# The 1.75” Hose

**Introduction:**

The fire streams project team started creating pump charts for every pumping apparatus. We used the existing hose found on each apparatus and pumped to our previously determined target flow. We recorded the pump discharge pressures required with each combination (engine, hose/nozzle) to reach that target flow and recorded master and discharge outlet pressures. Our goal was to balance each pumping apparatus to have a common pump discharge pressure for 100’, 200’ and 300’ of 1.75” hose taking into account differences in internal plumbing and fittings inherent in each of our apparatus. All the while maintaining our target flow range. After flowing and testing the hose/nozzle complement on each apparatus individually, the numbers were then compared side-by-side to all of the pumping apparatus in the fleet and major differences were found.

| EXAMPLE: INITIAL NUMBER COMPARISON | |
|---|---|
| APPARATUS 1 | APPARATUS 2 |
| 100’ @ 125 PSI | 100’ @ 110 PSI |
| 200’ @ 180 PSI | 200’ @ 150 PSI |
| 300’ @ 235 PSI | 300’ @ 200 PSI |

We were able to isolate the problem due to differences in the fire hose. On October 9, 2014, the fire streams project team and the crew from 5Y collected and tested ten different manufacturers and/or purchasing years of 1.75” hose. This hose was collected from our department inventory. The test focused on: diameter, length, dry weight, psi loss, and kink/whip. We collected a lot of data, but only included the main points in this section. The complete test results are listed at the end for your reference.

| EXAMPLE: OUTLET PSI (200’ OF 1.75” HOSE WITH 15/16” SMOOTH BORE) | | | |
|---|---|---|---|
| HOSE MANUFACTURER/YEAR | OUTLET PSI | TIP PSI | GPM |
| Mercedes/2012 | 130 | 50 | 182 |
| Key Big10/2014 | 150 | 50 | 182 |
| Angus/2005 | 210 | 50 | 182 |

**Friction Loss:**

The fire streams project team used a standard hose industry method to determine friction loss by using 200’ of 1.75” flowing 50 psi at the tip of a 15/16” smooth bore nozzle. We compared these numbers with the previous pump chart data and confirmed that high/low friction loss numbers in certain hose sections were a major factor in the differences between pump charts in our fleet. We were able to bring down the pump discharge pressures represented in the first example by removing the 58 sections of Angus in our fleet. We also removed three sections of Mercedes hose to improve the accuracy of our average average friction loss data. By averaging the remaining numbers: 121 sections have 25 psi loss and 95 sections have 20 psi loss per 50’. Going with 25 psi as the current average leaves room for error (10 percent margin of error for test gauges) and follows the Hazen-Williams (factor of 140) equation for calculating friction loss. The fire streams project team conducted additional flow tests using the same hose for each pumping apparatus. The pump discharge pressures in the majority of the apparatus could be balanced to create a common chart.

| HOSE MANUFACTURER | YEAR | TOTAL COUNT | FRICTION LOSS (PER 50’) |
|---|---|---|---|
| Key | 2000 | 97 | 25 |
| Key | 2002 | 32 | 20.5 |
| Key | 2010 | 19 | 22 |
| Key Eco 10 | 2013 | 7 | 21.25 |
| Angus | 2005 | 17 | 46.25 |
| Angus | 2006 | 41 | 37.5 |
| Mueller | 2005 | 24 | 25 |
| National | 2003 | 19 | 17.5 |
| Firequip (800 Attack Lite Poly) | 2009 | 18 | 20 |
| Mercedes (MTSS 800) | 2012 | 3 | 15 |

**Replacement:**

The department approved the replacement of the 60 sections we removed due to high/low friction loss per 50’. The fire streams project team tested and purchased new hose (Key Big 10) that has a 20-25 psi friction loss per 50’ and has the flow characteristics we were seeking. It proved to have the same pump discharge pressure needed as our current set up.
The fire streams project team then created various testing criteria that evaluates future purchases to meet the departments needs. The goal is to help members of our department make educated decisions when purchasing hose and nozzles.

