

CALCULATING PUMP DISCHARGE PRESSURE – MADE EASY

Compliments of web@station31.org

www.station31.org/calculating-pump-discharge-pressure.pdf - updated apr 30 2010

Summary: The goal of the pump operator, is to determine what Pump Discharge Pressure he must set for each supply line or handline. To determine this, the total GPM must be known first. GPM is generally determined by Nozzle Tip Size. Once the GPM is determined, then Friction Loss can be calculated for that GPM and the size of the fire hose that will be used. Device pressures must also be added to the Pump Discharge Pressure for each line.

- 1) The Officer should determine the fire load and how many Gallons Per Minute of water will be required, to attempt putting the fire out. Rule of thumb: Big Fire, Big Water (higher GPM).
- 2) The Nozzle Tip Size is primarily what determines how many Gallons Per Minute can be output from the nozzle. Memorize what Tip Sizes relate to what GPM, and where these Tips are used. These numbers are general Rule of Thumb for Station 31:

Smooth/Straight Bore & Master Stream Nozzles

<u>Tip Size</u>	<u>GPM</u>	
15/16	185	(1 ¾" cross-lays & 1 ¾" pre-connects) [round-up to 200GPM]
1	200	(master stream) [tip: for each 1/8 above 1" add 100GPM]
1 1/8	300	(master stream & 2 ½" pre-connect)
1 1/4	400	(master stream)
1 3/8	500	(deluge & truck/bucket)
1 1/2	600	(deluge & truck/bucket)
1 3/4	800	(deluge & truck/bucket)
2	1000	(deluge & truck/bucket)

Fog Nozzles

<u>Diameter</u>	<u>GPM</u>	
1 1/2	100	(1 ¾" cross-lays & 1 ¾" pre-connects)
2 1/2	250	(2 ½" pre-connect)

- 3) Friction Loss is created by the flow of water through the supply or handlines. The smaller the hose, and the faster motion of water (GPM), the higher the Friction Loss. You must compensate for the Friction Loss of each supply line or handline, by increasing the pressure that you are pumping the engine.

However in addition to what you calculate as the pressure/PSI required to compensate for the Friction Loss, you must also add the pressure/PSI requirements that each other device must have, that is in your supply or handline setup. These are the common pressure/PSI requirements for each common device:

50PSI = Smooth/Straight Bore Nozzles used on hand lines.

80PSI = Master Stream Nozzles including Deluge & Truck/Bucket)

100PSI = Fog Stream Nozzles

5PSI = Per Floor of Elevation (or truck height)

5PSI = Standpipe Connection

10PSI = Per Appliance (Gated Wye Connector, Truck 31 itself, etc)

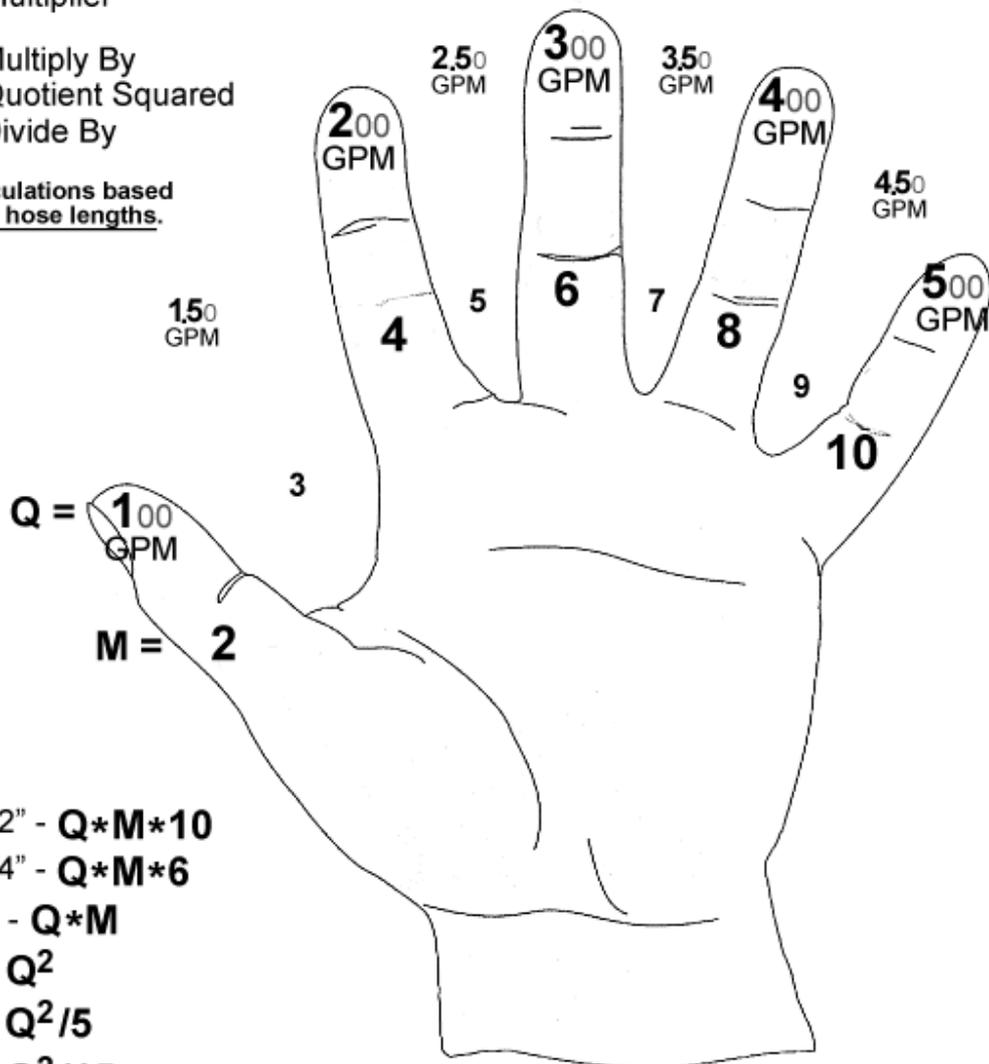
- 4) To calculate your total Pump Discharge Pressure requirements, you must add the pressure requirements for all your devices, plus the pressure which will compensate for the Friction Loss of the fire hose. The total PDP should be counted starting at the nozzle, and work your way back to the pumper. Each supply or handline must be calculated separately; the exception is the high-rise handlines after the Gated Wye, are only counted once.
- 5) To calculate the Friction Loss for a certain GPM and Hose Diameter, you can use the "Hand Method" to determine the Friction Loss.

