Introduction to the Hi-Flow™ Valve

The Hi-Flow™ control valves are pneumatic operated process control valves for use with controllers to regulate the flow of a process variable; that is steam, water, oil, gas, etc. Hi-Flow™ valves are perfect for applications in food processing, dairy production, HVAC, chemical/industrial processing, tire production, textile production, foundry operations, oil drilling rigs, automotive, and more.

Hi-Flow™ control valves were originally designed and manufactured by Taylor and are well known as a durable and dependable valve. Dwyer Instruments acquired the Hi-Flow™ line in 1991 and has continued manufacturing this great quality valve under the W.E. Anderson Division name. Dwyer Instruments offers units from stock and an exceptional lead time on made-to-order units.

FEATURES

- **Wide Rangeability:** This is the ability of a control valve to control from 100% of Cv down to low values of Cv. The ratio of the high to low values for the Hi-Flow™ valve is 50:1. The Hi-Flow™ valve offers good control at extremely low flow rates, which is particularly valuable when used on batch processes where initial flow is high, but the flow rate is low when the control point is reached.

- **Removable Seat Ring:** Seat ring screws into the body of the globe valve. The seat ring can be removed and replaced as the seat ring wears with use. Replacing the seat ring is much more cost effective than replacing the entire globe valve body.

- **High Capacity:** Hi-Flow™ valves have greater flow capacity than most conventional valves of the same size, offering the ability to use a smaller size valve that is less expensive.

- **Flow Characteristics:** Linear or equal percentage.

- **Selectable Fail Safe Condition:** Air-to-Raise or Air-to-Lower actuators and Push-to-Open and Push-to-Close valve bodies.

- **Packing:** Spring backed Teflon® V-rings to assure a tight seal on the stem.

- **Exceptional Shut-Off:** The Hi-Flow™ leakage rate meets ANSI/FCI 70-2 Class IV (0.01% of Cv in the closed position).

- **Adjustable Springs:** Springs are adjustable in the field for proper shut-off and control range.

- **Easy Maintenance:** Actuators can be removed as one part from the globe valve body without removing the valve from the line. Actuators of different sizes and actions can be field replaced and interchanged on all valve sizes.

Flow Capacity, Cv - Linear Characteristic

LIQUID SIZING COEFFICIENTS, Cv - Linear Characteristics

Pipe Body Size, In.	Total Travel In.	VALVE OPENING-PERCENT OF TOTAL TRAVEL									
		10	20	30	40	50	60	70	80	90	100
1/2	5/16	.78	1.50	2.30	2.90	3.60	4.40	5.10	5.80	6.20	6.45
3/4	7/16	1.19	2.40	3.60	4.80	5.90	7.10	8.40	9.70	10.50	10.75
1	1/2	1.81	3.80	5.80	7.80	9.75	11.75	13.75	15.80	17.10	17.42
1-1/4	9/16	2.57	5.40	8.20	11.00	13.80	16.60	19.50	22.30	24.75	25.30
1-1/2	5/8	3.25	6.80	10.20	13.80	17.25	20.80	24.25	27.75	31.00	32.10
2	3/4	4.67	10.30	15.50	21.00	26.24	31.90	37.30	43.25	48.50	50.30
2-1/2	7/8	7.9	15.72	23.6	31.5	39.3	47.2	55.0	62.9	70.7	78.6
3	1	11.3	22.60	34.0	45.3	56.6	67.9	79.1	90.6	101.9	113.2
4	1-1/8	20.1	40.20	60.3	80.5	100.6	120.7	140.8	161.0	181.3	201.2

LIQUID SIZING COEFFICIENTS, Cv - Linear Characteristics with Restricted Trim

Body Size, In.	Port Size In.	Total Travel, In.	VALVE OPENING-PERCENT OF TOTAL TRAVEL									
			10	20	30	40	50	60	70	80	90	100
1/2	1/2	5/16	.78	1.50	2.30	2.90	3.60	4.40	5.10	5.80	6.20	6.45
3/4	1/2	5/16	.39	.94	1.67	2.48	3.06	3.98	4.79	5.70	6.50	7.10
3/4	3/4	7/16	1.19	2.40	3.60	4.80	5.90	7.10	8.40	9.70	10.5	10.8
1	1/2	7/16	.34	.83	1.42	2.06	2.84	3.63	4.38	5.25	6.56	7.92
1	3/4	1/2	.76	1.56	2.74	3.62	4.86	6.17	7.58	9.30	11.1	12.5
1	1	1/2	1.81	3.80	5.80	7.80	9.75	11.8	13.8	1.58	17.1	17.4

LIQUID SIZING COEFFICIENTS, Cv - Linear Characteristics Needle Valve

Body Size, In.	Port Size In.	Total Travel, In.	VALVE OPENING-PERCENT OF TOTAL TRAVEL									
			10	20	30	40	50	60	70	80	90	100
1/2 to 1	1/32	3/4	0.003	0.004	0.005	0.006	0.007	0.008	0.010	0.013	0.016	0.021
	1/16	3/4	0.004	0.014	0.024	0.033	0.042	0.051	0.060	0.069	0.078	0.086
	3/32	3/4	0.010	0.027	0.045	0.064	0.083	0.102	0.121	0.139	0.157	0.171

