Head Pressure	$HP=\frac{feet}{2.304}$	$HP=\frac{meters}{0.1}$
Flow - Solid Stream	$Flow_{gpm}=29.7\cdot d_{in}^2\cdot\sqrt{np_{psi}}$	$Flow_{L\text{-}Min}=0.067\cdot d_{mm}^2\cdot\sqrt{np_{kPa}}$
Nozzle Reaction - Solid Stream	$NR_{lbs}=1.57*d_{in}^2*np_{psi}$	$NR_N=0.0015*d_{mm}^2*np_{kPa}$
Nozzle Reaction - Fog Stream	$NR_{lbs}=0.0505*q_{gpm}*\sqrt{np_{psi}}$	$NR_N=0.0156*q_{L\text{-}\min}*\sqrt{np_{kPa}}$
Friction Loss	$FL_{psi}=c*q_{100's\ of\ gpm}^2*l_{100's\ of\ feet}$	$FL_{kPa}=c*q_{100's\ of\ L\text{-}\min}^2*l_{100's\ of\ meters}$
Elevation Pressure	$EP_{psi}=0.5*h_{feet}$	$EP_{kPa}=10*h_{meters}$
Elevation Pressure - Standpipe	$EP_{psi}=5*(building\ stories\text{-}1)$	$EP_{kPa}=35*(building\ stories\text{-}1)$
$PDP=Nozzle\ Pressure+Total\ Pressure\ Loss$		$Total\ Pressure\ Loss=FL$ +- EP
$NPDP_{Draft}=PDP+Intake\ Pressure\ Correction$		$NPDP=PDP$ - $Intake$ Reading
Maximum Lift	$L_{feet}=1.13\cdot Hg_{inches}$	$L_{meters}=0.01356\cdot Hg_{mm}$
Pressure Correction	$Pressure\ Correction_{psi}=\frac{(Lift+Total\ Intake\ FL)}{2.3}$	$Pressure\ Correction_{kPa}=\frac{(Lift+Total\ Intake\ FL)}{0.1}$
Stream Adequacy	$Q_{flow\ gpm}=A_{width*depth\ (feet)}*V\frac{ft}{\min}*7.5$	$Q_{flow\ kPa}=A_{width*depth\ (m)}*V\frac{m}{\min}*1000$
Capacity of static source	$Capacity_{Square}=L*W*D*Gallons\ per\ unit^3$	$Capacity_{Round}=\pi r^2*Gallons\ per\ unit^3$
$Tender\ Flow\ Rate=\frac{(Water\ Tank\ Size\text{-}10\%)}{(Travel\ Time+Handling\ Time)}$	Travel Time = 0.65 + 1.7*Distance	Handling Time = Fill Site Time + Dump Site Time

Discharge Rates by Size

Inches (mm)	GPM (L/min)
1-1/2 (38)	125 (500)
1-3/4 (45)	175 (700)
2 (50)	200 (800)
2-1/2 (65)	250 (1000)
3	375 (1400)
3-1/2	500 (2000)
4	625 (2400)
4-1/2	750 (3000)
5	1000 (4000)
6	1440 (5500)

Common Conversions

1 inch	25.4 mm
1 mm	0.04 inch
1 gal	3.79 L
1 L	0.26 gal
1 ft	0.3 meter
1 meter	3.28 feet
1 yard	0.91meter
1 meter	1.09 yard
1 psi	6.89 kPa
1 kPa	0.15 psi
1 lb	0.454kg

Flow	PSI	GPM
Solid Stream - Handline	50	<=350
(with up to 1-1/2" nozzles, above 65 psi unmanageable)		
Solid Steam - Master	80	>350
Fog Stream	100	<=350
Fog Stream - Master	100	>350
Fog Stream - Low Pressure	50 to 75	
Fog Stream - High Pressure	800	8 to 15
Piercing	100	100
Chimney	100	1.5 to 3

GPM Flowing Method

GPM 1-1/2 Hose	GPM 2-1/2 Hose	FL per 100ft
50	200	10
55	220	12
60	240	14
65	260	16
70	280	18
75	300	20
80	320	23
85	340	26
90	360	29
95	380	32
100	400	35
105	420	39
110	440	43
115	460	47
120	480	51
125	500	55