**In Closing:**

Manufacturing processes have changed over the years. Internal hose diameters have increased past their marked bowl diameter. This is further complicating issues with fire attack and hose line management. We see increased weight, per section of hose, changes in friction loss coefficients that invite higher pressures, and hose that is more susceptible to thermal and friction insult because of its construction. Hose now is designed to expand more than necessary due to lower thread count. Hose is not being made true to diameter. This is a manufacturing issue, but one we can easily monitor in our current and future inventory. We now have a standard set of tests that we can administer before we make a purchasing

decision that will affect our operation for years. Additionally, the complete test results are included below for your reference.

**References:**


- NFPA 1961, Standard on Fire Hose, 2013 Edition.

- Podcast Episode 845: The Kitchen Table (Dennis Legear) http://www.blogtalkradio.com/fireengineeringtalkradio/2014/08/13/episode-845-the-kitchen-table#.U-uuPFABbmk.facebook

- Hose Dreams Article (Dennis Legear): http://countyfiretactics.com/2013/11/24/hose-dreams-by-dennis-legear/

## Complete Test Results:

**Firehouse Hose Numbers** of 1.75” Tested

| Manufacturer | Year | Marked Length | # | # | # | # | Notes |
|---|---|---|---|---|---|---|---|
| Key | 2000 | 50’ | 101115 | 101137 | 200134 | 200145 | |
| Key | 2002 | 50’ | 402109 | 402103 | 402121 | 402117 | |
| Key | 2010 | 50’ | 11108 | 11110 | 11103 | 11102 | |
| Key Eco 10 | 2013 | 50’ | 13107 | 13102 | 13103 | 13104 | |
| Key Big 10 | 2014 | 50' | NA | NA | NA | NA | |
| Angus | 2005 | 50’ | 405111 | 405119 | 405103 | **405107** | 405107<br>OOS Abrasion |
| Angus | 2006 | 50’ | 6176 | 6138 | 6171 | 6166 | |
| Mueller | 2005 | 50’ | 6102 | 6129 | 6112 | 6108 | |
| National | 2003 | 50’ | 303126 | 303118 | 303108 | 303123 | |
| Firequip 800 (Attack Lite Poly) | 2009 | 50’ | 9106 | 9119 | 9111 | 9105 | |
| Mercedes MTSS 800 (only 3 sections) | 2012 | 50’ | 12101 | 12103 | 12102 | NA | |
| (HR) Mercedes MTSS 800 | 2011/2012 | 75’ | HH11114 | HH12104 | NA | NA | |
| (HR) Firequip | 2008 | 75’ | H08106 | H09101 | NA | NA | |
| (HR) National | 2003 | 75’ | H103104 | **H103104** | NA | NA | H103104<br>OOS De-lamination |

Note:

- Firehouse hose numbers H405107 and H103104 were pulled out of service after testing due to a large abrasion and de-lamination found in the hose.

**Dry Weight/True Length** of 1.75” Hose

| Manufacturer | Year | Dry Weight (LBS) | Measured Length |
|---|---|---|---|
| Key | 2000 | 20 | 48' X 2 (101115/101137)<br>50’ X 2 (402145/200134) |
| Key | 2002 | 20 | 50' X 3<br>48’ X 1 (402103) |
| Key | 2010 | 19 | 48’ X 4 |
| Key Eco 10 | 2013 | 14 | 49' X 4 |
| Key Big 10 | 2014 | 18 | NA |
| Angus Ultima Lite | 2005 | 17 | 50’ X 4 |
| Angus | 2006 | 15 | 49' X 4 |
| Mueller | 2005 | 14 | 49’ X 4 |
| National | 2003 | 16 | 50’ X 4 |
| Firequip 800 (Attack Lite Poly) | 2009 | 15 | 50’ X 4 |
| Mercedes MTSS 800 (only 3 sections) | 2012 | 13 | 48’ X 4 |
| (HR) Mercedes MTS 800 | 2011/2012 | 20 | 75’ X 2 |
| (HR) Firequip | 2008 | 25 | 74’ X 2 |
| (HR) National | 2003 | 24 | 75’ X 2 |