Steam Service

Nomenclature

Cv = Valve flow coefficient
P1 = Inlet (upstream) pressure, psia
P2 = Outlet (downstream) pressure, psia
ΔP = Pressure drop, P1-P2, psi
W = Mass flow rate, lb/hr

Formulas: $$Cv = \frac{W}{2.1\sqrt{\Delta P\,(P_1 + P_2)}}$$

If pressure drop is greater than 50%, ΔP > P1/2, then use:

$$Cv = \frac{W}{1.65 \times P_1}$$

Example:
Medium: Steam
Flow Rate: 750 lb/hr
P1 = 100 psig: 100 + 14.7 = 114.7 psia
P2 = 95 psig: 95 + 14.7 = 109.7 psia
Pressure Drop: 5 psi

Needed Valve Cv:

$$Cv = \frac{750}{2.1\sqrt{(5) \times (114.7 + 109.7)}} = 10.66$$

Process Valve Sizing Formulas

For Heating or Cooling Water

$$GPM = \frac{\text{Btu/hr.}}{(\text{°F water temp. rise or drop}) \times 500}$$

$$GPM = \frac{\text{cfm} \times .009 \times \text{change in enthalpy of air - in Btu/\#air}}{\text{°F water temperature change}}$$

For Heating Water with Steam

lbs steam/hr = 0.50 x GPM x (°F water temp. rise)

For Heating or Cooling Water with Water

$$GPM_1 = GPM_2 \times \frac{(\text{°F water}_2 \text{ temp. rise or drop})}{(\text{°F water}_1 \text{ temp. rise or drop})}$$

For Heating Air with Steam Coils

$$\text{lbs steam/hr} = 1.08\ (\text{°F air temp. rise}) \times \frac{\text{cfm}}{1000}$$

For Heating Air with Water Coils

$$GPM = 2.16 \times \frac{\text{cfm} \times (\text{°F air temp. rise})}{1000 \times (\text{°F air temp. drop})}$$

For Radiation

$$GPM = \frac{\text{sq. ft. EDR}}{50}$$

lbs steam/hr. = 0.24 x sq/ft. EDR (low pressure steam) (assume 20°F water temperature drop.)

Valve Sizing

It is essential to correctly size a control valve for the application. The valve will not control the process effectively or efficiently if it is sized incorrectly. A control valve should always be sized according to the flow requirement, not the line size. A valve that is too oversized will result in poor controllability of the process. The system will fluctuate and cycle from the lack of control. A valve that is undersized will result in having to take a larger pressure drop across the valve to achieve needed flow. The system will lose more pressure making the pump work harder.

All control valves have a rated flow capacity expressed as the Cv rating. Cv, is the valve flow coefficient and is the number of U.S. gallons per minute of 60°F water that will pass through a fully open valve with a 1 psi pressure drop. For example, a Hi-Flow™ valve with a Cv rating of 10.75 will pass 10.75 GPM of water with a pressure drop of 1 psi. The higher the Cv, the higher the flow capacity of the valve.

To select the proper valve for the application it is necessary to calculate the needed flow capacity, or Cv. The necessary Cv for the application will be dependent upon the pressure drop across the valve. Pressure drop is the difference between the inlet and outlet pressure at full flow when the valve is fully open. The greater the pressure drop taken across the valve, the greater the flow through the valve. Design engineers try to keep the pressure drop as low as possible, but the valve, needs pressure drop to control the process.

Once the required Cv is determined, selection of the proper size control valve can be obtained by comparing the required Cv to the Cv values for the Hi-Flow™ valves. To size the valve properly, it is best to increase the required Cv at maximum flow by 10 to 15% to account for different operating conditions. Also, the minimum required controllable flow should fall within the rangeability of the valve. The rangeability of Hi-Flow™ valves is 50:1. For example, if a Hi-Flow™ valve was chosen with a Cv of 10.75, the minimum controllable Cv would be 10.75 divided by 50, or 0.215.

To calculate the required Cv for the application, use the following equations according to the process medium:

Liquid Service

Nomenclature

Cv = Valve flow coefficient
g = Specific gravity of liquid at flowing conditions
P1 = Inlet (upstream) pressure, psia
P2 = Outlet (downstream) pressure, psia
ΔP = Pressure drop, P1-P2, psi
Q = Volumetric flow rate, US GPM

For liquid service, the pressure drop, ΔP, must not exceed 50% of P1 to avoid cavitation damage.

