suction Strainer Flow Test Results - Pump Discharge Pressure and Net Pump Pressure**			
Device	**Flow Achieved (gpm)**	**Pump Discharge (psi)**	**Net Pump Pressure (psi)**
No strainer (Baseline Test)*	1800 gpm	68 psi	76 psi
Task Force Tips (A03HNX-JET-F)	1800 gpm	68 psi	76 psi
Kochek (LL60)	1040 gpm	60 psi	72 psi
Harrington (HTLLS-60NHLH)	924 gpm	58 psi	70 psi
Kochek Big Water (LL602)	1284 gpm	74 psi	85 psi
Ziamatic (QD-600-NST)	1666 gpm	66 psi	75 psi
Fol-Da-Tank (LFS6) [no jet pipe]	1594 gpm	60 psi	70 psi
Fol-Da-Tank (LFS6) [with jet pipe]	1590 gpm	58 psi	67 psi
Firovac (HVLL)	1864 gpm	82 psi	89 psi

Regarding physical data findings and the low-level strainer flow tests, the top performing strainers - Firovac and Task Force Tips – also had the largest outlet size and had large inlet screen sizes. Both of those low-level strainers used a wide-open casting design instead of a metal tube design.

Table 3 **Low-Level Suction Strainer Physical Data**			
Device	**Flow Achieved (gpm)**	**Outlet Diameter (in)**	**Inlet Screen (in^2)**
No strainer (Baseline Test)*	1800 gpm	NA	NA
Task Force Tips (A03HNX-JET-F)	1800 gpm	6.625 in	81.0 in^2
Kochek (LL60)	1040 gpm	5.75 in	23.75 in^2
Harrington (HTLLS-60NHLH)	924 gpm	5.75 in	25.95 in^2
Kochek Big Water (LL602)	1284 gpm	6.00 in	107.50 in^2
Ziamatic (QD-600-NST)	1666 gpm	6.00 in	68.25 in^2
Fol-Da-Tank (LFS6) [no jet pipe]	1594 gpm	6.00 in	56.00 in^2
Fol-Da-Tank (LFS6) [with jet pipe]	1590 gpm	6.00 in	56.00 in^2
Firovac (HVLL)	1864 gpm	6.125 in	138.06 in^2

Floating Suction Strainer Results

Seven different floating suction strainers were flow tested. The flow test results ranged from a low of 1,699 gpm (Harrington) to a high of 1864 gpm (Kochek Big Water). All of the floating strainers performed quite well with less than a 10% difference in flow between the lowest and highest performers. Any of the floating strainers that were flow tested should be able to support a 1,500 gpm pump at draft using a single suction inlet at no more than 10 feet of lift.

The Kochek (Big Water), Fol-Da-Tank, and Ziamatic strainers were clearly the top performers as evident in their 1800+ gpm flows and the low vacuum readings at the pump when those strainers were in use. In fact, all three of those floating strainers most likely could have flowed more water had the Hale QMax pump been able to take in more water through the single, side suction inlet. However, the pump had reached its suction inlet limit.

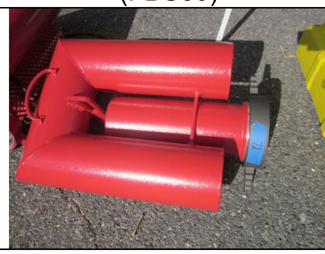
		
Kochek Big Water (FBS602)	Kochek (FBS60)	Fol-Da-Tank Float Dock (FDS6)
		
Ziamatic (FDS-600-NST)	Harrington (HTFBS-60NHLH)	Kochek (Original model)
		
	Task Force Tips (A03HNX-JET-F)	

Figure 43: Seven different floating strainers were flow tested.

Table 4
Floating Suction Strainer Flow Test Results
Motor Speed and Vacuum Reading

Device	Flow Achieved (gpm)	Motor Speed (rpm)	Vacuum Reading ("Hg)
No strainer (Baseline Test)*	1800 gpm	1225 rpm	17.0 in
Kochek Big Water (FBS602)	1864 gpm	1200 rpm	15.0 in
Kochek (FBS60)	1743 gpm	1150 rpm	17.0 in
Fol-Da-Tank Float Dock (FDS6)	1800 gpm	1150 rpm	16.5 in
Ziamatic (FDS-600-NST)	1800 gpm	1150 rpm	16.5 in
Harrington (HTFBS-60NHLH)	1699 gpm	1075 rpm	18.0 in
Kochek (original model)	1723 gpm	1100 rpm	18.0 in
Task Force Tips (A03HNX-JET-F)	1762 gpm	1100 rpm	16.0 in