CALCULATING FRICTION LOSS WITH THE HAND METHOD

Q = Quotient (relating to GPM requirement)
M = Multiplier

* = Multiply By
Q² = Quotient Squared
/ = Divide By

All calculations based on 100' hose lengths.



if 1 1/2" - **Q*M*10**
 if 1 3/4" - **Q*M*6**
 if 2.5" - **Q*M**
 if 3" - **Q²**
 if 4" - **Q²/5**
 if 5" - **Q²/15**

compliments of web@station31.org - updated apr 30 2010
www.station31.org/friction-loss-hand-method.gif

Friction Loss is generally calculated with every 100'.
 Keep this in mind when your handline may not equal 100' increments.
 (handlines have 50' links, 5" supply has 100' links).

ENGINE 31 FRICTION LOSS & PUMP PRESSURES

The following charts contain accurate Friction Loss calculations based on computer formulas

<p>Smooth Bore Nozzles (hand lines) 50psi plus:</p> <table border="1"> <thead> <tr> <th>Size</th> <th>GPM</th> <th>Hose</th> <th>FL (per 100')</th> </tr> </thead> <tbody> <tr> <td>15/16</td> <td>185</td> <td>1 3/4</td> <td>52psi (pre-connect)</td> </tr> <tr> <td>1 1/8</td> <td>265</td> <td>2 1/2</td> <td>14psi (2 1/2" line)</td> </tr> </tbody> </table>	Size	GPM	Hose	FL (per 100')	15/16	185	1 3/4	52psi (pre-connect)	1 1/8	265	2 1/2	14psi (2 1/2" line)	<p>Fog Nozzles (hand lines) 100psi plus:</p> <table border="1"> <thead> <tr> <th>Size</th> <th>GPM</th> <th>Hose</th> <th>FL (per 100')</th> </tr> </thead> <tbody> <tr> <td>1 1/5</td> <td>100</td> <td>1 3/4</td> <td>15psi</td> </tr> <tr> <td>2 1/2</td> <td>250</td> <td>2 1/2</td> <td>12psi</td> </tr> </tbody> </table>	Size	GPM	Hose	FL (per 100')	1 1/5	100	1 3/4	15psi	2 1/2	250	2 1/2	12psi																
Size	GPM	Hose	FL (per 100')																																						
15/16	185	1 3/4	52psi (pre-connect)																																						
1 1/8	265	2 1/2	14psi (2 1/2" line)																																						
Size	GPM	Hose	FL (per 100')																																						
1 1/5	100	1 3/4	15psi																																						
2 1/2	250	2 1/2	12psi																																						
<p>Master Stream (hand line) Using 2.5" couplings 80psi plus: For every 1/8 inch, add 100 GPM</p> <table border="1"> <thead> <tr> <th>Size</th> <th>GPM</th> <th>Hose</th> <th>FL (per 100')</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>265</td> <td>2 1/2</td> <td>14psi</td> </tr> <tr> <td>1 1/8</td> <td>336</td> <td>2 1/2</td> <td>22psi</td> </tr> <tr> <td>1 1/4</td> <td>415</td> <td>2 1/2</td> <td>34psi</td> </tr> <tr> <td>1 1/2</td> <td>597</td> <td>2 1/2</td> <td>71psi</td> </tr> </tbody> </table>	Size	GPM	Hose	FL (per 100')	1	265	2 1/2	14psi	1 1/8	336	2 1/2	22psi	1 1/4	415	2 1/2	34psi	1 1/2	597	2 1/2	71psi	<p>Master Stream (deluge/no FL or truck) 80psi plus: For every 1/8 inch, add 100 GPM Deluge on Engine has no Friction Loss</p> <table border="1"> <thead> <tr> <th>Size</th> <th>GPM</th> <th>Hose</th> <th>FL (per 100')</th> </tr> </thead> <tbody> <tr> <td>1 3/8</td> <td>502</td> <td>5</td> <td>2psi</td> </tr> <tr> <td>1 1/2</td> <td>597</td> <td>5</td> <td>2psi</td> </tr> <tr> <td>1 3/4</td> <td>813</td> <td>5</td> <td>5psi</td> </tr> <tr> <td>2</td> <td>1062</td> <td>5</td> <td>9psi</td> </tr> </tbody> </table>	Size	GPM	Hose	FL (per 100')	1 3/8	502	5	2psi	1 1/2	597	5	2psi	1 3/4	813	5	5psi	2	1062	5	9psi
