Models 15L, 15LX, 15LH, 15LHX, AND 15KX

Small Volume High Pressure Regulator

CAPACITY CHARTS

I. Determine the following quantities:

   a. Maximum and minimum inlet pressure at the regulator in psig., taking into account pipe line drop, if appreciable.

   b. Outlet (control) pressure.

   c. Desired flow rate, Q, of free gas in cubic feet per minute at standard conditions (60° and 14.7 psia) – SCFM.

   d. Desired model, control range, and end connection size and type.

II. If the fluid is a gas other than air, the flow rate must first be corrected for specific gravity. To accomplish this, a straight line is drawn from appoint on Scale Q (Chart A or B) corresponding to the flow rate chosen in Step-I-c above, through the value of specific gravity for the gas being considered, on the "specific gravity correction scale". Using the intersection of this line with the vertical line Z as a turning point, draw a line through 1.0 on the "specific gravity correction scale." The intersection of this line with Scale Q gives the equivalent value of flow rate corrected for specific gravity (equivalent flow rate of air).

III. Making preliminary selection of regulator model and control range by consulting the catalog specification sheets for compatibility with desired pressure conditions as stated in step I. If Model 15L, or 15LH is selected, use Chart A. Chart B is applicable to Models 15LX, 15LHX, and 15KX. On the applicable chart, locate the pressure curve cor responding to the minimum inlet pressure at flow, Q, and on the horizontal differential pressure scale, locate the minimum differential pressure (minimum inlet pressure minus outlet pressure, P). From this point on the differential pressure scale, follow a vertical line to an intersection with the previously located inlet pressure curve. From the intersection, follow a horizontal line to an intersection with line Z.

IV. Draw a line from this point on line Z through the corrected value of Q (step II above) to an intersection with scale C. If the line intersects scale C above the value .06 (on Chart A) or .018 (on Chart B) flow rate Q is excessive and must be reduced to a value which will result in an intersection on scale C below the limiting value.

V. Chart C should be consulted to insure that the model selected is capable of flow rate Q. From point on scale P, corresponding to the outlet pressure, draw a line to the point on scale EM cor responding to the desired model and end connection size and type. The intersection with scale Q must indicate a value greater than the desired flow rate (step I-c) or the flow rate found acceptable in step IV. The limiting "Q" so determined, represents the maximum possible flow rate through the size and type of end connection, selected on scale EM, and through a short length (6") of outlet pipe or tubing having the followinf inside diameter.

END CONNECTION TYPE & SIZE	TUBING, I.D.
_" Aminco	.075"
_" AND tubing	.176"
_" NPT	.302"
3/8" AND tubing	.277"

Should the desired flow rate closely approach this limiting value and, particularly if the proposed outlet tubing is significantly longer than 6" or smaller in diameter than the experimental size shown in the above table, then the ability to pass the required flow should be check by other means.

NOTE: If the outlet or control pressure is low relative to the inlet pressure, it is necessary to calculate the outlet pressure variations between minimum and maximum flow rates in order to determine if control pressure variation lies within acceptable limits. To accomplish this, the following steps should be taken.

VI. Chart A, B, C and table D permit determination of all components contributing towards variation in outlet pressure. These components are defined as follows:

V_1 = Pressure variation caused by travel of inner valve (Charts A or B).

V_2 = Pressure variation between no flow and desired flow caused by fluid friction through outlet passages and through a short length of outlet tubing. This variation also includes the outlet loss at discharge end of tubing (Chart C).

V_3 = Lockup pressure. Incremental pressure over that at "whisper" flow (zero value travel) necessary to produce tight shut off. (Table D).

V_4= Outlet pressure variation (at whisper flow) between maximum and minimum inlet pressure due to unbalance across the inner valve poppet. (Table D).

$V_1 + V_2$ = Total variation between "whisper: flow and desired flow (at constant inlet pressure).

V_3 = Variation between lockup and "whisper" flow.
V_4 = Variation due to change in inlet pressure at whisper flow. At another flow rate, V_4 , must be corrected by the difference between V_1 and values as determined at each of the two inlet pressures.