Table 5
Floating Suction Strainer Flow Test Results
Pump Discharge Pressure and Net Pump Pressure

Device	Flow Achieved (gpm)	Pump Discharge (psi)	Net Pump Pressure (psi)
No strainer (Baseline Test)*	1800 gpm	68 psi	76 psi
Kochek Big Water (FBS602)	1864 gpm	84 psi	91 psi
Kochek (FBS60)	1743 gpm	74 psi	82 psi
Fol-Da-Tank Float Dock (FDS6)	1800 gpm	72 psi	80 psi
Ziamatic (FDS-600-NST)	1800 gpm	70 psi	78 psi
Harrington (HTFBS-60NHLH)	1699 gpm	62 psi	71 psi
Kochek (original model)	1723 gpm	62 psi	71 psi
Task Force Tips (A03HNX-JET-F)	1762 gpm	66 psi	74 psi

Of special note was the performance of the Harrington floating strainer. Around the 1000 gpm flow point a strange but significant vortex was formed prohibiting higher intake flow. In order to secure a higher flow reading, one member of the project team used a pike pole to push the Harrington floating strainer farther down in the water. It was only then that the 1699 gpm flow was attained.

Table 6
Floating Suction Strainer Physical Data

Device	Flow Achieved (gpm)	Outlet Diameter (in)	Inlet Screen (in^2)
No strainer (Baseline Test)*	1800 gpm	NA	NA
Kochek Big Water (FBS602)	1864 gpm	6.00 in	117.00 in^2
Kochek (FBS60)	1743 gpm	5.75 in	104.50 in^2
Fol-Da-Tank Float Dock (FDS6)	1800 gpm	6.00 in	89.13 in^2
Ziamatic (FDS-600-NST)	1800 gpm	6.00 in	127.50 in^2
Harrington (HTFBS-60NHLH)*	1699 gpm	5.75 in	25.95 in^2
Kochek (original model)	1723 gpm	5.75 in	87.13 in^2
Task Force Tips (A03HNX-JET-F)	1762 gpm	6.625 in	81.00 in^2

Box-Style Suction Strainer Results

Only one, actual box strainer was available for testing, so a Kochek Big Water Bottom Guard Barrel Strainer was added to the project since that strainer is designed to operate similar to a box strainer. In reality, both the Fol-Da-Tank and Ziamatic floating suction strainers can also function as box strainers if the floats are removed The Fol-Da-Tank and Ziamatic floating suction strainers were not tested as box strainers since results had already been obtained during the floating strainer test process and no change in test results was expected.

Regarding the flow tests on the two Kochek products, both strainers performed very well (1830 gpm and 1864 gpm respectively) and at relatively consistent vacuum readings. There was little difference in the performance between the box strainer and the bottom guard barrel strainer.

	
Kochek BX60	Kochek BC602BG

Figure 44: Two, box-style strainers were flow tested. The barrel strainer with bottom guard was used because it deploys and operates much like a box strainer.

Table 7 **Box-Style Suction Strainer Flow Test Results** **Motor Speed and Vacuum Reading**			
Device	**Flow Achieved (gpm)**	**Motor Speed (rpm)**	**Vacuum Reading ("Hg)**
No strainer (Baseline Test)*	1800 gpm	1225 rpm	17.0 in
Kochek Box (BX60)	1830 gpm	1200 rpm	15.5 in
Kochek Bottom Guard (BS602BG)	1864 gpm	1200 rpm	15.0 in

Table 8 Box-Style Suction Strainer Flow Test Results Pump Discharge Pressure and Net Pump Pressure			
Device	**Flow Achieved (gpm)**	**Pump Discharge (psi)**	**Net Pump Pressure (psi)**
No strainer (Baseline Test)*	1800 gpm	68 psi	76 psi
Kochek Box (BX60)	1830 gpm	72 psi	80 psi
Kochek Bottom Guard (BS602BG)	1864 gpm	76 psi	83 psi

Both of the box-style strainers most likely could have flowed more water had the Hale QMax pump been able to take in more water through the single, side suction inlet. However, the pump had reached its suction inlet limit.