1 atm (atmospheric pressure)	14.7psi (101 kPa)	
Change in atmospheric press.	0.5 psi decrease per 1000ft	
1 gallon of water	8.34 lbs (3.78 kg)	
1 foot of water	0.434 psi	
Volume when steam	1700 times	
Latent heat of vaporization	970 btu (1023 kJ)	
Freezing	32°F (0°C)	
Boiling	212°F (100°C)	
1 liter water	.1 m x .1 m x .1m, 1kg	
1 m^3 water	1000L and weighs 1000kg	
1 ft^3 water	7.5 gallons, 62.5 lbs	
1 ft (0.3m) lift	0.885 in Hg (22 mm Hg)	
Max theoretical lift	33.8 ft (10.3 m)	
Required vacuum for prime	22 in Hg	
Water Rise	1.13 ft per in Hg	

Hand Method - 1-3/4" Hose

Thumb	1	100	12
Index	2	125	9
Middle	3	150	9
Ring	4	175	9
Pinky	5	200	9

For gpm to be flowed, multiply col 2 x col 4 to compute approximate friction loss per 100ft of hose.

Condensed Q (Friction loss/100 ft)

3" Hose $FL_{psi}=Q_{100's\ of\ gpm}^2$

4" Hose $FL_{psi}=\frac{Q_{100's\ of\ gpm}^2}{5}$

5" Hose $FL_{psi}=\frac{Q_{100's\ of\ gpm}^2}{15}$

Hand Method 2-1/2"

Thumb	2	100
	3	150
Index	4	200
	5	250
Middle	6	300
	7	350
Ring	8	400
	9	450
Pinky	10	500

Take col 2 times (col 3 /100) for approx. FL per 100ft

Friction Loss	>350 gpm	>1400 L/min
Hose Appliance	10psi	70 kPa
Master Stream	25psi	175 kPa

(if flow <350, assume FL=0)

Rule of Thumb - Nozzle

Solid $NR_{lbs}=\frac{Q_{gpm}}{3}$

Fog $NR_{lbs}=\frac{Q_{gpm}}{2}$

Hydrant Color Codes

Class AA	Light Blue	>1500 (5680)
Class A	Green	1000-1499 (3785 to 5675)
Class B	Orange	500-999 (1900 to 3780)
Class C	Red	<500 (1900)

Flow Required

Multiply by percent involved. 25, 50, 75, 100

$GPM_{fully\ involved}=\frac{Building\ Length*\ Building\ Width}{3}*\#\ of\ Stories$

Friction Loss Coefficients	
Single Hoselines	
0.75	1100
1.00	150
1.25	80
1.50	24
1.75 with 1.5 coupling	15.5
2.00	8
2.50	2
3 with 2.5 coupling	0.8
3 with 3 coupling	0.677
3.50	0.34
4.00	0.2
4.50	0.1
5	0.08
6	0.05
4 (Standpipe)	0.374
5 (Standpipe)	0.126
6 (Standpipe)	0.052

Friction Loss Coefficients	
Siamesed Lines - Equal Length	
Two 2.5	0.5
Three 2.5	0.22
Two 3 with 2.5 Couplings	0.2
One 3 with 2.5 couplings, one 2.5	0.3
One 3with 3 couplings, one 2.5	0.27
Two 2.5, one 3 with 2.5 couplings	0.16
Two 3 with 2.5 couplings, one 2.5	0.12

Friction Loss Coefficients	
Siamesed Lines of Equal Length	
Two 65mm	0.789
Three 65mm	0.347
Two 77mm with 65mm couplings	0.316
Two 77mm with 77mm couplings	0.268
One 77mm with 65mm couplings, one 65mm	0.473
One 77mm with 77mm couplings, one 65mm	0.426
Two 65mm lines, one 77mm with 65mm couplings	0.253
Two 77mm with 65mm couplings, one 65mm	0.189

