Friction Loss and Nozzle Flow Reference

Friction Loss per 100' Fire Hose
$FL = CQ^2$

GPM	1 ½" hose	1 ¾" hose	2 ½" hose	3" hose w/ 2 ½" coups	4" hose	5" hose	6" hose
100	24.0	15.5	2.0				
125	37.5	24.2	3.1	1.2			
200		62.0	8.0	3.2			
250		96.8	12.5	5.0			
300			18.0	7.2	1.8		
350			24.5	9.8	2.4		
400			32.0	12.8	3.2	1.3	
450				16.2	4.1	1.6	
500				20.0	5.0	2.0	1.2
600				28.8	7.2	2.9	1.8
700				39.2	9.8	3.9	2.4
800				51.2	12.8	5.1	3.2
900				64.8	16.2	6.5	4.0
1000					20.0	8.0	5.0
1100					24.2	9.7	6.0
1200					28.8	11.5	7.2
1300					33.8	13.5	8.4
1400					39.2	15.7	9.8
1500					45.0	18.0	11.2

Solid Stream Nozzle Flow Rates
$GPM = 29.7\ d^2\ \sqrt{NP}$

Tip Size (inches)	Tip Size (decimal)	Handline Flow @ 50 psi	For field use Round to	Master Stream @ 80 psi	For field use Round to
1/2	0.5	52	50		
5/8	0.625	82	80		
3/4	0.75	118	120		
7/8	0.875	161	160		
15/16	0.9375	184	180		
1	1	210	200		
1 1/8	1.125	266	250		
1 1/4	1.25	328	325	415	400
1 3/8	1.375			502	500
1 1/2	1.5			597	600
1 5/8	1.625			701	700
1 3/4	1.75			814	800
1 7/8	1.875			933	900
2	2			1,063	1,000

Fire Hose Friction Loss Coefficients – Single Line

Hose diameter and type	coefficient (C)
¾" booster	1,100
1" booster	150
1 ¼" booster	80
1 ½" rubber lined	24
1 ¾" with 1 ½" couplings	15.5
2" with 1 ½" couplings	8
2 ½" rubber lined	2
2 ¾" with 3" couplings	1.5
3" with 2 ½" couplings	0.8
3" with 3" couplings	0.677
3 ½"	0.34
4" hose	0.2
4 ½" hose	0.1
5" hose	0.08
6" hose	0.05

Standpipe Friction Loss Coefficients

4" pipe	0.374
5" pipe	0.126
6" pipe	0.052

Nozzle Pressures

Solid stream nozzles – handline	50 psi
Solid stream nozzles – master streams	80 psi
Fog nozzles – all types	100 psi

Friction Loss Allowances – Appliances, Apparatus, Systems

Master stream appliances flowing at capacity	25 psi
Aerial devices	25 psi
Wye and manifold appliances flowing >350 GPM	10 psi
Standpipe system	25 psi

Fire Hose Friction Loss Coefficients – Siamese Lines of Equal Length

Hose diameter and type	coefficient (C)
Two 2 ½"	0.5
Three 2 ½"	0.22
Two 2 ¾" with 3" couplings	0.38
Three 2 ¾" with 3" couplings	0.17
Two 3" with 2 ½" couplings	0.2
One 3" with 2 ½" couplings, one 2 ½"	0.3
One 3" with 3" couplings, One 2 ½"	0.27
One 3" with 3" couplings, One 2 ¾" with 3" couplings	0.24
Two 2 ½", one 3" with 2 ½" couplings	0.16
Two 2 ¾" with 3" couplings, One 3" with 3" couplings	0.12
Two 3" with 2 ½" couplings, one 2 ½"	0.12
Two 3" with 3" couplings, Two 2 ¾" with 3" couplings	0.1

Additional Water Available from Hydrant

Percent drop = $\frac{\text{(static pressure – residual pressure) X 100}}{\text{Static pressure}}$

Percent decrease of pump intake pressure	Additional Water available
0-10%	3 times amount being delivered
11-15%	2 times amount being delivered
16-25%	same amount as being delivered
25% +	less than the amount being delivered

First Digit Method

Get the static pressure, open the line, get the residual pressure
Subtract the residual pressure from the static pressure = psi drop
Multiply the first digit of the static by 1,2, or 3 = volumes available
If the psi drop is = or < 1st digit x 1 = 3 like volumes are available
If the psi drop is = or < 1st digit x 2 = 2 like volumes are available
If the psi drop is = or < 1st digit x 3 = 1 like volume is available
Any psi drop greater than 1st digit x3 = no additional water available

Area, Volume and Weight

Capacity = 7.5 gallons x cubic feet

Capacity = volume in gallons
7.5 = number of galls per cubic foot
cubic feet = area filled with water

Capacity = L x W x D x 7.5

Capacity = volume in gallons of rectangular storage
L = length in feet
W = width in feet
D = depth in feet
7.5 = number of gallons per cubic foot

Capacity = π x r^2 D x 7.5

Capacity = volume in gallons of cylindrical storage
r = radius in feet
D = average depth in feet (or length of horizontal tank)
7.5 = number of gallons per cubic foot

Weight = 62.5 lbs. x cubic feet

Weight = total weight of water
62.5 = pounds per cubic foot of water
cubic feet = area filled with water

$A = \pi d^2 / 4$

A = area of circle in square inches
d = diameter of circle in inches
π = the constant pi = 3.1416

$A = \pi r^2$

A = area of circle in square inches
R = radius of circle in inches
π = the constant pi = 3.1416

Velocity, Flow and Friction loss

$V = 12.1 \sqrt{NP}$

V = flow velocity in feet per second
12.1 = a constant
NP = nozzle pressure in pounds per square inch

$GPM = 29.7 \times d^2 \times \sqrt{NP}$

GPM = discharge in gallons per minute
29.7 = a constant for fire protection nozzles
d = nozzle diameter in inches
NP = nozzle pressure in pounds per square inch

$FL = CQ^2L$

FL = friction loss in pounds per square inch
C = friction loss coefficient for type and size of hose(s)
Q = flow rate in hundreds of gallons per minute
L = hose length in hundred of feet

Q = GPM / 100

Q = flow rate in hundreds of gallons per minute
GPM = actual flow through hose
100 = a constant

L = hose length / 100

L = hose length in hundred of feet
Hose length = actual length of hose
100 = a constant

$C = FL / Q^2$

C = friction loss coefficient for hose
FL = friction loss in pounds per square inch
Q = flow rate in hundreds of gallons per minute
L = hose length in hundred of feet