## Pressure Rating

$P = \frac{2St}{D-t}$ $S = \frac{P(D-t)}{2t}$

P is the pressure rating in psi.
S is the Hydrostatic Design Basis (usually 4000 psi) divided by the safety factor (which is 2 for the three standards).
DR is the Dimension Ratio for D2241 and C905 but is OD/t for D1785

*Where:*
P = pressure, psi
S = circumferential stress, psi
D = outside diameter of pipe, inches
d = inside diameter of pipe, inches (average based on mean wall)
t = average wall thickness, inches

**Volume capacity-gallons** per ft. length = VG = V x 0.004329

**Volume capacity-cubic inches** per ft. length = V = 0.7854 x $d^2$ x12

**Outside pipe surface,** sq. ft per ft. length = AO = $\frac{D^2 \pi}{12}$

**Inside pipe surface,** sq. ft. per ft. length = $A_I = \frac{d \pi}{12}$

**Cross-sectional plastic area,** sq. in. = $A = \frac{(D^2 - d^2) \pi}{4}$

**Cross sectional flow area,** sq. in. = $A_F = \frac{d^2 \pi}{4}$

**Weight of PVC pipe,** lb. per ft. length = $W_{PVC}$ = .632 x A

**Weight of CPVC pipe,** lb. per ft. length = $W_{CPVC}$ = .705 x A

**Weight of water in pipe,** lb. per ft. length = $W_W$ = 0.433 $A_F$

**Weight of water filled pipe,** lb. per ft. length = $W_{WFP} = W_{PVC}$ (or $W_{CPVC}$) + $W_W$

**Radius of gyration,** inches = $r_g = \sqrt{\frac{D^2 + d^2}{4}}$

**Moment of inertia,** inches fourth = $I = Ar_g^2$ .0491 $(D^4 - d^4)$

**Section modulus,** inches cube = $Z = \frac{2_I}{D} / = 0.0982 \times \frac{(D^4 - d^4)}{D}$

## Thermal Expansion and Contraction

$\Delta L = 12\ yL\ (\Delta T)$
*Where:*
$\Delta L$ = expansion or contraction of pipe in inches
y = Coefficient of thermal expansion
(see PVC or CPVC material Thermal properties)
L = Length of pipe run in feet
$\Delta T$ = Temperature change °F (Maximum temperature – Temperature @ Installation or maximum system temperature – lowest system temperature, whichever is greater)

## Friction Loss (Hazen-Williams equations)

$$f = .2083 \times (100/C)^{1.852} \times \frac{G^{.1.852}}{d^{.4.8655}}$$

*Where:*
f = friction head of feet of water per 100' for the specific pipe size and I.D.
C = a constant for internal pipe roughness (=150 for thermoplastic pipe)
G = flow rate of U.S. gallons per minute
d = inside diameter of pipe in inches

## Water Velocities

$$V = .3208 \times \frac{G}{A}$$

*Where:*
V = velocity in feet per second
G = gallons per minute
A = inside cross sectional area in square inches

## Gallons Per Minute Through Pipe

GPM = 0.0408 x Pipe Diameter Inches2 x Feet Per Minute Velocity

## Pressure Drop in Valves

$$P = \frac{G^2 \times S_g}{CV^2}$$

*Where:*
P = Pressure drop in PSI; feet of water = PSI/.4332
G = Gallons per minute
Sg = Specific gravity of liquid
$C_V$ = Gallons per minute per 1 PSI pressure drop (see Valve product Cv from manufacturer)

## Water Conversions

1 foot of head = 0.434 PSI
1 gallon = 231 cubic inch = 8.333 pounds
1 pound water = 27.7 cubic inches
1 cubic foot water = 7.5 gallon = 62.5 pounds (salt water = 64.3 pounds)
1 miner's inch = 9 to 12 gallons per minute

$$\text{Horsepower to Raise Water} = \frac{\text{Gallons Per Minute} \times \text{Total Head in Feet}}{3960}$$