Table 9 Box-Style Suction Strainer Physical Data			
Device	**Flow Achieved (gpm)**	**Outlet Size (in)**	**Inlet Screen (in^2)**
No strainer (Baseline Test)*	1800 gpm	NA	NA
Kochek Box (BX60)	1830 gpm	5.75 in	114.00 in^2
Kochek Bottom Guard (BS602BG)	1864 gpm	6.00 in	117.45 in^2

Basket-Style Suction Strainer Results

Only two, basket-style strainers were available for testing - one of which had no indication of manufacturer, the other strainer was made by Red Head. Both basket strainers performed very well (1852 gpm and 1886 gpm respectively) and most likely could have flowed more water had the pump's side suction inlet been capable of taking in more water. There were no performance issues with either basket strainer.

Red Head
Style 139

Unknown Make/Model
Possible Akron Brass

Figure 45: Two, basket-style strainers were flow tested.

Table 10
Basket-Style Suction Strainer Flow Test Results – Motor Speed and Vacuum Reading

Device	Flow Achieved (gpm)	Motor Speed (rpm)	Vacuum Reading ("Hg)
No strainer (Baseline Test)*	1800 gpm	1225 rpm	17.0 in
Red Head (Style 139)	1852 gpm	1200 rpm	15.5 in
Unknown (Possible Akron)	1886 gpm	1200 rpm	14.5 in

Table 11
Basket-Style Suction Strainer Flow Test Results – Pump Discharge Pressure and Net Pump Pressure

Device	Flow Achieved (gpm)	Pump Discharge (psi)	Net Pump Pressure (psi)
No strainer (Baseline Test)*	1800 gpm	68 psi	76 psi
Red Head (Style 139)	1852 gpm	74 psi	82 psi
Unknown (Possible Akron)	1886 gpm	78 psi	85 psi

Table 12 Basket-Style Suction Strainer Physical Data			
Device	**Flow Achieved (gpm)**	**Outlet Size (in)**	**Basket Circumference (in)**
No strainer (Baseline Test)*	1800 gpm	NA	NA
Red Head (Style 139)	1852 gpm	6.0 in	22.25 in
Unknown (Possible Akron)	1886 gpm	6.0 in	29.00 in

Barrel Strainer Results

Ten barrel strainers were flow tested and each strainer achieved a flow in excess of 1700 gpm. Some of the strainers came from 50+ year-old pumpers; limited manufacturer data was available on those strainers.

The three top performers that all flowed over 1800 gpm also all had a barrel larger than 6-inches. The Kochek and the Akron both used 8-inch tubing in their design and the “unknown” model had a 7-3/8-inch diameter. All three top performing barrel strainers most likely could have flowed more water if the Hale QMax pump could have taken in more water using the single, side suction inlet. However, the pump had reached its intake limit on that suction inlet.

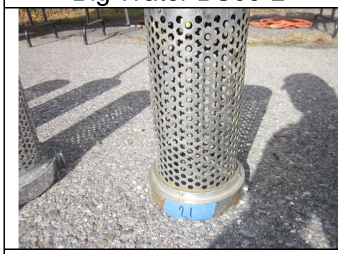
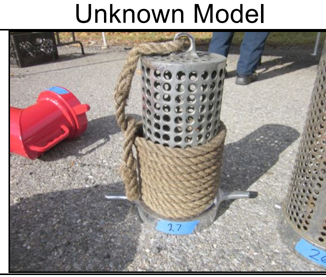
		
Kochek Big Water BS60-2	Akron Style 340	Harrington HTBS-60NH
		
Unknown Make/Model Possible American LaFrance	Kochek BS60	Unknown Make/Model Possible Seagrave
		
Elkhart Model 315	Powhatan Unknown Model	Unknown Make/Model
		
	Unknown Make/Model Possible Seagrave	

Figure 46: Ten, barrel strainers were flow tested.

