Discharge Flow Test Results: Pleasant Valley Community Fire Company - Special Unit 6

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Background

Special Unit 6 is a water supply pumper operated by the Pleasant Valley Community Fire Company located in Carroll County, Maryland. The 2003 pumper was built by 4-Guys on an International chassis. The unit has a 330 hp International diesel motor, a 1500 gpm Hale Q-Max pump, and carries 1,500-feet of 5-inch hose. Over the last few years, members of the Pleasant Valley Community Fire Company have participated in several, rural water supply drills where they have used Special Unit 6 as a water supply piece for filling tankers. One point of discussion that resulted from those rural water supply drills involved the flow capability of the pumper when pumping through its side-mounted, high flow discharge. The pumper has both a side-mounted and a rear-mounted high flow discharge and the discussion involved the question of which discharge would be the preferred discharge to use when pumping only one 5-inch supply line. After the June 4, 2006, water supply drill held in Lineboro, Maryland, Chief Michael Gist (PVCFC) and Greg Dods of GBW Associates, LLC agreed to flow test the two high flow discharges in order to determine which discharge had the better performance when supplying 5-inch LDH. The results of those flow tests are presented in this report.

Vehicle Specifications

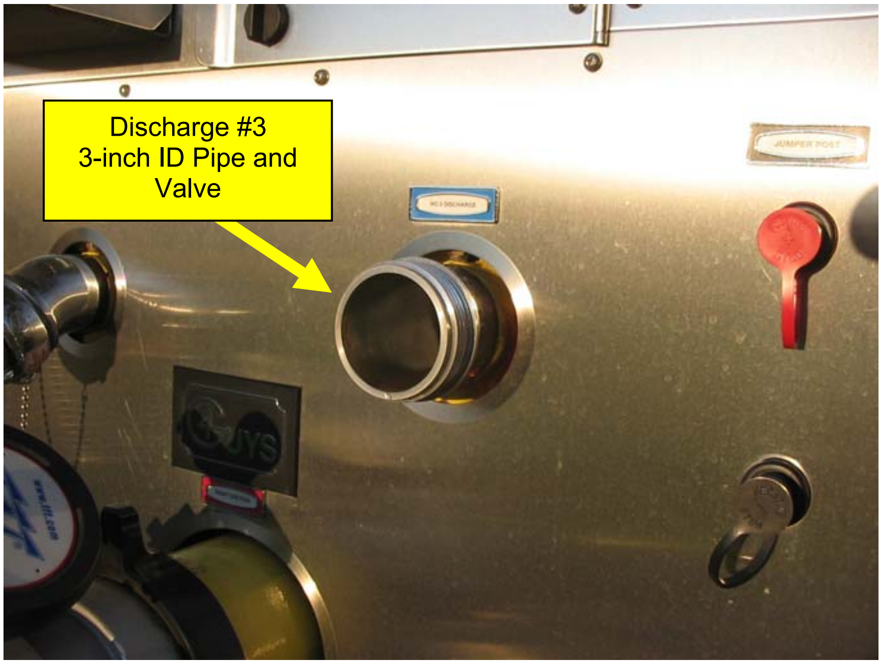
Chassis: 2003 International
Body: 4-Guys
Motor: International DT530 330 hp with a governed speed of 2345 rpm
Pump: Hale QMax U150 1500 gpm single-stage pump

Pump Rated Capacity

1500 gpm	at 150 psi NPP	1358 rpm
1050 gpm	at 200 psi NPP	1484 rpm
750 gpm	at 250 psi NPP	1642 rpm

Discharge #3 Specifications (Labeled as “Discharge 3” on pump panel)

- Located on the right side of the pump
- 3-inch ID pipe
- 3-inch quarter-turn ball valve as the discharge control valve
- No obstructions or restrictions noted inside the pipe or valve
- Discharge is trimmed out with a 5-inch Storz 30-degree turn-down elbow fitting



Rear Discharge Specifications (Labeled as "Rear Discharge" on pump panel)

- Located on the rear of the vehicle; left side
- 3-inch ID pipe is run through the on-board water tank; there is at least an 8-ft run of pipe possessing three (3) ninety-degree elbows between the pump manifold connection and the discharge outlet
- 3-inch quarter-turn ball valve as the discharge control valve
- No obstructions noted at the discharge opening; unable to view inside of valve.
- Discharge is trimmed out with a 5-inch Storz 30-degree turn-down elbow fitting