VII. **To determine V_1** – From the intersection on scale C found in step IV, draw a line to a point on scale M corresponding to the outlet pressure consistent with the model number and control pressure range selected in step I-d. The intersection with scale V_1 gives the value of this component of outlet pressure variation.

VIII. **To determine V_2** – Using Chart C, draw a line from a point on scale P_2 corresponding to the outlet pressure, through a value on scale Q corresponding to the desired flow rate, to an intersection with line Z. From this point draw a line through a point on scale M corresponding to the model selected. The intersection with scale V_2 gives the value of this component of outlet pres sure variation.

IX. **To determine V_3** – Consult Table D and read value of V_3 for the model and control pressure range selected.

X. To determine V_4 – If inlet pressure declines or decays, it in necessary to calculate V_4, by referring to Table D.

$$V_4 = U \text{ (from Table D) X } \frac{\text{P1 (initial) – P1 (final)}}{1000}$$

To determine the total outlet pressure variation due to all factors, the following symbols and equations are applicable.

Q = Desired flow rate.

P_2 = Desired (set) outlet pressure.

P_Q = Outlet pressure while passing flow rate "Q"

P_L = Outlet pressure lock up.

V_{1f} = V_1 at final (lowest) inlet pressure.

V_{1h} = V_1 at initial (highest) inlet pressure.

At any inlet pressure and setting of P_2, P_Q is the lower outlet pressure and P_L the highest. Assuming a declining inlet pressure, the following equations apply.

At initial Inlet Pressure

$$P_L = P_2 + V_{1h} + V_2 + V_3$$

$P_Q = P_2$ (Control pressure set while regulator is flowing at rate Q.)

At Final (Lowest) Inlet Pressure
(Assuming no adjustment in outlet pressure is made)

$$P_L = P_2 + V_{1h} + V_2 + V_3 + V_4$$

$$P_Q = P_2 + V_4 – (V_{1f} - V_{1h})$$

V_2 and V_3 are not affected by inlet pressure change and need not be redetermined for the lower inlet pressure.

If inlet pressure is steady, only the first set of equations are applicable.

EXAMPLE:

Initial inlet pressure, P_1 = 2500 psi
(Diff. Press. = 2300 psi).

Final inlet Pressure = P_{1f} = 1600
(Diff. Pressure. – 1400 psi).

Desired (set) outlet pressure, P2 = 200 psig.

Desired flow rate , Q = 13 SCFM of Helium (Sp. Grav. = .138).

Determine:

(1) Regulator model, pressure range, end connection.

(2) Total variation in outlet pressure due to all factors.

Q (corrected) = 5 SCFM.

Select Model 15L, control range 0-300, _ tube (AND-10050).

C = .006 (at 1600 psi inlet pressure). This is below limiting value of .06.

C (Max) from Chart C = 72 SCFM. Therefore model selected has ample capacity.

V_{1h} = 1.8 psi.

V_{1f} = 2.8 psi

V_2 = 0.6 psi

V_3 = 3.0 psi

$$V_4 = 5.4 \times \frac{P_1 - P_{1f}}{1000} = 4.9 \text{ psi}$$

At initial Pressure

P_L = 200 + 1.8 + 0.6 + 3.0 = 205.4 psig.

P_Q = 200 psig.

At final Pressure

P_L = 200 + 1.8 + 0.6 + 3.0 + 4.9 = 210.3 psig.

P_Q = 200 + 4.9 – (2.8 – 1.8) = 203.9 psig.

Total Variation 210.3 – 200 = 10.3 psi.

If Model 15KX has been chosen, the total variation would have been 7.6 psi for the same service conditions.

The total variation in outlet pressure may be divided almost equally above and below the desired outlet pressure by initially setting the outlet pressure somewhat below the “desired: outlet pressure. Thus, in the example, if P_Q has been set initially at 195 psi, then the outlet pressure limits would be 200 +5.3/-5.0 psi.