## **PSI Loss** in 1.75” Hose

| Manufacturer | Year | Length | Tip | Outlet PSI Guage | 100’ PSI Guage | Tip PSI | Total PSI Loss | Loss Per 50’ |
|---|---|---|---|---|---|---|---|---|
| Key | 2000 | 200’ | 15/16” | 150 | 105 | 50 | 100 | 25 |
| Key | 2002 | 200’ | 15/16” | 132 | 95 | 50 | 82 | 20.5 |
| Key | 2010 | 200’ | 15/16” | 138 | 80 | 50 | 88 | 22 |
| Key Eco10 | 2013 | 200’ | 15/16” | 135 | 98 | 50 | 85 | 21.25 |
| Key Big 10 | 2014 | 200’ | 15/16” | 150 | 100 | 50 | 100 | 25 |
| Angus | 2005 | 200’ | 15/16” | 235 | 138 | 50 | 185 | 46.25 (See Note) |
| Angus | 2006 | 200’ | 15/16” | 200 | 124 | 50 | 150 | 37.5/ 32.5 (See Note) |
| Mueller | 2005 | 200’ | 15/16” | 150 | 110 | 50 | 100 | 25 |
| National | 2003 | 200’ | 15/16” | 120 | 88 | 50 | 70 | 17.5 |
| Firequip 800 (Attack Lite Poly) | 2009 | 200’ | 15/16” | 130 | 92 | 50 | 80 | 20 |
| Mercedes MTSS 800 | 2012 | 150’ | 15/16” | 110 | 98 | 50 | 60 | 15 |
| (HR) Mercedes MTSS 800 | 2011/2012 | 150’ | 15/16” | 125 | 96 | 50 | 75 | 18.75 |
| (HR) Firequip | 2008 | 150’ | 15/16” | 155 | 104 | 50 | 105 | 26.25 |
| (HR) National | 2003 | 150’ | 15/16” | 105 | 84 | 50 | 55 | 13.75 |

Note:

- Further testing of different Angus 2006 (FH #: 06129, 06144, 06145, 06153) was done on October 17, 2014 to ensure accuracy due to the amount of Friction loss originally found. 32.5 psi per 50’ section was found (180 psi @ Outlet, 120 psi @ 100’, 50 psi @ tip). These higher friction loss numbers impact our pump charts significantly.
- When looking at the numbers consider a 10 percent margin of error in the gauges.

## **True Diameter Measurement** of Marked 1.75” Hose

| Manufacturer | Year | Dry External Thickness | Charged External Diameter (Static) | Static PSI | Subtraction Results |
|---|---|---|---|---|---|
| Key | 2000 | 0.375 | 2.09375 | 175 | 1.71875 |
| Key | 2002 | 0.4375 | 2.125 | 165 | 1.6875 |
| Key | 2010 | 0.375 | 2.125 | 170 | 1.75 |
| Key Eco 10 | 2013 | 0.3125 | 2.0625 | 165 | 1.75 |
| Key Big 10 | 2014 | 0.3125 | 2.125 | 155 / 100 | 1.8125 |
| Angus | 2005 | 0.34375 | 2.1875 | 235 | 1.84375 |
| Angus | 2006 | 0.3125 | 2.1875 | 225 | 1.875 |
| Mueller | 2005 | 0.3125 | 2.15625 | 170 | 1.84375 |
| National | 2003 | 0.3125 | 2.09375 | 160 | 1.78125 |
| Firequip 800 (Attack Lite Poly) | 2009 | 0.34375 | 2.125 | 150 | 1.78125 |
| Mercedes MTSS 800 (only 3 sections) | 2012 | 0.3125 | 2.0625 | 150 | 1.75 |
| (HR) Mercedes MTSS 800 | 2011/2012 | 0.25 | 2.0625 | 155 | 1.8125 |
| (HR) Firequip | 2008 | 0.3125 | 2.125 | 175 | 1.8125 |
| (HR) National | 2003 | 0.34375 | 2.15625 | 150 | 1.8125 |

Note:

- The Static pressure was based off closing the 15/16” after 50 PSI (Pitot) was found at the tip. Testing confirmed that running the static pressure up and down after getting anywhere from 40-60 psi at the tip and then shutting down didn't change the external diameter measurement at all.
- Angus 2005 and 2006 was measured as larger than 1.75” but has the highest friction loss.
- When looking at the numbers consider a 10 percent margin of error in the gauges.