Table 13
Barrel Strainer Flow Test Results – Motor Speed and Vacuum Reading

Device	Flow Achieved (gpm)	Motor Speed (rpm)	Vacuum Reading ("Hg)
No strainer (Baseline Test)*	1800 gpm	1225 rpm	17.0 in
Kochek Big Water (BS60-2)	1852 gpm	1175 rpm	15.0 in
Akron (Style 340)	1864 gpm	1225 rpm	15.5 in
Harrington (HTBS-60NH)	1723 gpm	1050 rpm	17.0 in
Possible American LaFrance 1960's	1762 gpm	1075 rpm	16.5 in
Kochek (BS60)	1738 gpm	1100 rpm	17.0 in
Possible Seagrave (1959)	1762 gpm	1100 rpm	16.5 in
Elkhart (Model 315)	1762 gpm	1125 rpm	16.5 in
Powhatan (Unknown model)	1723 gpm	1100 rpm	17.5 in
Unknown Make and Model	1830 gpm	1200 rpm	15.5 in
Possible Seagrave (1959)	1762 gpm	1150 rpm	17.0 in

Table 14
Barrel Strainer Flow Test Results – Pump Discharge Pressure and Net Pump Pressure

Device	Flow Achieved (gpm)	Pump Discharge (psi)	Net Pump Pressure (psi)
No strainer (Baseline Test)*	1800 gpm	68 psi	76 psi
Kochek Big Water (BS60-2)	1852 gpm	74 psi	81 psi
Akron (Style 340)	1864 gpm	76 psi	84 psi
Harrington (HTBS-60NH)	1723 gpm	64 psi	72 psi
Possible American LaFrance 1960's	1762 gpm	66 psi	74 psi
Kochek (BS60)	1738 gpm	64 psi	72 psi
Possible Seagrave (1959)	1762 gpm	66 psi	74 psi
Elkhart (Model 315)	1762 gpm	68 psi	76 psi
Powhatan (Unknown model)	1723 gpm	62 psi	71 psi
Unknown Make and Model	1830 gpm	74 psi	82 psi
Possible Seagrave (1959)	1762 gpm	68 psi	76 psi

Even with the variance in outlet opening and inlet screen sizes, all of the barrel strainers performed above what was expected.

Table 15 Barrel Strainer Physical Data Part 1			
Device	**Flow Achieved (gpm)**	**Outlet Size (in)**	**Inlet Screen (in^2)**
No strainer (Baseline Test)*	1800 gpm	NA	NA
Kochek Big Water (BS60-2)	1852 gpm	6.00 in	72.96 in^2
Akron (Style 340)	1864 gpm	6.125 in	69.08 in^2
Harrington (HTBS-60NH)	1723 gpm	5.875 in	70.40 in^2
Possible American LaFrance 1960's	1762 gpm	6.00 in	83.60 in^2
Kochek (BS60)	1738 gpm	5.75 in	87.78 in^2
Possible Seagrave (1959)	1762 gpm	6.00 in	69.50 in^2
Elkhart (Model 315)	1762 gpm	6.00 in	113.24 in^2
Powhatan (Unknown model)	1723 gpm	6.00 in	43.12 in^2
Unknown Make and Model	1830 gpm	6.25 in	73.56 in^2
Possible Seagrave (1959)	1762 gpm	5.875 in	76.83 in^2

Even with the variance in hole size and number, all of the barrel strainers performed above what was expected.

Table 16 Barrel Strainer Physical Data Part 2			
Device	**Flow Achieved (gpm)**	**Hole Size (in)**	**Number Of Holes**
No strainer (Baseline Test)*	1800 gpm	NA	NA
Kochek Big Water (BS60-2)	1852 gpm	5/16 in	1216
Akron (Style 340)	1864 gpm	3/8 in	628
Harrington (HTBS-60NH)	1723 gpm	3/8 in	640
Possible American LaFrance 1960's	1762 gpm	3/8 in	760
Kochek (BS60)	1738 gpm	3/8 in	798
Possible Seagrave (1959)	1762 gpm	1/2 in	360
Elkhart (Model 315)	1762 gpm	7/16 in	760
Powhatan (Unknown model)	1723 gpm	3/8 in	392
Unknown Make and Model	1830 gpm	5/16 in	968
Possible Seagrave (1959)	1762 gpm	1/2 in	392

Ice Suction Strainer Results

Only one ice strainer was available for testing and it performed well enough to support a 1500 gpm flow – although that flow most likely was the strainer's peak flow given the high vacuum reading. Therefore, there is some value to considering the use of a barrel or basket strainer through a hole in the ice since all of the barrel and basket strainers tested outperformed the ice strainer and… a hole has to be cut in the ice to deploy the ice strainer, why not just deploy a barrel or basket strainer.

Kochek
IS60

Figure 47: Only one ice strainer was flow tested.