Friction Loss Coefficient - Single	
20 mm	1741
25 mm	238
32 mm	127
38 mm	38
45 mm	24.6
50 mm	12.7
65 mm	3.17
70mm with 77mm couplings	2.36
77mm with 85mm couplings	1.27
77mm with 77mm couplings	1.06
90mm	0.53
100mm	0.305
115mm	0.167
125mm	0.138
150mm	0.083
100mm (Standpipe)	0.6
125mm (Standpipe)	0.202
150mm (Standpipe)	0.083

Number and Sizes of Intake Hoses		
Rated Capacity - gpm (L/min)	Hose Size in(mm)	Suction Lines
250 (1000)	3 (75)	1
300 (1100)	3 (75)	1
350 (1300)	4 (100)	1
500 (2000)	4 (100)	1
750 (3000)	4.5 (110)	1
1000 (4000)	6 (150)	1
1250 (5000)	6 (150)	1
1500 (6000)	6 (150)	2
1750 (7000)	6 (150)	2
2000 (8000)	6 (150)	2
2000 (8000)	8 (200)	1
2250 (9000)	6 (150)	3
2250 (9000)	8 (200)	1
2500 (10000)	6 (150)	3
2500 (10000)	8 (200)	1
3000 (12000)	6 (150)	4
3000 (12000)	8 (200)	2

IN to MM (Rounded)	
0.50	13
0.63	16
0.75	19
0.88	22
1.00	25
1.13	29
1.25	32
1.38	35
1.50	38
1.75	45
2.00	50
2.25	57
2.50	65
2.75	70
3.00	77
3.50	90
4.00	100
4.50	115
5.00	125
6.00	150

Lift (feet,m)	Vacuum (inHg,mmHg)	Air Pressure (psi,kPa)
33.9 (10.3)	30 (762)	14.7 (101)
32.2 (9.8)	29.04 (738)	14 (96.5)
29.9 (9.1)	26.96 (685)	13 (89.6)
27.6 (8.4)	24.88 (632)	12 (82.7)
25.3 (7.7)	22.8 (579)	11 (75.8)
23 (7)	20.72 (526)	10 (69)
20.7 (6.3)	18.64 (473)	9 (62.1)
18.4 (5.6)	16.56 (420)	8 (55.2)
16.1 (4.9)	14.48 (367)	7 (48.3)
13.8 (4.2)	12.4 (314)	6 (41.4)
11.5 (3.5)	10.32 (262)	5 (34.5)
9.2 (2.8)	8.24 (209)	4 (27.6)
6.9 (2.10)	6.12 (155)	3 (20.7)
4.6 (1.4)	4.08 (104)	2 (13.8)
2.3 (0.7)	2.04 (52)	1 (6.9)

$$Percent\ Drop = \frac{(Static - Residual)(100)}{Static}$$

Percent Drop of Intake, Water Available	
0-10	3 times amount delivered
11-15	2 times amount being delivered
16-25	Same amount as being delivered
25+	Not as much as being delivered

Principles of Pressure

Fluid pressure is perpendicular to any surface on which it acts.

Fluid pressure at a point in a fluid at rest is the same intensity in all directions.

The pressure of liquid in an open vessel is proportional to its depth.

The pressure of liquid in an open vessel is proportional to the density of the liquid.

Pressure applied to a confined fluid from without is transmitted equally in all directions.

The pressure of a liquid on the bottom of a vessel is independent of the shape of the vessel.

Principles of Friction Loss

If all other conditions are the same, FL varies directly with the length of the hose or pipe.

When hoses are the same, FL varies with the square of the increase in velocity of the flow.

For the same discharge, FL varies inversely as the fifth power of the diameter of the hose.

For a given flow velocity, FL is the same, regardless of the pressure on the water.

Maximum Distance Relay (Feet)				
Flow	2-1/2	3	4	5
250	1440	3600	13200	33000
500	360	900	3300	8250
750	160	400	1450	3670
1000	90	225	825	2050
1250	50	140	525	1320

$$Engines\ Needed = \frac{(Relay\ Distance)}{MDR} + 1$$