MODEL AND CONTROL PRESSURE RANGE		LOCKUP (PSI) V3	UNBALANCE PER 1000 PSI CHANGE IN INLET PRESSURE “U” *
15L	0-25, 0-60, 0-150	1.7	3.0
15L	0-300	3.0	5.4
15L	0-750	6.0	11.0
15LH	0-1000	9.0	16.0
15LH	0-2000	19	33.0
15LX	0-25, 0-60, 0-150	1.7	1.0
15LX	0-300	3.0	1.8
15LX	0-750	6.0	3.7
15LX	0-10000	9.0	5.5
15LHX	0-2000, 0-3100	19	11.0
15KX	ALL RANGES	12	6.9

TABLE “D”

$$* \; V_4 = U \times \frac{\text{Decrease in inlet pressure}}{1000}$$

Chart A. (For Models 15L and 15LH)

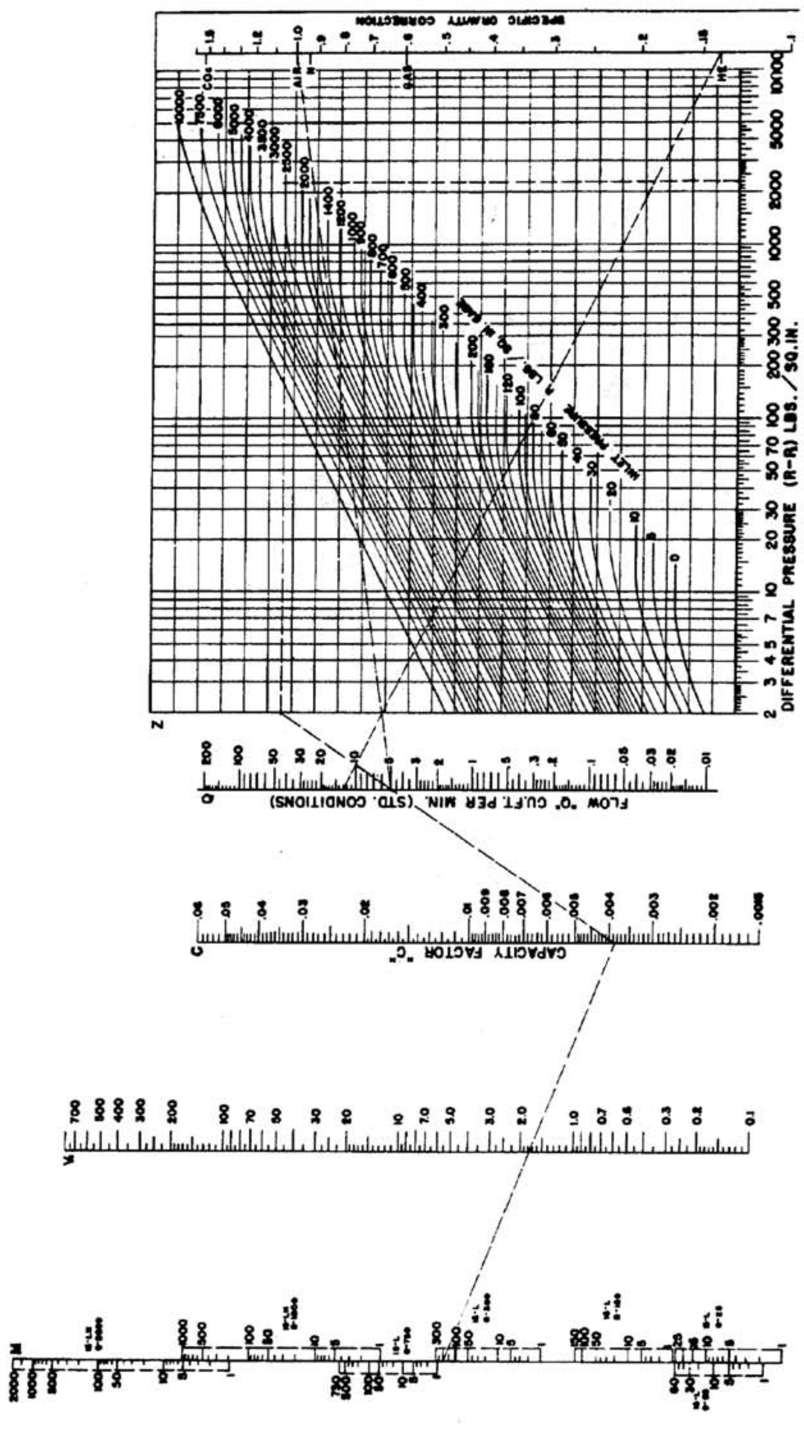


Chart B. (For Models 15LX, 15LHX, & 15KX)