Formula: $Cv = Q\sqrt{\frac{g}{\Delta P}}$

Example 1:
Medium: Water
Specific Gravity: 1.0
Flow Rate: 100 GPM
Pressure Drop: 5 psi

Needed Valve Cv:

$$Cv = 100\sqrt{\frac{1.0}{5}} = 44.72$$

Example 2:
Medium: Water
Specific Gravity: 1.0
Flow Rate: 110 GPM
Valve Cv: 50.3

Pressure Drop:

$$\Delta P = \left(\frac{Q^2}{Cv}\right) = \left(\frac{110^2}{50.3}\right) = 4.78 \text{ psi}$$

Gas Service

Nomenclature

Cv = Valve flow coefficient
G = Specific gravity of gas at flowing conditions
P1 = Inlet (upstream) pressure, psia
P2 = Outlet (downstream) pressure, psia
ΔP = Pressure drop, P1-P2, psi
Q = Volumetric flow rate, SCFH
T = Flow temperature, in °R = (460 + °F)
psia = psig + 14.7

Formula: $Cv = \frac{Q}{963}\sqrt{\frac{G \times T}{\Delta P\,(P_1 + P_2)}}$

If pressure drop is greater than 50%, ΔP > P1/2, use:

$$Cv = \frac{Q\sqrt{G \times T}}{750\,P_1}$$

Example:
Medium: Nitrogen
Specific Gravity: 0.966
Flow Rate: 10,000 SCFH
P1 = 100 psig: 100 + 14.7 = 114.7 psia
P2 = 95 psig: 95 + 14.7 = 109.7 psia
Pressure Drop: 5 psi
Temperature 70°F: 70 + 460 = 530°R

Needed Valve Cv:

$$Cv = \frac{10{,}000}{963}\sqrt{\frac{(.966) \times (530)}{(5) \times (114.7 + 109.7)}} = 7.01$$

Trim Styles

Flow Characteristic

The Hi-Flow™ valve is a control valve that is regulating the amount of flow through the valve. How the flow through the valve changes as the valve opens corresponds to the trim style, or flow characteristic, of the valve. The trim style is the shape of the plug in the valve. As the valve opens, the plug shape changes the size of the valve opening, which changes the flow rate through the valve.

There are two types of trim styles, or flow characteristics available in the Hi-Flow™ Series; Linear (Fig. 1) and Equal Percentage (Fig. 2). With Linear trim, equal increments of plug travel provide equal increments of flow change. With Equal Percentage trim, equal increments of plug travel provide uniform percentage increments of flow change. The correlation between plug travel and flow is shown in Figure 3. The actual flow rate by plug travel is shown on pages 14 and 15.

Choosing the optimum valve characteristic may require a detailed study of the process equipment and its operating conditions. However, in many applications, any valve will operate well and the characteristic need not be considered. Typically these are applications were load changes are small (maximum load no greater than three times the minimum).

A linear valve characteristic is nearly always desirable when the major load change in the process requires merely a change in flow through the valve. Such a load change could be a controller set point adjustment or some other load in the process itself calling for a new valve position. For example, when water is being heated by steam supplied through a control valve, a change in cold water temperature or in the rate of water throughout will call for a linear valve. On the other hand, fluctuations in steam pressure call for an equal percentage valve. There is no ideal solution and the user must decide what is best for the application.

Reduced Flow or Restricted Trim

The Hi-Flow™ Series offers restricted, a smaller port size, trim in the 3/4″ and 1″ size valve body. This allows a reduction in the flow rate through the valve without a reduction in pipe size. The 1″ valve size is available with the 3/4″ and 1/2″ trim sizes, and the 3/4″ valve size is available with the 1/2″ trim size. The restricted trim is available in Linear or Equal Percentage characteristic. The flow rates are shown on pages 14 and 15.

The Hi-Flow™ Series offers needle plugs that reduce the orifice size from full port to a much smaller area size. Needle plugs are ideal for control of small flow rates and come in Linear (Fig. 4) or Equal Percentage (Fig. 5) characteristic. Needle plugs are available in the 1/2″, 3/4″, and 1″ body sizes. Linear characteristic needle plug sizes are 3/32″, 1/16″, and 1/32″. Equal Percentage characteristic needle plug sizes are 3/8″, 5/16″, 1/4″, 3/16″, and 1/8″. The flow rates are shown on pages 14 and 15.

