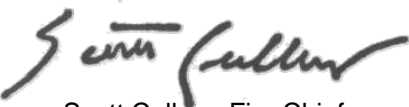




**City of Winchester
Fire & Rescue Department
STANDARD OPERATING PROCEDURE**



Section:	Fire Suppressions Operations	SOP:	8.1
Subject:	Standardized Hydraulics Practices	Executed:	January 1, 2006
		Revised:	March 20, 2009 March 5, 2010
Approved:			
 Scott Cullers, 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
- Type nozzles
- 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

STANDARDS

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 20 PSI as the minimum friction loss figure for these devices. This means that 20 PSI is to be added to 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 a Siamese or wye at 10 PSI. This means that 10 PSI is added for the friction loss whenever these appliances are used or being calculated.

Nozzle Pressure:

- Handheld smooth bore nozzle (1-1/4" or less) **50 PSI**
- Master stream with smooth bore nozzle (1-1/4" or larger) **80 PSI**
- All fog nozzles **100 PSI**

Elevation:

Although elevation loss is .433 PSI per foot of ascending or descending elevation, the Department will use ½ PSI per foot or **5 PSI** per story (floor).

Booster Line:

Friction loss for either 3/4" or 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. (Known as the Lt. Terry Braithwaite load)
- Supply pump operators are to ensure that the supply line is filled with water before the throttle is advanced.
- (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 or larger the starting pressure is to be **75 PSI**.
- Targeted maximums: **200 PSI 3"**
 175 PSI 4"
- 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 STEPS 3 AND 4 FAIL to 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 HIS ENGINE PRESSURE USING THE FORMULA $FL=CQ^2L$ AND ADDING 40 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.)
- A nominal expectation of a gutterlined 4" in town is 400 GPM 500'

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 pak containing 1-3/4" HOSE is employed.

Pre-Piped Waterways:

FL will vary with flow and diameter of the piping. Use **20 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

FRICION LOSS $FL=CxQ^2XL$ QUANTITY

COEFFICIENT

Size of Hose	Coefficient
¾" Booster	1100
1" Booster	150
1 ½"	24
1 ¾"	15.5
2 ½"	2
Single 3"	.8
Dual 3"	.2
Single 4"	.2
(1)4" & (1)3"	.1

X

Hose	Nozzle	NP	GPM
1 ½"	Fog	100	100
1 ¾"	Fog	100	200
2 ½"	Fog	100	250
2 ½"	1" tip	50	200
2 ½"	1 1/8" tip	50	250
2 ½"	1 ¼" tip	50	300
Master	1 ¼" tip	80	400
Master	1 3/8" tip	80	500
Master	1 ½" tip	80	600
Master	1 5/8" tip	80	700
Master	1 ¾" tip	80	800
Master	1 7/8" tip	80	900
Master	2" tip	80	1000
Master	Fog	100	500-1000

X

LENGTH

Length of hose / 100

PUMP PRESSURE

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

FRICION LOSS

NOZZLE PRES.

ELEVATION

APPLIANCES

FL (from above)

+

NP (from above)

+

+/- ½ Psi per ft.

+

10 psi Wyes 10 psi Siamese 20 psi Master Stream 20 psi Pre-piped waterway
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SUPPLY OPERATIONS

3" Hose supply	100 psi (200 psi max)
4" Hose supply	75 psi (175 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
Trashline/Fog	1 ¾"	200	100'	162 psi
Crosslay/Fog	1 ¾"	200	150'	193 psi
Crosslay/Fog	1 ¾"	200	200'	224 psi
Apt. Line/Fog	1¾"/3"	200	150'/150'	207.8 psi
Blitz line 1 ¼"SB	2½"	300	200'	86 psi
Boosterline/Fog	1"	-	100'	160 psi
Deck Gun 1 3/8" SB	-	500	-	100 psi
Rear Attack	1"	200	200'	174 psi
Monitor	Dual 3"	500	200'	110 psi

FORMULAS

GPM of a nozzle	$GPM = 29.7xD^2x\sqrt{NP}$
Nozzle reaction (smooth bore)	$NR = 1.57xD^2xNP$
Nozzle reaction (fog nozzle)	$NR = .0505xQx\sqrt{NP}$
Amount of water in a cylinder	$GAL. = 3.14xr^2xL/231$
Square roots of Nozzles pressures	$\sqrt{50}=7.0 \sqrt{80}=8.9 \sqrt{100}=10$

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