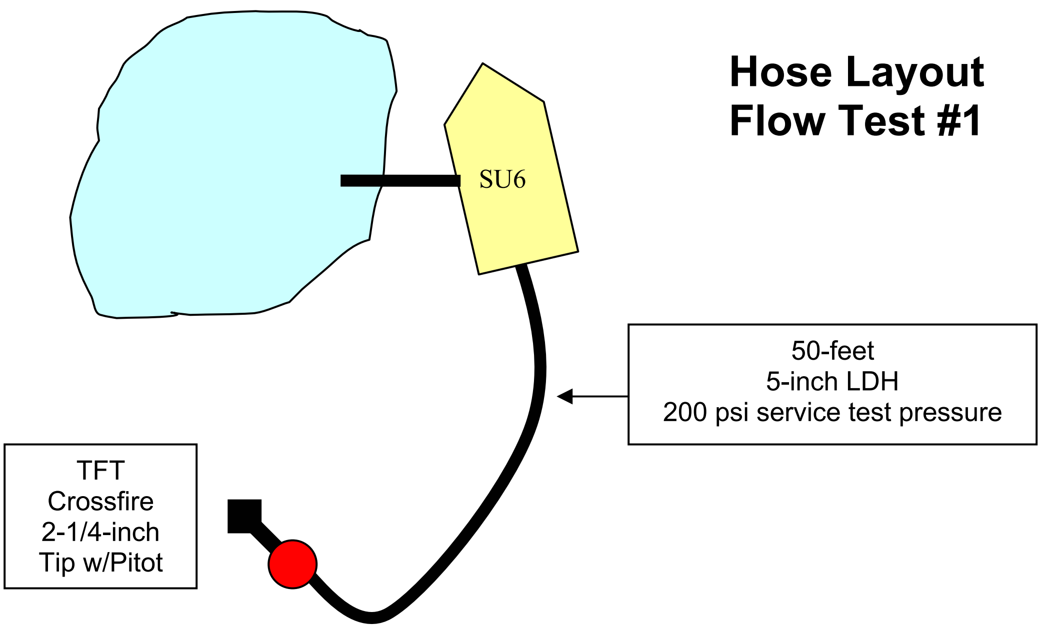
Problem Statement #1:

What is the flow capability of the rear high-flow discharge?

Flow Test Methodology and Layout

The goal of the first flow test was to determine how much water could be moved through the rear, high-flow discharge while operating from draft. The set-up would require the use of a single 5-inch line connected to the test discharge which would supply a portable monitor. The only limitations placed on this test scenario were the governed speed of the motor (2,345 rpm) and the 200 psi annual service test pressure of the 5-inch hose.

The test layout consisted of a 50-ft section of 200 psi test pressure, 5-inch hose which was connected to the Rear Discharge on one end and connected to a Task Force Tips Crossfire portable monitor on the other end. The portable monitor was equipped with an integrated waterway pitot tube and a 2-1/4-inch smooth bore nozzle. The pumper was positioned to draft from a firewater storage pond using 20-feet of 6-inch hard suction hose and a Kochek high-flow floating strainer. The lift was estimated at 8-feet based upon previous flow tests done at the same drafting site.



Flow Test Results

For Flow Test #1, the operator of Special Unit 6 was instructed to obtain a prime and discharge water out of the Rear Discharge at a 150 psi discharge pressure as registered on the Rear Discharge's line gauge. During Flow Test #1, the position of the control valve for the Rear Discharge was "fully-open". Once 150 psi was attained on the individual discharge gauge, a reading was taken at the portable monitor. The pitot reading at the portable monitor was 46 psi or 1,021 gpm (Freeman's Formula). The motor speed was also recorded using the vehicle's digital tachometer mounted on the pump panel. The motor speed was recorded as 1,314 rpm.

The operator was then instructed to discharge water at 200 psi to the Rear Discharge – the maximum discharge pressure based upon the service test pressure of the 5-inch hose. Again, the position of the control valve was fully-open. The pitot reading at the portable monitor was 60 psi or 1,167 gpm. The motor speed was recorded at 1,476 rpm using the vehicle's digital tachometer mounted on the pump panel.