Diagram of Linear Plug

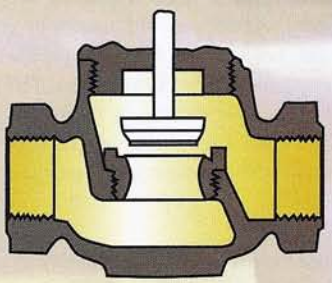


Figure 1. Push-to-Close Linear Valve Body

Diagram of Equal Percentage Plug

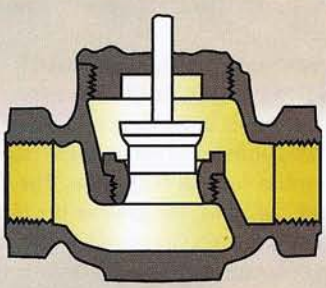


Figure 2. Push-to-Close Equal Percentage Valve Body

Flow Chart

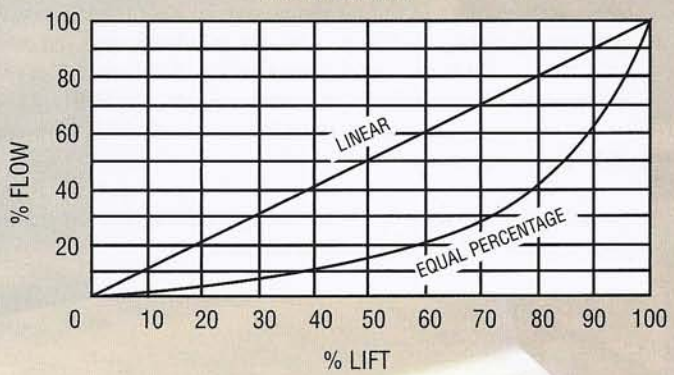


Figure 3. Inherent Flow Characteristics of Hi-Flow™ Valves

Diagram of Linear Needle

Figure 4. Push-to-Close Linear Needle Plug

Diagram of Equal Percentage Needle

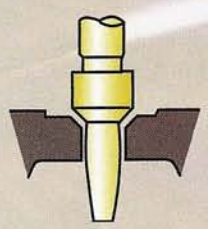


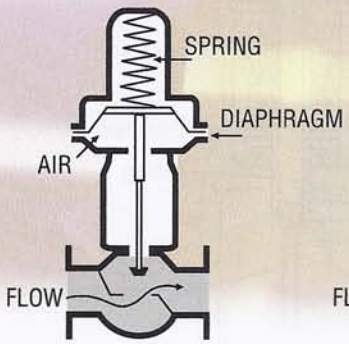
Figure 5. Push-to-Close Equal Percentage Needle Plug

Valve Operation

The Hi-Flow™ Series is offered in 2-way and 3-way body styles. 2-way valves are used for flow control and 3-way valves are used for either mixing or diverting service. With the 2-way type valve there are choices of Push-to-Open or Push-to-Close valve bodies and Air-to-Raise and Air-to-Lower actuators. The choice of the valve body and actuator depend on the desired valve action on loss of air pressure, the fail position. It is desirable that a failure in the operating air supply put the valve in the position of greatest safety for the process and equipment.

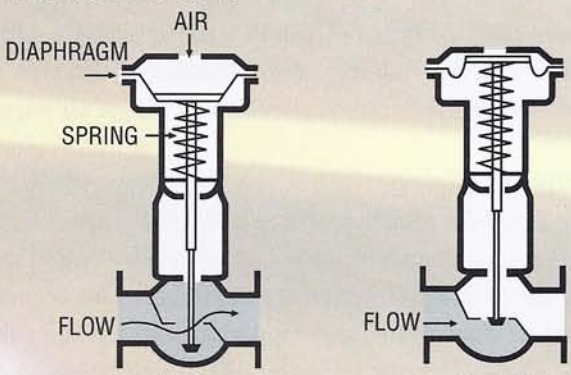
2-Way, Valve Action: Air-to-Open, Spring Closed (Air Off, Normal Position) "Normally Closed" or "Reverse Acting"

Valve Body: Push-to-Close
Actuator: Air-to-Raise



Air On Air Off

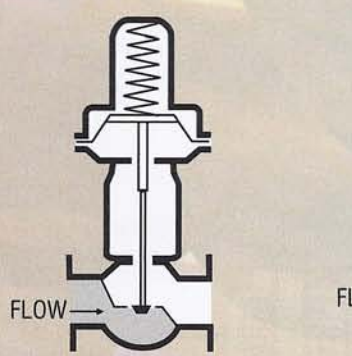
Valve Body: Push-to-Open
Actuator: Air-to-Lower



Air On Air Off

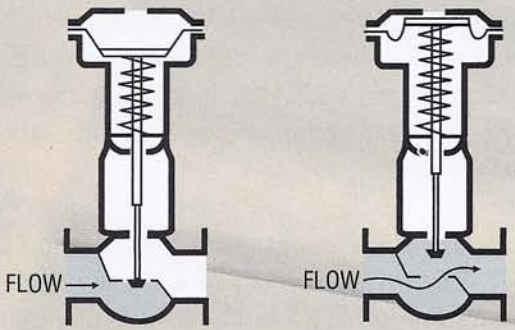
2-Way, Valve Action: Air-to-Close, Spring Open (Air Off, Normal Position) "Normally Open" or "Direct Acting"

Valve Body: Push-to-Open
Actuator: Air-to-Raise



Air On Air Off

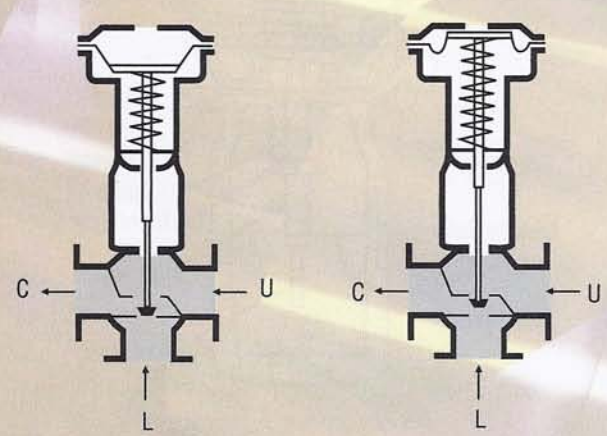
Valve Body: Push-to-Close
Actuator: Air-to-Lower



