Calculating Friction Loss

Standard: NFPA 1002, Standard on Fire Apparatus Driver/Operator Professional Qualifications

Indication: The Driver Operator needs to be able to calculate friction loss in fire hose in order to produce an effective fire stream.

Procedure: In the field, we calculate friction loss in 3" hose by using the "Q^2" method, and friction loss in 2½" hose by the "$2Q^2$". Friction loss in 1¾" hose is calculated by memorization.

Maximum Efficient Flow in Fire Hose

The maximum efficient flow, also referred to as critical velocity, is the maximum amount of water that can be put through a fire hose before the fire stream breaks up and becomes ineffective. The table below lists hose sizes with the associated flows. Keep in mind that these flows are conservative in that more water can be supplied if needed but this table should be used as a guideline.

Hose Size	Critical Velocity
1¾"	200 gpm
2½"	300 gpm
3"	500 gpm
5"	1200 gpm

Friction Loss

Friction loss is pressure used to overcome resistance while forcing water through fire hose, pipes, and appliances. To calculate the friction loss, it is necessary to know the following:

- The volume or quantity of water flowing (gpm)
- The size of the hose
- The length of the lay

There are many ways to estimate the friction loss in fire hose. Methods like the old hand, new hand, drop 10, and the condensed "Q" are just a few that you may have learned. Conceivably, the most accurate method to determine friction loss is to conduct your own tests. By doing this you will know, with almost exact certainty, the volume of water flowing at specific pressures. Additionally, this enables us to have consistency in friction loss calculations department wide.

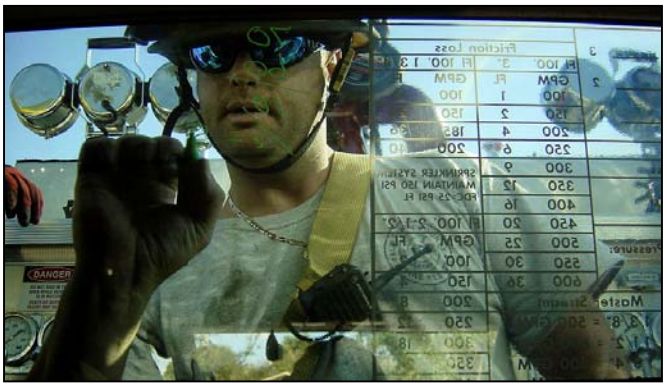
Friction Loss in 1¾" Hi-Combat Hose

(Average coefficient was determined to be: 10.8)

GPM	Friction Loss in 100'
100	12 psi
150	24 psi
185	36 psi
200	40 psi

Calculating Friction Loss in 3" Hose

An easy and accurate way of calculating friction loss is to look at the table below. Take the **1st digit** of the flow (gpm) and multiply it by the **1st digit** of the next number immediately below it. The result is friction loss per 100' of 3" hose. For example, if the flow is 200 gpm, take 2 and multiple it by 2 (the 1st digit of the next number down the column). The answer is 4, which is the friction loss in 100 feet of 3" hose. Let's try a flow of 350 gpm, 3 x 4 equals 12, which is the friction loss in 100 feet of 3" hose. This method is known as Q^2 or condensed Q.



(Average coefficient was determined to be: .72)

GPM	Friction Loss in 100'
100	1 psi
150	2 psi
200	4 psi
250	6 psi
300	9 psi
350	12 psi
400	16 psi
450	20 psi
500	25 psi
550	30 psi
600	36 psi

Calculating Friction Loss in 2½" Hose

The process of calculating friction loss in 2½" hose is accomplished by figuring the friction loss as you would for 3" hose and then doubling the result. For example, if the flow in 100 feet of 3" hose is 300 gpm, then the friction loss is 9 psi per 100'. Next, double 9 to obtain the answer of 18 psi per 100 feet.

(Average coefficient was determined to be: 1.68)

GPM	Friction Loss in 100'
100	2 psi
150	4 psi
200	8 psi
250	12 psi
300	18 psi
350	24 psi
400	32 psi

Appliance Loss

Friction loss in small appliances (double males, double females, reducers, wyes, and siamese) is negligible, and therefore, will not be calculated. Add 25 psi for friction loss for the deck gun when mounted on the engine (Freightliners only) and 15 psi when used as a ground monitor.

Friction Loss in 1½" Hose

The maximum efficient flow of 1½" hose is 150 GPM. Typically, the only apparatus that still utilizes 1½" hose is brush apparatus where friction loss is generally not an issue and therefore not calculated.

Flow of Less Than 100 GPM

NFPA requires a minimum flow of 95 GPM for a handline. This minimum flow rate is to ensure sufficient water is flowing for Firefighter safety. Generally, the friction loss of flows of less than 100 GPM in any size hose is negligible and therefore not calculated.