# VALVE SIZING BY COMPUTATION



## FORMULA KEY

$C_V$ = Valve flow coefficient

D = Nominal pipe size, inches

$d_P$ = Nominal valve size, inches

$F_L$ = Pressure recovery factor, Liquid (See valve page)

$F_P$ = Piping geometry factor, which is a capacity correction factor for a valve with reduced inlet and expanded outlet piping of the same size or a valve with expanded outlet piping only. (For Intimidator, see table on facing page.)

$$= \frac{1}{\sqrt{\frac{\sum k\, C_V^2}{890 d^4} + 1}}$$

$F_R$ = Valve Reynolds Number factor = 1 if $C_V > 0.1$ and viscosity <1000 cs. (consult factory for other applications)

G = Specific gravity of liquid at flowing temperature

K = Specific heat ratio (see table)

$$\frac{Cp}{Cv} = \frac{\text{Specific heat at constant pressure}}{\text{Specific heat at constant volume}}$$

M = Molecular weight (see table)

$P_1$ = Initial fluid pressure psia = [$p_1$ (psig) + 14.7]

$P_2$ = Reduced fluid pressure psia = [$p_2$ (psig) + 14.7]

$P_C$ = Critical pressure of liquid (water = 3206 psia)

$P_V$ = Vapor pressure of liquid at inlet temperature (water @ 60°F = 0.2563 psia)

$\Delta P$ = Comparative fluid pressure factor = $P_1 - P_2$

$\Delta P_C$ = Critical pressure drop (psi)

$$= P_1 - .96\, P_V + .28\sqrt{\frac{P_V^3}{P_C}}$$

Q = Flow - SCFM or GPM

$T_1$ = Initial absolute temperature of gas = [$t_1$ (°F) + 460]

W = Flow - lb/hr

$X_T$ = Pressure recovery factor, Gas (See valve page)

Z = Compressibility factor (Typically = 1)

$\sum k$ = Valve/piping friction factor

$$1.5\left(1 - \frac{d^2}{D^2}\right)^2$$

### STEAM (MASS)

$$C_V = \frac{W}{19.3\, F_P\, P_1\, Y\, F_R}\sqrt{\frac{T_1\, Z}{XM}}$$

### GAS (VOLUME)

$$C_V = \frac{Q}{7320\, F_P\, P_1\, Y\, F_R}\sqrt{\frac{T_1\, MZ}{X}}$$

**SUBCRITICAL FLOW**

if $X < \frac{X_T\, K}{1.4}$

$X \quad \frac{\Delta P}{P_1} = \frac{P_1 - P_2}{P_1}$

$Y \quad 1 - \frac{X}{2.14\, X_T\, K}$

**CRITICAL FLOW**

if $X \geq \frac{X_T\, K}{1.4}$

$X \quad \frac{X_T\, K}{1.4}$

$Y \quad .667$

### LIQUID (VOLUME)

**SUBCRITICAL FLOW**

if $\Delta P < \Delta P_C\, F_L^2$

$$C_V = \frac{Q}{F_P\, F_R\sqrt{\frac{\Delta P}{G}}}$$

**CRITICAL FLOW**

if $\Delta P \geq \Delta P_C\, F_L^2$

$$C_V = \frac{Q}{F_L\, F_P\, F_R\sqrt{\frac{\Delta P_C}{G}}}$$

### AVERAGE VALUE OF K & M TABLE

| | K | M |
|---|---|---|
| Air | 1.4 | 29 |
| Nitrogen | 1.404 | 28 |
| Oxygen | 1.401 | 32 |
| Hydrogen | 1.41 | 2 |
| Carbon Dioxide | 1.304 | 44 |
| Steam | 1.31 | 18.3 |

# INTIMIDATOR PIPING GEOMETRY FACTORS

**$F_P$**
**for Expanded Outlet Only**

| d/D | Valve Size | 1/2 | | 3/4 | | | 1 | | | | 1-1/2 | | | 2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Port Size | 1/4 | 5/8 | 1/4 | 5/8 | 7/8 | 1/4 | 5/8 | 7/8 | 1 1/4 | 7/8 | 1 1/4 | 1 3/4 | 1 1/4 | 1 3/4 | 2 1/4 |
| 1 | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| .9 | | 1.0 | 1.03 | 1.0 | 1.01 | 1.04 | 1.0 | 1.0 | 1.02 | 1.06 | 1.0 | 1.01 | 1.04 | 1.0 | 1.02 | 1.05 |
| .8 | | 1.0 | 1.05 | 1.0 | 1.02 | 1.07 | 1.0 | 1.01 | 1.04 | 1.09 | 1.01 | 1.02 | 1.06 | 1.01 | 1.03 | 1.07 |
| .7 | | 1.0 | 1.05 | 1.0 | 1.02 | 1.07 | 1.0 | 1.01 | 1.04 | 1.1 | 1.01 | 1.02 | 1.06 | 1.01 | 1.03 | 1.08 |
| .6 | | 1.0 | 1.05 | 1.0 | 1.02 | 1.07 | 1.0 | 1.01 | 1.04 | 1.09 | 1.01 | 1.02 | 1.06 | 1.01 | 1.03 | 1.07 |
| .5 | | 1.0 | 1.04 | 1.0 | 1.02 | 1.05 | 1.0 | 1.0 | 1.03 | 1.07 | 1.01 | 1.02 | 1.05 | 1.01 | 1.02 | 1.06 |
| .4 | | 1.0 | 1.03 | 1.0 | 1.01 | 1.04 | 1.0 | 1.0 | 1.02 | 1.05 | 1.0 | 1.01 | 1.03 | 1.0 | 1.01 | 1.04 |
| .3 | | 1.0 | 1.02 | 1.0 | 1.01 | 1.02 | 1.0 | 1.0 | 1.01 | 1.03 | 1.0 | 1.01 | 1.02 | 1.0 | 1.01 | 1.02 |