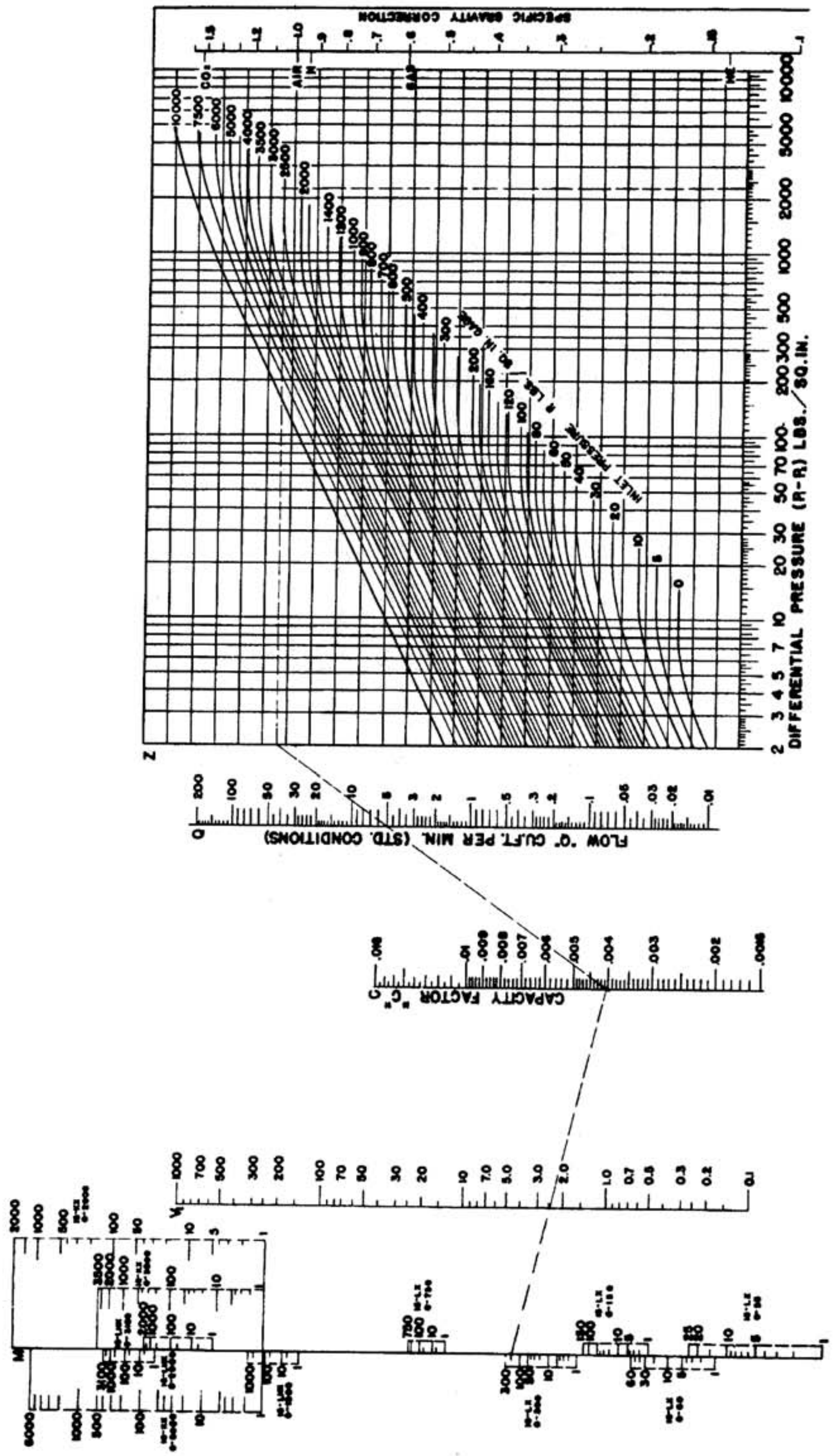
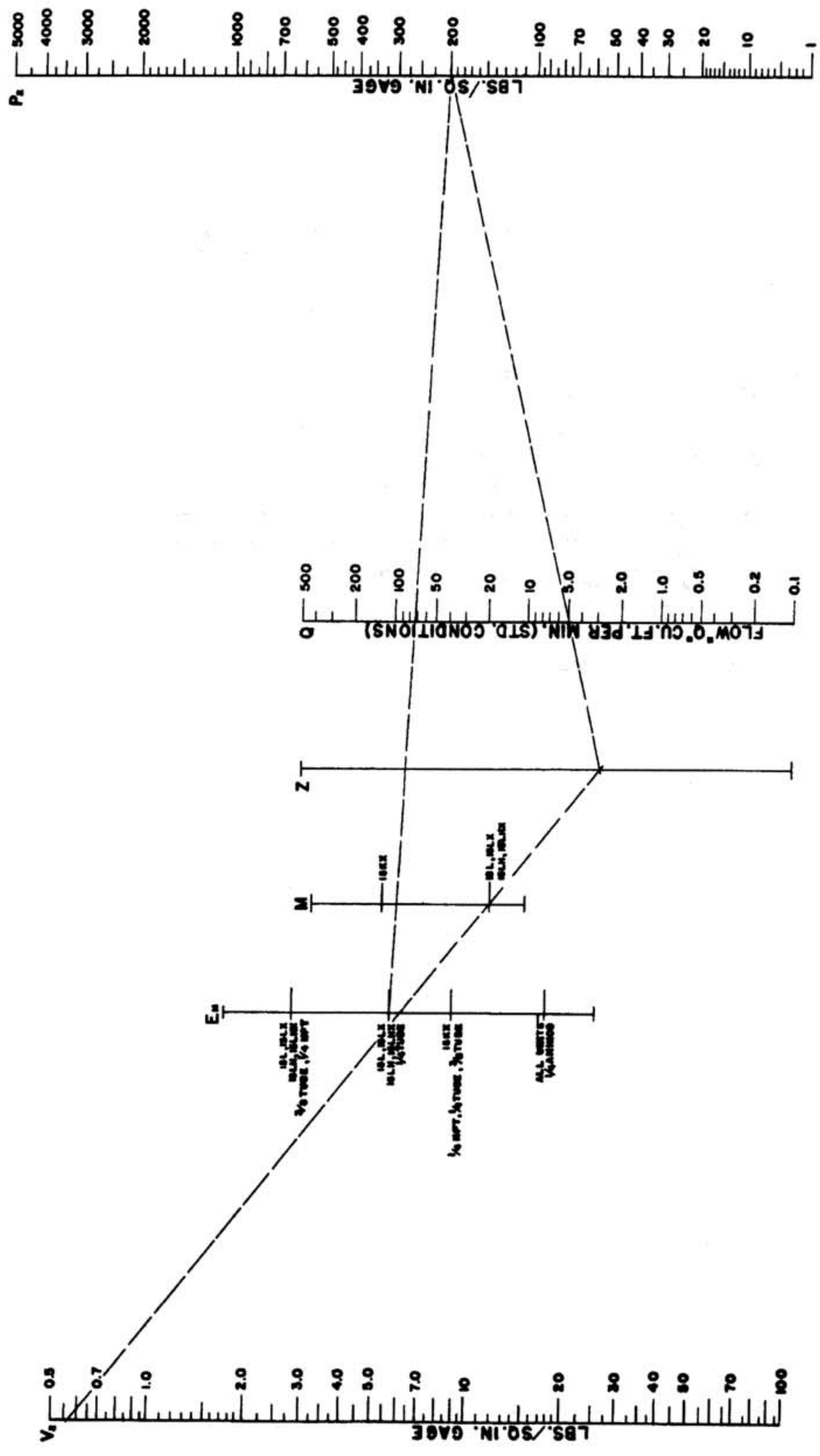


Chart C. (For Model 15L & 15LH)



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