Air On Air Off

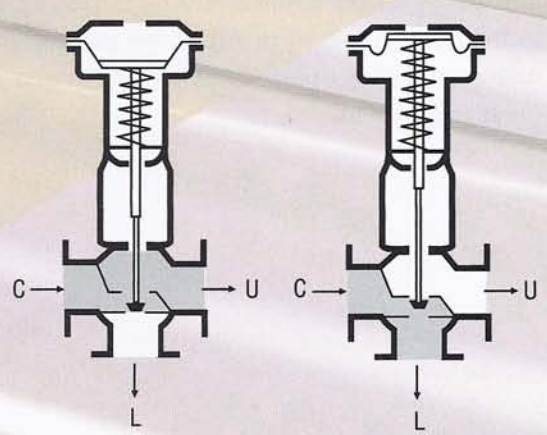
3-Way

Mixing



Air On Air Off

Diverting



Air On Air Off

Actuators

Actuator Action

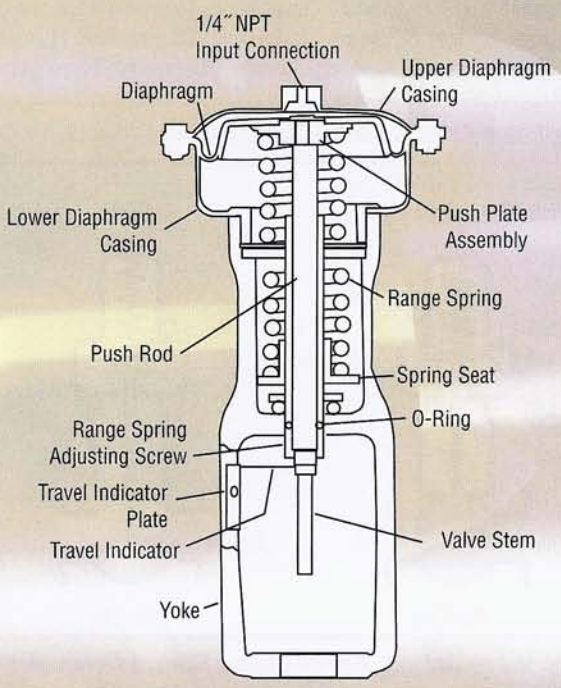
The Hi-Flow™ valve incorporates a Lin-E-Aire® pneumatic actuator that automatically controls the valve. The opening, closing and throttling of the valve plug in the valve body is accomplished by varying the air pressure to the diaphragm in the actuator.

There are two types of Lin-E-Aire® actuators; Air-to-Lower and Air-to-Raise. The selection of the type depends upon the desired operation on loss of air supply.

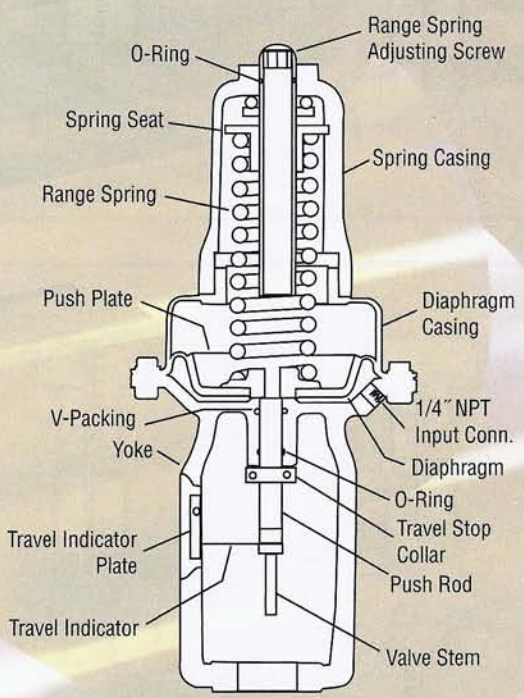
Actuator Sizing

The Lin-E-Aire® actuator size and spring are selected to meet the requirements of the application. There are three sizes of actuators available. The actuator must be sized to be large enough to shut-off the valve. The shut-off pressure is the difference between the inlet (upstream) and outlet (downstream) pressure when the valve is closed. If there is no outlet pressure, then the shut-off pressure is just the maximum upstream pressure. The charts on pages 18 to 20 show example model numbers with the maximum shut-off pressure for the three different actuator sizes. The column labeled MAX USP (maximum upstream pressure) is the maximum pressure that the actuator can shut-off against.

Standard operating range is 3 to 15 psig (.21 to 1.0 bar). The spring size is automatically chosen at the factory to provide a 3 to 15 psi operating range at the customer provided shut-off pressure. When ordering a valve the shut-off pressure must be given. The spring has an operating range of shut-off pressures that it will operate, and the Lin-E-Aire® actuators have range spring adjustments for adjusting the valve in the field. It is best to adjust the valve in the application so that it operates at the particular shut-off pressure present.