Flow Test Data – Flow Test #1 – Rear Discharge

Pump Discharge Pressure	Pitot Pressure on 2-1/4-inch tip	Flow Achieved	Motor rpm Reading
150 psi	46 psi	1,021 gpm	1,314 rpm
200 psi	60 psi	1,167 gpm	1,476 rpm

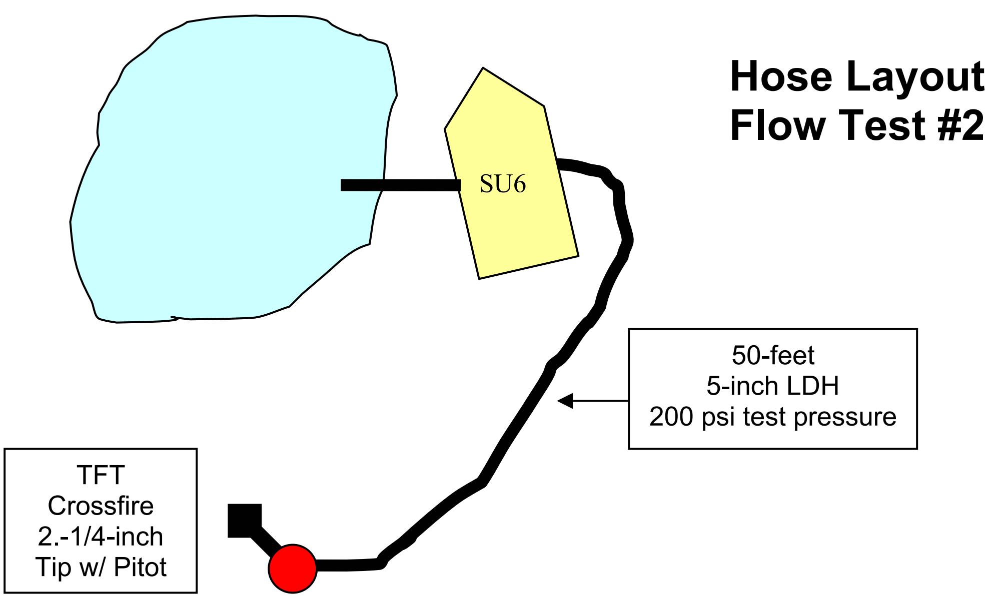
Problem Statement #2:

What is the flow capability of Discharge #3?

Flow Test Methodology and Layout

The goal of Flow Test #2 was to determine how much water could be moved through the right-side, high-flow discharge while operating from draft. The set-up would require the use of a single, 5-inch line connected to the test discharge which would in turn supply a portable monitor. The only limitations placed on the test scenario were the governed speed of the motor (2,345 rpm) and the 200 psi annual service test pressure of the 5-inch hose.

The test layout consisted of a 50-ft section of 200 psi test pressure, 5-inch hose which was connected to Discharge #3 on one end and connected to a Task Force Tips Crossfire portable monitor on the other end. The portable monitor was equipped with an integrated waterway pitot tube and a 2-1/4-inch smooth bore nozzle. The pumper was positioned to draft from a firewater storage pond using 20-feet of 6-inch hard suction hose and a Kochek high-flow floating strainer. The lift was estimated at 8-feet based upon previous flow tests done at the same drafting site.



Flow Test Results

For Flow Test #2, the operator of Special Unit 6 was instructed to obtain a prime and discharge water out of Discharge #3 at a 150 psi discharge pressure as registered on Discharge #3's line gauge. During Flow Test #2, the position of the control valve for Discharge #3 was "fully-open". Once 150 psi was attained on the individual discharge gauge, a reading was taken at the portable monitor. The pitot reading at the portable monitor was 66 psi or 1,224 gpm (Freeman's Formula). The motor speed was also recorded using the vehicle's digital tachometer mounted on the pump panel. The motor speed was recorded as 1,343 rpm.

The operator was then instructed to discharge water at 200 psi to Discharge #3 – the maximum discharge pressure based upon the service test pressure of the 5-inch hose. Again, the position of the control valve was fully-open. The pitot reading at the portable monitor was 96 psi or 1,476 gpm. The motor speed was recorded at 1,550 rpm using the vehicle's digital tachometer mounted on the pump panel.

