



**City of Winchester  
Fire & Rescue Department  
STANDARD OPERATING PROCEDURE**



<b>Section:</b>	Fire Suppressions Operations	<b>SOP:</b>	8.1
<b>Subject:</b>	Standardized Hydraulics Practices	<b>Executed:</b>	January 1, 2006
		<b>Revised:</b>	March 20, 2009 March 5, 2010 March 6, 2015
<b>Approved:</b>	 Scott Cullers, Fire Chief		<b>Revised:</b>  Allen W. Baldwin, Fire Chief

**PURPOSE**

To set a standardized procedure for Hydraulic Calculation for the Department. This will benefit personnel, fire-ground operations, communications, training, and testing procedures.

**BACKGROUND**

In general there are many factors that influence friction loss/hydraulics. Among those that are most prevalent are:

- Diameter of the hose
- Length of the hose lines
- Quantity or GPM of water flowing
- Nozzle and hose types
- Elevation
- Appliances such as wyes and Siamese
- Master stream devices

Other less significant factors area:

- Snaked hose lines (can increase FL up to 6%)
- Protruding gaskets
- Poor inner lining of hose
- The need to calculate friction loss in booster line

**PROCEDURES**

All pump operators should be familiar with the different type of equipment carried on the units they operate as not all equipment such as hose lengths and nozzles are the same. The calculated numbers may vary slightly for different apparatus. The establishment of

this departmental procedure will eliminate the need for pressure compensation related to the condition of hose linings, protruding gaskets, and snaked hose lines, and will establish the following standard.

### **Master Streams:**

Both Ladder Pipes and Deluge Sets have losses that must be considered. Style, make, and GPM's affect the friction loss in these devices to a large degree. Unless measured with a pitot tube it is impossible to know exactly how much loss is for a given flow. The Department has set **25 PSI** as the minimum friction loss figure for these devices. This means that **25 PSI** is to be added as the loss for the appliance whenever a ladder pipe or deluge set is being flowed or calculated.

### **Wyes & Siamese:**

These appliances may also vary in friction loss due to style, make, age, size, and amount of water flowing. The Department has set the standard for friction loss in Siamese or Wye **appliances** at **10 PSI per appliance utilized in that particular line when flowing 350 gpm or more.**

### **Nozzle Pressure:**

- Handheld smooth bore nozzle (**1 ¼"** or less) **50 PSI**
- Master stream with smooth bore nozzle (**1 ¼"** or larger) **80 PSI**
- Fog nozzles **75 PSI low pressure, (80 PSI Truck 2), 100 PSI**

### **Elevation:**

Although elevation loss is **.434 PSI** per foot of ascending or descending elevation, the Department will use **0.5 PSI** per foot or **5 PSI** per story (floor). **NOTE: No elevation is considered for the first floor.**

### **Booster Line:**

**Friction loss for 1"** booster hose will be considered at **30 PSI** per 100'.

### **Supply Operation:**

Should the attack pumper not provide its own supply hose or elect to gutterline the hose it has dropped; the supply pumper is to position as to be able to reverse lay from the attack pumper to a viable water source. This protocol may be assumed whenever the attack pumper does not direct the supply pumper to "pick-up" its lines.

- Supply hose loads shall be finished off so that the lead coupling is visible/identifiable and secure when the line is pulled. If a wrench is attached it shall be secure.
- A minimum of 25' (1/2 length) of hose is to accompany the coupling when the line is pulled.

- Supply pump operators are to ensure that the supply line is filled with water before the throttle is increased. (Putting the pump into gear after the supply hose has been attached, the hydrant connection made and the waterway opened may help insure this.)
- Supplying water to the attack pumper will begin with an automatic starting pressure when the attack piece is ready. For supplies involving 3" HOSE and smaller the starting pressure is to be **100 PSI**. For supplies involving 4" HOSE the starting pressure is to be **75 PSI**, for supplies involving 5" Hose the starting pressure is to be **50 PSI**.
- Targeted maximums:
  - 200 PSI 3"**
  - 175 PSI 4"**
  - 150 PSI 5"**
- Should the original starting pressure be inoperable, the attack pumper is to notify the supply pumper to EITHER raise OR lower pressure. A ONE TIME **25 PSI** adjustment is to be made.
- Should these steps not be adequate, the attack pumper is to inform the supply pumper of such AND advise the supply pumper of his required flow (GPM).
- The supply pumper operator is then to CALCULATE THEIR ENGINE PRESSURE USING THE FORMULA  $FL=CQ^2L$  AND ADDING **20** PSI FOR RESIDUAL PRESSURE.