**$F_P$**
**for Reduced Inlet & Expanded Outlet of the Same Size**

| d/D | Valve Size | 1/2 | | 3/4 | | | 1 | | | | 1-1/2 | | | 2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Port Size | 1/4 | 5/8 | 1/4 | 5/8 | 7/8 | 1/4 | 5/8 | 7/8 | 1 1/4 | 7/8 | 1 1/4 | 1 3/4 | 1 1/4 | 1 3/4 | 2 1/4 |
| 1 | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| .9 | | 1.0 | .995 | 1.0 | .997 | .993 | 1.0 | .999 | .996 | .992 | .999 | .998 | .994 | .999 | .997 | .992 |
| .8 | | .998 | .981 | .999 | .991 | .976 | 1.0 | .997 | .987 | .971 | .997 | .992 | .978 | .997 | .989 | .974 |
| .7 | | .997 | .963 | .999 | .983 | .953 | .999 | .993 | .974 | .945 | .994 | .984 | .958 | .993 | .978 | .95 |
| .6 | | .995 | .945 | .998 | .974 | .929 | .999 | .989 | .96 | .917 | .991 | .976 | .936 | .99 | .967 | .925 |
| .5 | | .993 | .926 | .998 | .965 | .906 | .999 | .985 | .947 | .891 | .988 | .967 | .915 | .986 | .955 | .90 |
| .4 | | .991 | .91 | .997 | .956 | .886 | .999 | .981 | .935 | .868 | .985 | .96 | .897 | .983 | .944 | .88 |
| .3 | | .99 | .897 | .997 | .95 | .87 | .999 | .979 | .925 | .85 | .982 | .953 | .882 | .98 | .936 | .862 |

# Linear Valve Specification Form

SPENCE

## CONTROL VALVE SPEC SHEET

Project/Job _____ Data Sheet_____of_____

Unit/Customer _____ Spec _____

P.O./LCO File # _____ Tag_____

Item _____ Dwg_____

Contract _____ Service _____

MFR Serial#_____

**Fluid** ❑ Steam ❑ Water ❑ Gas_____ ❑ Liquid_____ Crit Pres PC

**Service Conditions**

Flow ❑ #/hr ❑ gpm ❑ scfh ❑ _____

Inlet Pressure ❑ psig ❑ psia ❑ _____

Outlet Pressure ❑ psig ❑ psia ❑ _____

Temperature ❑ °C ❑ °F _____

Max Press/Temperature:_____ /_____

Density/MW/SG

Viscosity

Vapor Pressure ❑ psia ❑ _____

Required $C_V$ _____

Noise (dBA) Allowable_____

| Max. Flow | Norm. Flow | Min. Flow | Shut-off Pressure |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**Line Info** Pipe Size In_____/Sch_____ Pipe Size Out_____/Sch_____

**Valve, Body & Bonnet**

Body Size in. ❑ ½ ❑ ¾ ❑ 1 ❑ 1¼ ❑ 1½ ❑ 2 ❑ 2½ ❑ 3 ❑ 4 ❑ 6 ❑ 8 ❑ 10 ❑ 12 ❑ 16

ANSI Class ❑ 125 ❑ 150 ❑ 250 ❑ 300 ❑ 600 ❑ 900 ❑ 1500 ❑ 2500 ❑ 4500 ❑ Other_____

Body/Bonnet Material: ❑ Cast Iron ❑ Cast Steel ❑ Cr Mo ❑ 316SS ❑ Bronze ❑ Hast C ❑ Titanium ❑ Alloy 20 ❑ Other_____

End Conn. Inlet/Outlet: ❑ NPT ❑ SWE ❑ BWE Sch._____ ❑ Sep. Flanges ❑ Int. Flanges ❑ Other_____

Packing Material: ❑ PTFE ❑ BTG ❑ Laminated Graphite ❑ Kalrez ❑ Other

**Trim Size** ❑ 100% ❑ 60% ❑ 40% ❑ 20% ❑ Other_____

**Actuator**

Spring Action: ❑ Air to Open ❑ Air to Close ❑ Last Position ❑ None

Available Air Supply Pressure: Max._____ Min._____

Manual Override: ❑ Yes ❑ No ❑ Type_____

**Solenoid** ❑ Yes ❑ No ❑ Type_____ ❑ Voltage_____

**Positioner** ❑ Yes ❑ No ❑ Type_____ ❑ Pneu ❑ I/P

**Switch** ❑ Yes ❑ No ❑ Type_____

**Air Set** ❑ Yes ❑ No ❑ Type:_____ ❑ Range:_____

**Other Accessories** ❑ Yes ❑ No ❑ Type_____

**Test** ANSI/FCI Leakage Class: ❑ II ❑ III ❑ IV ❑ V ❑ VI ❑ Leslie VIII