Size	GPM	Hose	FL (per 100')																																						
1	265	2 1/2	14psi																																						
1 1/8	336	2 1/2	22psi																																						
1 1/4	415	2 1/2	34psi																																						
1 1/2	597	2 1/2	71psi																																						
Size	GPM	Hose	FL (per 100')																																						
1 3/8	502	5	2psi																																						
1 1/2	597	5	2psi																																						
1 3/4	813	5	5psi																																						
2	1062	5	9psi																																						
<p>Master Stream (deck gun on ground) 80psi plus: For every 1/8 inch, add 100 GPM Using 2.5" couplings</p> <table border="1"> <thead> <tr> <th>Size</th> <th>GPM</th> <th>Hose</th> <th>FL (per 100')</th> </tr> </thead> <tbody> <tr> <td>1 3/8</td> <td>502</td> <td>3</td> <td>20psi</td> </tr> <tr> <td>1 1/2</td> <td>597</td> <td>3</td> <td>28psi</td> </tr> <tr> <td>1 3/4</td> <td>813</td> <td>3</td> <td>52psi</td> </tr> <tr> <td>2</td> <td>1062</td> <td>3</td> <td>90psi</td> </tr> </tbody> </table>	Size	GPM	Hose	FL (per 100')	1 3/8	502	3	20psi	1 1/2	597	3	28psi	1 3/4	813	3	52psi	2	1062	3	90psi	<p>Truck Supply <u>Ladder starts at 117psi</u></p> <p>80psi – bucket's master stream nozzle 10psi – truck device/piping 25psi – assuming 50' (1/2) extended 2psi – friction loss assuming 1 link & 500gpm</p> <p>Add 5psi – per floor of elevation (Add 25psi additional if fully extended)</p>																				
Size	GPM	Hose	FL (per 100')																																						
1 3/8	502	3	20psi																																						
1 1/2	597	3	28psi																																						
1 3/4	813	3	52psi																																						
2	1062	3	90psi																																						
<p>Cross-Lays, High Rise & Trash Lines</p> <ul style="list-style-type: none"> • <u>Cross-Lays start at 154psi</u> 50psi – 15/16 smooth bore nozzle 104psi – friction loss assuming 200' & 185gpm Add 5 psi – per floor of elevation • <u>High Rise Operation starts at 122psi</u> 50psi – 15/16 smooth bore nozzle 52psi – friction loss assuming 100' (pack) & 185gpm 10psi – Y connector 10psi – friction loss assuming 100' of 3" & 370gpm Add 5psi – per floor of elevation • <u>Trash Line/Fog starts at 107psi</u> 100psi – fog nozzle 7psi – friction loss assuming 50' & 100gpm Add 8psi if full 100' is used • <u>Trash Line/Solid starts at 75psi</u> 50psi – 15/16 smooth bore nozzle 25psi – friction loss assuming 50' & 185gpm Add 25psi if full 100' is used 	<p>Other Calculations</p> <ul style="list-style-type: none"> • handline links are every 50 foot • 5 inch supply links are every 100 feet • 50psi for smooth/straight bore handlines • 100psi for fog stream handlines • 80psi for master streams • 10psi per device (Y connectors, etc) • 5psi per standpipe connection • 150psi start for commercial standpipe/sprinkler • 100 psi start for residential sprinkler • .5psi per foot or: 5psi per floor (assuming 10 foot) 																																								