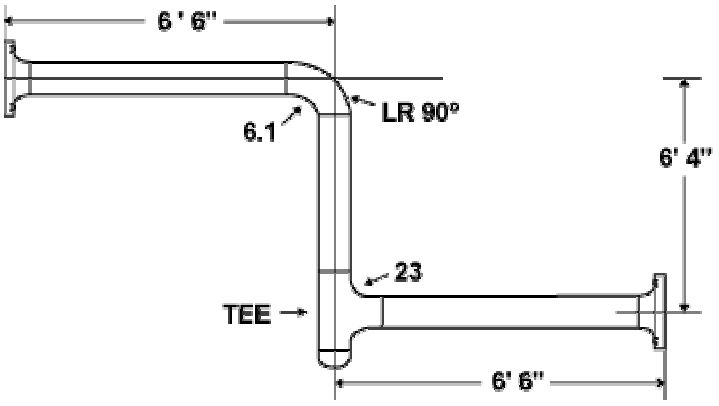
Flow Resistance for Fittings

EQUIVALENT LENGTH OF WELDBEND ELBOWS AND STRAIGHT TEES

Nominal Pipe Size	Long Radius	Short Radius	Welding Tee (Branch)
1"	1.1	1.4	3.9
1 1/4"	1.4	1.8	5.2
1 1/2"	1.6	2.1	6.0
2"	2.1	2.8	7.8
2 1/2"	2.6	3.3	9.3
3"	3.1	4.1	11
4"	4.0	5.4	15
5"	5.1	6.7	19
6"	6.1	8.1	23
8"	8.0	11	30
10"	10	12	38
12"	12	16	45
14"	13	18	49
16"	15	20	56
18"	17	23	63
20"	19	25	71
24"	23	30	85
30"	30	36	140
36"	38	42	170
42"	45	50	200
48"	52	58	240



The information given in the chart above illustrates the resistance of fittings to the flow of liquids. The resistance given in the equivalent of the straight pipe, and should be assumed as approximate information. Allowances have been made up for the curvature of elbows, so that the resistance values should be added to the total center-to-end dimensions of the piping configuration.

Resistance of Pipe: (6.6 + 6.4 + 6.6) = 19.6
Resistance of Elbow: = 6.1
Resistance of Tee: = 23.0
48.7

Therefore, the total resistance of the entire assembly to the flow of liquid would be equal to the resistance of 48.7 Linear feet 6" straight pipe.
There are a number of general formulas for determination of steady flow pressure drop available. One preferred by many is expressed as follows:

$$\Delta p = \frac{.00219 f \rho v^2 L}{d}$$

Where: Δp = Pressue drop (psi)
f =Friction factor (dimensionless)
ρ = Density (lb/ft^3)
v = Mean velocity of flow (ft/sec)
L = Equivalent length of straight pipe (ft)
d = Inside diameter of pipe (m)

In order to determine the friction factor, *f*, for use with this formula, it is necessary to first calculate the appropriate Reynolds number, *R*, and then to select it from the graph below.

The formula for calculating R is: $R = \frac{124 d v \rho}{u}$

Where: R = Reynolds number (dimensionless)
μ = Absolute viscosity (centipoise)

Values for *ρ* and *u* for different liquids and gases are available in various engineering handbooks.

As an example, if water at 70ºF is flowing through the 6" assembly of the previous page at an average velocity of 20ft/sec. the pressure drop due to flow friction (only) may be calculated as follows:

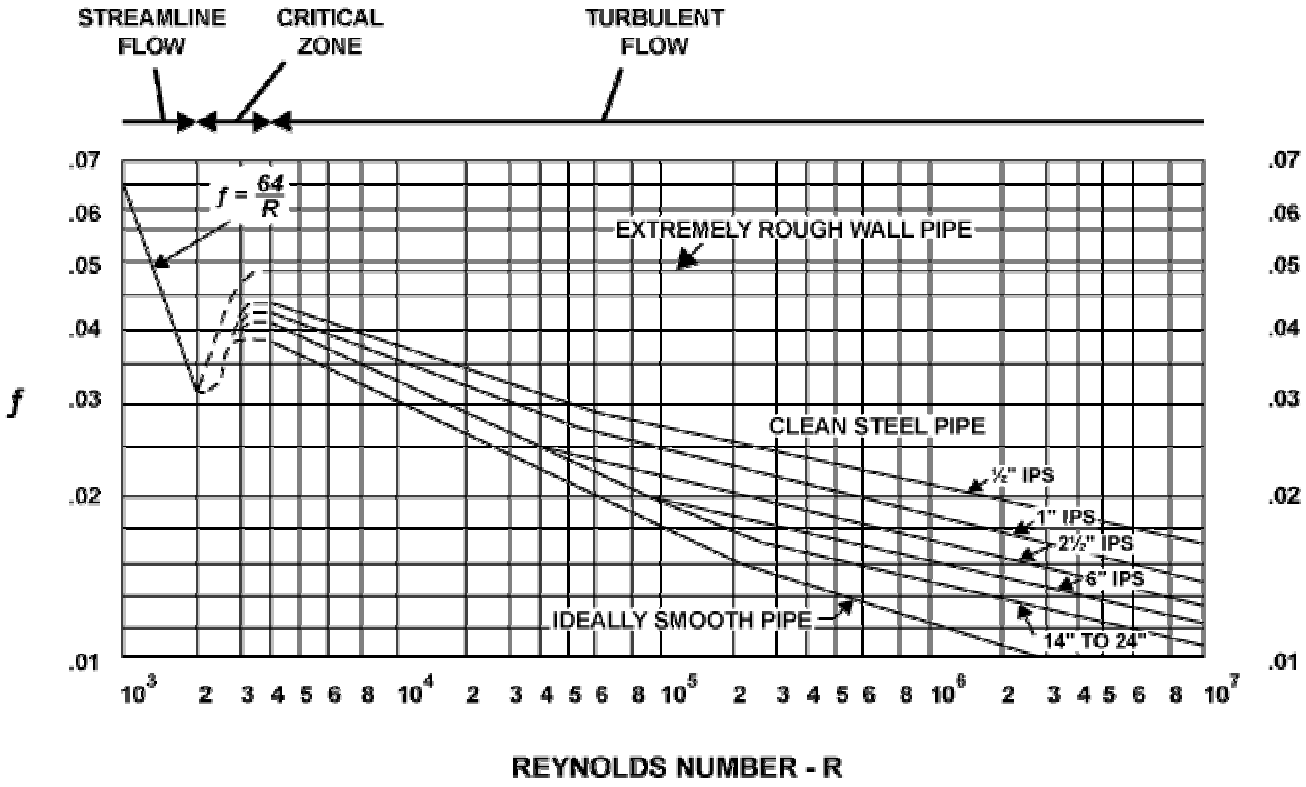
For water $U = 470(T+30)^{-1.35} = 0.94$ and $\rho = 62.37\ lb/ft^3$

$$R = \frac{124(6.06)(20)(62.37)}{0.94} = 99700 \simeq 10^5$$

then $f = .015$ (From graph below)

and $\Delta p = \frac{.00129(.015)(62.37)(20)^2(48.43)}{6.06} = 3.86 \simeq 4$

Therefore, the approximate pressure drop from flange to flange, due only to flow friction, is 4 psi. Calculation of total pressure drop would have to also take into account any change in elevation.


STREAMLINE FLOW
CRITICAL ZONE
TURBULENT FLOW
f = 64/R
EXTREMELY ROUGH WALL PIPE
CLEAN STEEL PIPE
½" IPS
1" IPS
2½" IPS
6" IPS
IDEALLY SMOOTH PIPE
14" TO 24"
f
.07
.06
.05
.04
.03
.02
.01
10^3 2 3 4 5 6 8 10^4 2 3 4 5 6 8 10^5 2 3 4 5 6 8 10^6 2 3 4 5 6 8 10^7
REYNOLDS NUMBER - R