| **KINK/WHIP** IN 1.75" HOSE AT VARIOUS TIP PSI (PAGE 1 of 2) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **HOSE MANUFACTURER** | **YEAR** | **HOSE LENGTH** | **TIP SIZE** | **TIP PSI NOTES (IF PROBLEM)** | | | |
| | | | | | **40** | **50** | **60** |
| Mueller | 2005 | 200' | 15/16" | OPENING | | | |
| | | | | WHIP/KINK | KINK | KINK | KINK |
| | | | | FRONT MOVEMENT | KINK | KINK | KINK |
| | | | | REAR MOVEMENT | KINK | KINK | KINK |
| National | 2003 | 200' | 15/16" | OPENING | | | |
| | | | | WHIP/KINK | | | |
| | | | | FRONT MOVEMENT | | | |
| | | | | REAR MOVEMENT | | | |
| Firequip 800 (Attack Lite Poly) | 2009 | 200' | 15/16" | OPENING | | | |
| | | | | WHIP/KINK | | KINK | |
| | | | | FRONT MOVEMENT | | KINK | |
| | | | | REAR MOVEMENT | | KINK | |
| Mercedes MTSS 800 (only 3 sections) | 2012 | 150' | 15/16" | OPENING | | | |
| | | | | WHIP/KINK | KINK | KINK | KINK |
| | | | | FRONT MOVEMENT | KINK | KINK | KINK |
| | | | | REAR MOVEMENT | KINK | KINK | KINK |
| (HR) Mercedes MTSS 800 | 2011/2012 | 150' | 15/16" | OPENING | | | |
| | | | | WHIP/KINK | KINK | KINK | KINK |
| | | | | FRONT MOVEMENT | KINK | KINK | KINK |
| | | | | REAR MOVEMENT | KINK | KINK | KINK |
| (HR) Firequip | 2008 | 150' | 15/16" | OPENING | | | |
| | | | | WHIP/KINK | | | |
| | | | | FRONT MOVEMENT | | | |
| | | | | REAR MOVEMENT | | | |
| (HR) National | 2003 | 150' | 15/16" | OPENING | | | |
| | | | | WHIP/KINK | KINK | KINK | KINK |
| | | | | FRONT MOVEMENT | KINK | KINK | KINK |
| | | | | REAR MOVEMENT | KINK | KINK | KINK |

| KINK/WHIP IN 1.75" HOSE AT VARIOUS TIP PSI (PAGE 2 of 2) | | | | | | | |
|---|---|---|---|---|---|---|---|
| HOSE MANUFACTURER | YEAR | HOSE LENGTH | TIP SIZE | TIP PSI NOTES (IF PROBLEM) | 40 | 50 | 60 |
| Key | 2000 | 200' | 15/16" | OPENING | | | |
| | | | | WHIP/KINK | | | |
| | | | | FRONT MOVEMENT | | | |
| | | | | REAR MOVEMENT | | | |
| Key | 2002 | 200' | 15/16" | OPENING | YES | | |
| | | | | WHIP/KINK | YES | | |
| | | | | FRONT MOVEMENT | | | |
| | | | | REAR MOVEMENT | | | |
| Key | 2010 | 200' | 15/16" | OPENING | | | |
| | | | | WHIP/KINK | SMALL WHIP | | |
| | | | | FRONT MOVEMENT | | | |
| | | | | REAR MOVEMENT | | | |
| Key Eco 10 | 2013 | 200' | 15/16" | OPENING | | | |
| | | | | WHIP/KINK | | KINK | |
| | | | | FRONT MOVEMENT | | KINK | |
| | | | | REAR MOVEMENT | | KINK | |
| Key Big 10 | 2014 | 200' | 15/16" | OPENING | | | |
| | | | | WHIP/KINK | | | |
| | | | | FRONT MOVEMENT | | | |
| | | | | REAR MOVEMENT | | | |
| Angus | 2005 | 200' | 15/16" | OPENING | | GOOD | |
| | | | | WHIP/KINK | | GOOD | |
| | | | | FRONT MOVEMENT | | GOOD | |
| | | | | REAR MOVEMENT | | GOOD | |
| Angus | 2006 | 200' | 15/16" | OPENING | | | |
| | | | | WHIP/KINK | | | |
| | | | | FRONT MOVEMENT | | | |
| | | | | REAR MOVEMENT | | | |