THE HAZEN-WILLIAMS FRICTION LOSS FORMULA

$$P = 4.52Q^{1.85}/C^{1.85}d^{4.87}$$

Where

P = pressure loss in psi/foot length of pipe
Q = flow in the pipe in gpm
C = roughness coefficient of the pipe
d = inside diameter of the pipe in inches

Note 1: It should be noted that the units of P in the Hazen-Williams formula are psi/foot, while in the equation used to determine flow from a nozzle, the units of P are psi. The fact that different units are attached to the variable P can be confusing to those learning sprinkler system hydraulics for the first time.

Note 2: Based upon the complexity of the formula (with fractional exponents), the formula is ideal for use with computers, however, the formula can also be used with a hand-held calculator. The term d^4 is defined as d x d x d x d, while the term d^5 is defined as d x d x d x d x d. The term $d^{4.87}$ is a number whose value is between d^4 and d^5. This number can be computed using a hand-held calculator with a y^x (or EE) function.

Note 3: The pipe roughness coefficients utilized with the Hazen-Williams formula are provided in NFPA 13. The following are the values of the "C" factors utilized in the Hazen-Williams formula:

Piping Material Type	System Type	Roughness Coefficient ("C" Factor)
Unlined Cast Iron/Ductile Iron Piping	Underground Piping	100
Cement-Lined Cast Iron/Ductile Iron Piping	Underground Piping	120
Steel Piping	Wet and Deluge System	120
Steel Piping	Dry and Preaction System	100
Galvanized Steel	All System Types	120
Stainless Steel	All System Types	150
Copper Tubing	Wet Systems	150
Plastic Pipe/Tubing	Wet Systems	150

Note 4: NFPA 13 requires that steel pipe used in a sprinkler or a standpipe system be either Schedule 10 or Schedule 40 pipe. The term "schedule" refers to the minimum wall thickness of the steel pipe. Steel pipe with other pipe wall thicknesses are permitted to be used when the pipe is specially listed.

Note 5: NFPA 13 indicates that steel pipe with a wall thickness of less than Schedule 40 is not permitted to be threaded or be provided with "cut groove" (unless the pipe is specially listed). This requirement means that Schedule 10 pipe much be connected using either grooved couplings with roll grooves or with plain end pipe fittings.

Note 6: A "cut groove" is a "grove" which is formed by removing a portion of the wall of steel pipe. A "roll grove" is a grove which is formed by "pressing" an indentation onto the pipe. "Grooved couplings" are used to connect "grooved" piping.

Note 7: NFPA 13 requires that copper tubing used in a sprinkler or standpipe system be either Type K, L or M.

Note 8: The following are the inside diameters of Schedule 10 and Schedule 40 steel pipe:

STEEL PIPE		**Inside Diameter**	
Nominal Pipe Size (inches)	**Outside Diameter** (inches)	**Schedule 10** (inches)	**Schedule 40** (inches)
1		1.097	1.049
1-1/4		1.442	1.380
1-1/2		1.682	1.610
2		2.157	2.067
2-1/2		2.635	2.469
3		3.260	3.068
3-1/2		3.760	3.548
4		4.260	4.026
5		5.295	5.047
6			6.065

Note 9: 3-1/2 inch and 5 inch pipe are no longer manufactured. Information on these two pipe sizes is provided because these pipe sizes may be utilized in older existing systems.

Note 10: The following are the inside diameters of Type K, L and M copper tubing:

COPPER TUBING		**Inside Diameter**		
Nominal Tube Size (Inches)	**Outside Diameter** (Inches)	**Type K** (Inches)	**Type L** (Inches)	**Type M** (Inches)
3/4				0.811
1				1.055
1-1/4				1.291
1-1/2				
2				
2-1/2				
3				
3-1/2				
4				
5				
6				
8				

* * * * *