Table 17
Ice Strainer Flow Test Results
Motor Speed and Vacuum Reading

Device	Flow Achieved (gpm)	Motor Speed (rpm)	Vacuum Reading ("Hg)
No strainer (Baseline Test)*	1800 gpm	1225 rpm	17.0 in
Kochek (IS60)	1504 gpm	975 rpm	21.0 in

Table 18
Ice Strainer Flow Test Results
Pump Discharge Pressure and
Net Pump Pressure

Device	Flow Achieved (gpm)	Pump Discharge (psi)	Net Pump Pressure (psi)
No strainer (Baseline Test)*	1800 gpm	68 psi	76 psi
Kochek (IS60)	1504 gpm	48 psi	58 psi

Table 19 **Ice Strainer Flow Test Results** Part 1			
Device	**Flow Achieved (gpm)**	**Outlet Size (in)**	**Vacuum Reading ("Hg)**
No strainer (Baseline Test)*	1800 gpm	NA	NA
Kochek (IS60)	1504 gpm	5.75 in	104.5 in^2

Table 20 **Ice Strainer Flow Test Results** Part 2			
Device	**Flow Achieved (gpm)**	**Hole Size (in)**	**Number Of Holes**
No strainer (Baseline Test)*	1800 gpm	NA	NA
Kochek (IS60)	1504 gpm	3/8 in	950

Final Thoughts and Considerations

The suction strainer flow test project was born after several years of observing sub-standard, low-level suction strainer performance during rural water supply drills across the United States. During those observations, it became more and more clear to Project Team members that low-level suction strainers were often the flow restriction in a perfectly good water supply operation – unbeknownst to the pump operators and dump site personnel.

The results of the suction strainer flow test project validate in many ways what was already known about low-level suction strainers from a "gut feeling" perspective. The Project Team was surprised a bit by the stellar performance of all the barrel strainers given the variances in design; but then again, the barrel strainer is the mainstay in pump performance certification testing. It was also good to see the strong performance of the most commonly used floating strainers.

With preliminary test results released in late 2017, several folks have noted that a number of the suction strainer flow tests had flows exceeding the 1800 gpm base flow measured when no suction strainer was used. While the Project Team has no definitive answer for this occurrence, the team provides three considerations:

- The “no suction strainer” flow test was the very first flow test completed on project test day. It was done right after sunrise and was the first pumping of the day for the fire pump. We know that both pump and motor performance can improve some after those devices warm-up. Since none of the larger flows were greater than 86 gpm above the 1800 gpm “no strainer” test, it is quite likely that the 4.8% increase in flow during some of the later flow tests in the day was related to improved performance of the diesel motor and/or fire pump.

- A second possibility (although not proven by the Project Team) is that suction strainers help to organize the flow of water into the cylindrical shape suction hose conduit – much like a stream shaper does on a master stream device. Therefore, it is also likely that the 4.8% increase in flow during some of the flow tests was attributed to the use of a suction strainer to produce more organized inlet flow into the suction hose.

- The final possibility is the combination of both motor/pump warm-up performance improvement and the suction strainer helping to reduce turbulent flow at the suction hose entry point.

Because the Project Team chose to use the “more throttle produces no more pump output” as the flow data collection point, pump discharge pressures for all of the tests were below 150 psi because the discharge control valves to the three hose lines were in the fully-open position, thus limiting back pressure at the discharge manifold.

For this project, low discharge pressure was not a problem since the tests only involved using all of the water available at the suction inlet for comparison of strainer performance. However in a real life situation, a pump operator most likely would want to discharge at a higher discharge pressure if he or she was also pumping attack lines or supplying jet siphons.

What is important to remember is that at a higher pump discharge pressure (and resultant net pump pressure) one might encounter a lower flow because centrifugal fire pumps produce high flow at low pressure and high pressure at low flow. Therefore, folks wishing to replicate this flow test project are urged to do so using a 150 psi net pump pressure control measure in order to uncover any differences in suction strainer comparative flow performances. While the flows probably will vary some, the performance comparison between suction strainers probably will remain unchanged – meaning the top performing strainers will remain top performing.

Finally, it is clear there are variances in suction strainer performance between brands and styles of strainers. Owners and potential buyers of suction strainers are encouraged to flow test each strainer during annual pump service testing so that definitive flow measurements are obtained for each strainer and pump combination. Learning on the emergency scene that a recently purchased suction strainer cannot support the 1,000 gpm fire flow is a big problem; learning that information at annual pump test time or drill night is not. Therefore, fire departments are encouraged to flow test all suction strainers before the strainers are needed at a real event.

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