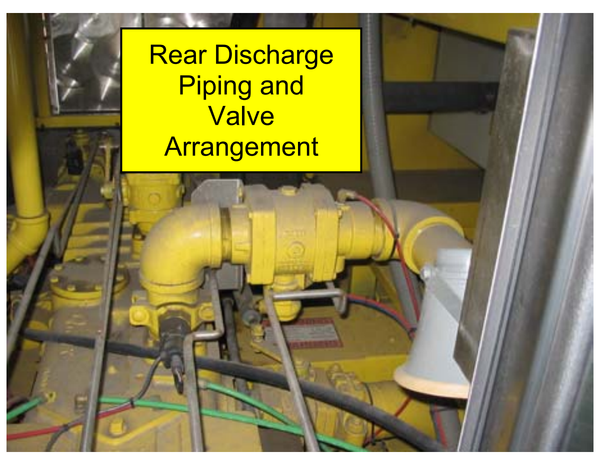
Flow Test Data – Flow Test #2 – Discharge #3

Pump Discharge Pressure	Pitot Pressure on 2-1/4-inch tip	Flow Achieved	Motor rpm Reading
150 psi	66 psi	1224 gpm	1343 rpm
200 psi	96 psi	1476 gpm	1550 rpm

Recommendations & Discussion

The results of the flow tests show that when supplying a single, 5-inch LDH hose line, Discharge #3 should be the discharge "of choice" – for it consistently provided greater flows in all of the test scenarios. When discharging at 150 psi, Discharge #3 flowed 19.9% more water than the Rear Discharge with only a 2.2% increase in motor speed. When discharging at 200 psi, Discharge #3 flowed **26.5%** more water than the Rear Discharge with only a 5.0% increase in motor speed.

The explanation for the difference in flows between the two high flow discharges is simple. Even though both discharges have the same outlet and valve configuration, the flow difference is contributed to the piping arrangement. Discharge #3 is piped directly off of the pump body through a short length of pipe. The Rear Discharge utilizes several feet of pipe and three, 90-degree elbows in order to plumb the outlet to the rear of the vehicle. This increase in pipe length and the use of the elbows reduce the flow capability of that discharge when compared to Discharge #3. Thus, it is much easier for the pump to discharge water out of Discharge #3 than it is to push water out of the Rear Discharge.



During the flow tests there was some discussion about modifying Discharge #3 so that 1500 gpm could be flowed from that discharge at a lower discharge pressure (e.g. 150 psi). As with any modification proposal, one must conduct a cost-benefit analysis. The proposal presented for SU6 was to change Discharge #3's valve and piping from 3-inch to 4-inch. The main obstacle seen with that proposal is that the current valve and piping arrangement is a "machined" arrangement. The 3-inch hole on the pump body was machined at the time of manufacture and there is no easy – or cost effective –method to retrofit that pump body with a 4-inch hole and piping. In consult with design engineers from Hale, a 4-inch pipe and 4-inch valve arrangement on Discharge #3 would certainly flow 1500 gpm at 150 psi. However, given SU6's current configuration, a retrofit from 3-inch to 4-inch would not provide a significant benefit when compared to the cost of the modification. The increase in valve size would reduce the discharge pressure needed but in terms of significant flow increase, that increase probably would not occur unless the size of the supply hose is increased.

Finally, it is the opinion of GBW Associates, LLC that:

1. All driver/operators of Special Unit 6 should be instructed to use Discharge #3 when they are supplying a single, 5-inch supply line. Those driver/operators must also be instructed to not exceed 200 psi discharge pressure on Discharge #3 and the Rear Discharge when they are supplying 5-inch LDH – otherwise they will be exceeding the service test pressure of the hose. One exception – should the unit be supplying higher test pressure hose, such as Neidner's 300 psi service test pressure hose, then the 200 psi guideline does not apply.

2. The proposed modification of SU6's Discharge #3 to a 4-inch valve and pipe arrangement is not cost effective and should not be pursued at this time. Special Unit 6 can easily flow more than 1,000 gpm through either of its high flow discharges; and a 1,000 gpm flow is a generally accepted target flow for filling tankers. The advantage of SU6 is that it carries 1,500-feet of 5-inch hose and has two, high flow discharges. These features make the unit very versatile in rural water supply operations by being able to supply water in many different scenarios.

3. Special Unit 6 should be flow tested supplying its 1,500-feet of 5-inch LDH while operating from a draft of 10-feet or less. Conducting such a flow test will provide the upper "benchmark" of the unit's flow capabilities. All driver/operators would then know how much the unit can flow when all of the supply line has been laid out and they are pumping that supply hose at its service test pressure.