Air-to-Lower Actuator



Air-to-Raise Actuator

Selecting the Proper Valve

In selecting a valve, pick a valve that fits the application where it is being installed.

Data needed to choose the proper valve:

1. Media: Water, steam, or other gas or fluid.
- Needed to check chemical compatibility with the valve material.
- Needed for valve sizing.

2. Process Temperature: Standard operating conditions and maximum.
- Standard temperature is used for valve sizing.
- Maximum temperature must be below valve temperature rating.

3. Process Pressure: Standard operating conditions and maximum.
- Standard pressure is used for valve sizing and actuator sizing.
- Maximum pressure must be below valve pressure rating.

4. Required Flow Capacity
- Application flow rate needed for valve sizing.

5. Valve Operation
- 2-way or 3-way.
- Action of the valve on air pressure loss. Fail Closed or Fail Open.

6. Trim Style
- Linear or Equal Percentage flow characteristic.
- Restricted or needle trim for low flows.

7. Valve Body Size and Connection

8. Options
- Current to Pressure Transducer.
- Positioner.

Valve Body

The Hi-Flow™ Valve Series offers two types of valve bodies, Push-to-Close (Fig. 1) and Push-to-Open (Fig. 2). Selection depends upon the valve action required in case of actuator air supply failure.

Push-to-Close: In this type the valve stem moves downward, pushing the valve plug closer to its seat in the valve body. This movement decreases the flow through the valve.

Push-to-Open: In this type the valve stem moves downward, pushing the valve plug away from its seat in the valve body. This movement increases flow through the valve.

Depending on actuator style, the Push-to-Open offers a plug that will close from upstream pressure on air supply loss.

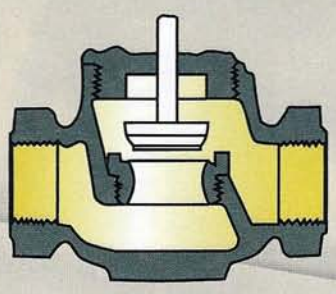


Figure 1. Push-to-Close Linear Valve Body

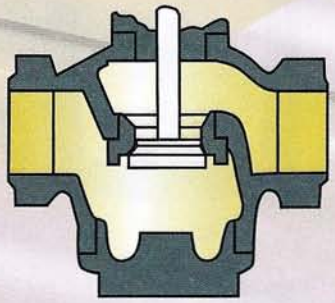


Figure 2. Push-to-Open Linear Valve Body

Flow Capacity, Cv - Equal Percentage Characteristic

LIQUID SIZING COEFFICIENTS, Cv - Equal Percentage Characteristics

Pipe Body Size, In.	Total Travel In.	VALVE OPENING-PERCENT OF TOTAL TRAVEL									
		10	20	30	40	50	60	70	80	90	100
1/2	3/8	.26	.42	.65	1.00	1.60	2.50	3.80	5.00	5.60	5.90
3/4	1/2	.32	.49	.78	1.26	2.05	3.25	5.30	6.80	7.90	8.70
1	5/8	.40	.65	1.05	1.70	2.76	4.55	7.40	10.02	12.00	13.30
1-1/4	3/4	.54	.87	1.40	2.35	3.75	6.30	10.05	14.50	17.00	19.50
1-1/2	7/8	.62	1.05	1.80	3.15	5.10	8.40	15.00	20.00	25.50	30.00
2	1	.73	1.26	2.20	3.85	6.60	11.50	20.00	28.00	36.00	43.00

LIQUID SIZING COEFFICIENTS, Cv - Equal Percentage Characteristics Restricted Trim

Body Size, In.	Port Size In.	Total Travel, In.	VALVE OPENING-PERCENT OF TOTAL TRAVEL									
			10	20	30	40	50	60	70	80	90	100
1/2	1/2	3/8	.26	.42	.65	1.00	1.60	2.50	3.80	5.00	5.60	5.90
3/4	1/2	13/32	0.201	0.357	0.564	0.894	1.54	3.23	4.06	4.88	5.75	6.42
1	1/2	7/16	.194	.350	.577	.910	1.55	3.15	3.87	4.81	6.14	7.54
1	3/4	9/16	.342	.532	.858	1.39	2.34	4.22	5.30	7.24	8.90	10.50

LIQUID SIZING COEFFICIENTS, Cv - Equal Percentage Characteristics Needle Valve

Body Size, In.	Port Size In.	Total Travel, In.	VALVE OPENING-PERCENT OF TOTAL TRAVEL									
			10	20	30	40	50	60	70	80	90	100
1/2 to 1	1/8	3/4	.029	.042	.050	.061	.086	.122	.166	.229	.317	.409
	3/16	3/4	.057	.077	.097	.130	.175	.224	.310	.455	.628	.871
	1/4	3/4	.067	.089	.123	.185	.261	.377	.553	.785	1.10	1.46
	5/16	3/4	.089	.118	.152	.205	.313	.462	.670	1.03	1.49	2.15
	3/8	3/4	.093	.149	.191	.289	.447	.702	1.05	1.51	2.20	3.07