#### 4" Hose:

- Bleeders on 4" hose intake valves should be carried in the **open position**
- 4" hose relief valves are to be pre-set at **100 PSI**
- Target maximum safe pressure on 4" hose is **175 PSI (tested to 200 PSI)**
- Rotate the lead section to prevent excessive wear
- Drag only flat – short distance – never on edge
- Load couplings toward the bulkhead – no couplings should flip (use Dutchman)
- Use turndowns with all 4" hose connections
- The pumper laying the hose is to insure the appropriate adapters are provided (Siamese, wye, storz 2 ½, etc.)

#### Fire Department Connections:

- Supplying protective sprinkler and standpipe systems shall be at **150 PSI** at the Siamese, or **175 PSI** at the Siamese if a high-rise pack containing **1 ¾"** HOSE is employed.

#### Pre-Piped Waterways:

FL will vary with flow and diameter of the piping. Use **25 PSI** loss if exacts are not known. When supplying a ladder truck the starting pressure is to be **150 PSI**

# Hydraulic Standards

Winchester Fire & Rescue Department

## FRICITION LOSS $FL=C \times Q^2 \times L$

COEFFICIENT		
	National	PONN
Size of Hose	Coefficient	Coefficient
1" Booster	150	
1 3/4"	15.5	10
2 1/2"	2	1.5
Single 3"	.8	0.5
Dual 3"	.2	0.1
Single 4"	.2	
Single 5"	.08	
(1)4" & (1)3"	.1	

QUANTITY			
Hose	Nozzle	NP	GPM
1 3/4"	Fog	75 or 100	200
2 1/2"	Fog	75 or 100	250
2 1/2"	1" tip	50	200
2 1/2"	1 1/8" tip	50	250
2 1/2"	1 1/4" tip	50	300
Master	1 1/4" tip	80	400
Master	1 3/8" tip	80	500
Master	1 1/2" tip	80	600
Master	1 5/8" tip	80	700
Master	1 3/4" tip	80	800
Master	1 7/8" tip	80	900
Master	2" tip	80	1000
Master	Fog	100	500-1000
T-2 Master	Fog	80	250-1250

LENGTH
Length of hose / 100

## PUMP PRESSURE

$$PP=FL + NP + +/- EL. + APPLIANCES$$

### FRICITION LOSS

### NOZZLE PRES.

### ELEVATION

### APPLIANCES (ONLY if flows >350 gpm)

FL (from above)

+

NP (from above)

+

+/- 0.5 Psi per ft.

+

10 psi Wyes  
10 psi Siamese  
25 psi Master Stream  
25 psi Pre-piped waterway

## SUPPLY OPERATIONS

3" Hose supply	100 psi (200 psi max)
4" Hose supply	75 psi (175 psi max)
5" Hose supply	50 psi (150 psi max)
One time +/- change if not adequate	25 psi
Standpipe Connection	150 psi
Standpipe Connection w/ highrise pack	175 psi
Truck/Tower 2 Supply	150 psi (100' max)
4" Gutterline (expect 400 gpm)	500' max

## RESIDUAL PRESSURE

Static - Residual x 100 / Static = % of drop	
0-10%	3 times more available
11-15%	2 times more available
16-25%	1 times more available

## PRECONNECTS

Type/Nozzle	Hose	GPM	Length	EP	EP
				NATIONAL	PONN
Trashline/Fog	1 3/4"	200	150'	162 psi	135 psi
Crosslay/Fog	1 3/4"	200	200'	224 psi	155 psi
Rear Longline 1" Tip	1 3/4"	200	300'	236 psi	170 psi
Blitz line 1 1/4" SB	2 1/2"	300	200'	86 psi	77 psi
Boosterline/Fog	1"	-	100'	160 psi	
Deck Gun 1 3/8" SB	-	500	-	105 psi	
Monitor	Dual 3"	500	200'	115 psi	110 psi

## FORMULAS

GPM of a nozzle	$GPM = 29.7 \times D^2 \times \sqrt{NP}$
Nozzle reaction (smooth bore)	$NR = 1.57 \times D^2 \times \sqrt{NP}$
Nozzle reaction (fog nozzle)	$NR = .0505 \times Q \times \sqrt{NP}$
Amount of water in a cylinder	$GAL. = 3.14 \times r^2 \times L / 2.31$
Square roots of Nozzles pressures	$\sqrt{50}=7.0 \quad \sqrt{80}=8.9 \quad \sqrt{100}=10$

## WATER SPECIFICS

1 gal. = 8.3lbs, 231 cu in, absorbs 9300 BTU  
1 cu. ft. = 62.5lbs, 1728 cu in, 7.5 gal.  
Expansion ratio of H2O @ 212°F = 1700:1  
Atmos. Press. = 14.7 1" of Merc.=13" lift

## HYDRANTS

RED	0 - 499 gpm
ORANGE	500 - 999 gpm
GREEN	1000 - 1499 gpm
BLUE	1500 - up gpm

## CLASS A PUMPER

150 psi @ 100% capacity  
200 psi @ 70% capacity  
250 psi @ 50% capacity