Control Valves - Hi-Flow™ Series

Globe Valves, Ideal for Steam and Water Flow Control, 1/2″ to 4″ Sizes, 2-Way or 3-Way

2-Way with positioner and current to pressure transducer

2-Way Flanged

3-Way

W.E. Anderson Hi-Flow™ control valves are single seated, top or cage guided globe valves - probably the simplest, from a construction standpoint, yet most versatile control valve in use. The Hi-Flow™ valve can fit applications with a smaller size valve since the valve has a greater flow capacity than most conventional valves of the same size. Coupled with the high flow capacity, the Hi-Flow™ valve maintains a wide rangeability of 50:1 to insure precise control. Heavy duty Hi-Flow™ valves are ruggedly constructed of the highest quality materials, precision machined, and performance tested to assure years of trouble free service. Standard packing consists of Teflon® V-rings and wiper to minimize friction without leakage at high operating pressures. Available in brass, iron, or 316 SS body, trim is 316 SS with all welded plug construction to provide superior durability and corrosion resistance.

FEATURES

- Wide Rangeability of 50:1
- Exceptional shut-off and leak rate that meets ANSI/FCI 70-2 Class IV (0.01% of Cv in the closed position)
- Selectable fail safe condition with Air-to-Raise or Air-to-Lower actuators and Push-to-Open or Push-to-Close valve bodies
- Linear or equal percentage flow characteristics
- Low flow options of restricted trim or needle plug
- Removable and replaceable seat ring

APPLICATIONS

- Flow control, mixing, or diverting service.
- Perfect for steam, water or compatible glycol solutions.

SPECIFICATIONS

Valve Body
Service: Compatible liquids, gases, and steam.
Line Size: 1/2″ to 4″.
Body Style: 2-way or 3-way globe.
End Connections: 1/2″ to 2″ female NPT, 1-1/2″ to 4″ flanged.
Pressure Limit: Iron and Bronze Body: 250 psi (17.2 bar), 316 SS Body: 300 psi (20.7 bar).
Wetted Materials:
Body Material: Iron, bronze, or 316 SS.
Trim: 316 SS.
Packing: Teflon®.
Temperature Limits: 20 to 400°F (-7 to 204.4°C).

Actuator
Type: Pneumatic spring/diaphragm.
Control Signal: 3 to 15 psi (0.21 to 1.0 bar) standard. Custom ranges available.
Maximum Supply Pressure: 220, 222, and 230: 100 psi (6.89 bar). 221, 223, 231, and 233: 50 psi (3.45 bar).
Air Connection: 1/4″ female NPT.
Temperature Limit: 150°F (66°C).

Positioners and current-to-pressure transducers available factory mounted. See Series 165 for positioners and see Series 2800 and 2900 for transducers.

How to Order:

Select model number from model chart or standard product chart and supply maximum upstream pressure, USP.

Control Valves - Hi-Flow™ Series Model Chart

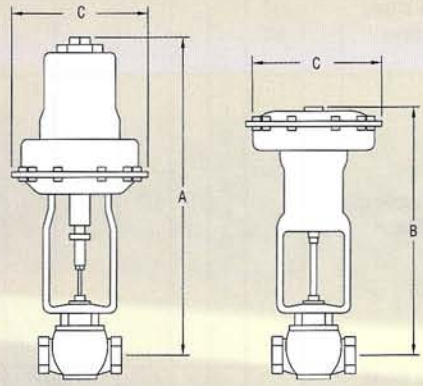
Example	2	00	1	V	A	3	2	230		LO	2001VA32-230-LO Hi-Flow™ Globe Valve; 2-way, 3/4″ NPT connection, linear plug, bronze body, 316 SS trim, reduced port 1/2″ size.
Configuration	2 3										2-way 3-way
Valve Body Action		00 01									Push-To-Close Push-To-Open (2-way only)
Connection Size			0 1 2 3 4 5 6 7 8								1/2″ NPT 3/4″ NPT 1″ NPT 1-1/4″ NPT 1-1/2″ NPT (or Flange with LRF option) 2″ NPT (or Flange with LRF option) 2-1/2″ Flange (see options) 3″ Flange (see options) 4″ Flange (see options)
Valve Seat				V W							Single Seat (2-way only) Double Seat (3-way only)
Valve Plug Type					A L S N						Linear Linear Needle (2000 to 2002 only) Equal Percentage (2000 to 2002 only) Equal Percentage Needle (2000 to 2002 only)
Valve Body Material						1 3 4					Ductile Iron Bronze 316 SS
Trim Material							2				316 SS
Actuator								220 221 222 223 230 231 233			Air-To-Lower, 20 in^2 Air-To-Lower, 45 in^2 Air-To-Lower, 45 in^2 Air-To-Lower, 80 in^2 Air-To-Raise, 20 in^2 (2-way only) Air-To-Raise, 45 in^2 (2-way only) Air-To-Raise, 80 in^2 (2-way only)
Needle Plug Port Size									2 3 4 5 6 7 8 9		1/8″ for Type N valve plug 3/16″ for Type N valve plug 1/4″ for Type N valve plug 5/16″ for Type N valve plug 3/8″ for Type N valve plug 1/32″ for Type L valve plug 1/16″ for Type L valve plug 2/32″ for Type L valve plug
Options										A L0 L1 Z LRF HRF	Positioner factory mounted (specify positioner model) Reduced port: 3/4″ to 1/2″ port size (2001 only) Reduced port: 1″ to 1/2″ port size (2002 only) Reduced port: 1″ to 3/4″ port size (2002 only) Special operating range (2-10 psi, 10-18 psi) Low Range Flange: Class 125 in Iron or Class 150 Bronze, 316 SS body (for 1-1/2″ and 2″ sizes only, standard on 2-1/2″, 3, and 4″ size) High Range Flange: Class 250 in Iron or Class 300 in Bronze, 316 SS body (for 1-1/2″ to 4″ sizes)

Control Valves — Hi-Flow™ Series

2-Way Simplified Selection Guide with Standard Products

PIPE SIZE	C_v 100%	BODY MATERIAL	MODEL NO. (AIR-TO-OPEN)	MAX. USP psi (bar) 3-15 (.21-1.0)	A IN. (MM)	C IN. (MM)
1/2″	6.45	BRONZE	2000VA32-230	250 (17.2)	19¾ (501.7)	7¾ (196.9)
		316SS	2000VA42-230	300 (20.7)	19¾ (501.7)	7¾ (196.9)
3/4″	10.75	BRONZE	2001VA32-230	250 (17.2)	19¾ (501.7)	7¾ (196.9)
			2001VA32-231	250 (17.2)	20⅜ (517.5)	10⅝ (269.9)
		316SS	2001VA42-230	285 (19.7)	19¾ (501.7)	7¾ (196.9)
			2001VA42-231	300 (20.7)	20⅜ (517.5)	10⅝ (269.9)
1″	17.42	BRONZE	2002VA32-230	166 (11.4)	20⅜ (512.8)	7¾ (196.9)
			2002VA32-231	250 (17.2)	20¹³⁄₁₆ (528.6)	10⅝ (269.9)
		316SS	2002VA42-230	166 (11.4)	20⅜ (512.8)	7¾ (196.9)
			2002VA42-231	300 (20.7)	20¹³⁄₁₆ (528.6)	10⅝ (269.9)
1¼″	25.30	BRONZE	2003VA32-230	98 (6.8)	20⅜ (515.9)	7¾ (196.9)
			2003VA32-231	245 (16.9)	20¹⁵⁄₁₆ (531.8)	10⅝ (269.9)
			2003VA32-233	250 (17.2)	25¹³⁄₃₂ (645.3)	13⅜ (339.7)
		316SS	2003VA42-230	98 (6.8)	20⅜ (515.9)	7¾ (196.9)
			2003VA42-231	245 (17.0)	20¹⁵⁄₁₆ (531.8)	10⅝ (269.9)
			2003VA42-233	300 (20.7)	25¹³⁄₃₂ (645.3)	13⅜ (339.7)
1½″	32.10	BRONZE	2004VA32-230	65 (4.5)	20¹¹⁄₁₆ (525.5)	7¾ (196.9)
			2004VA32-231	168 (11.6)	21⅛ (541.3)	10⅝ (269.9)
			2004VA32-233	250 (17.2)	25²⁵⁄₃₂ (654.8)	13⅜ (339.7)
		316SS	2004VA42-230	65 (4.5)	20¹¹⁄₁₆ (525.5)	7¾ (196.9)
			2004VA42-231	168 (11.6)	21⅛ (541.3)	10⅝ (269.9)
			2004VA42-233	300 (20.7)	25²⁵⁄₃₂ (654.8)	13⅜ (339.7)
2″	50.30	BRONZE	2005VA32-230	31 (2.1)	20¹⁵⁄₁₆ (531.8)	7¾ (196.9)
			2005VA32-231	88 (6.1)	21⅝ (547.7)	10⅝ (269.9)
			2005VA32-233	175 (12.1)	26½ (661.2)	13⅜ (339.7)
		316SS	2005VA42-230	31 (2.1)	20¹⁵⁄₁₆ (531.8)	7¾ (196.9)
			2005VA42-231	88 (6.1)	21⅝ (547.7)	10⅝ (269.9)
			2005VA42-233	175 (12.1)	26½ (661.2)	13⅜ (339.7)
*2½″	78.60	IRON	2006VA12-233	105 (7.2)	26¼ (666.8)	13⅜ (339.7)
		BRONZE	2006VA32-233	105 (7.2)	26¼ (666.8)	13⅜ (339.7)
		316SS	2006VA42-233	105 (7.2)	26¼ (666.8)	13⅜ (339.7)
*3″	113.2	IRON	2007VA12-233	52 (3.6)	27 (686)	13⅜ (339.7)
		BRONZE	2007VA32-233	52 (3.6)	27 (686)	13⅜ (339.7)
		316 SS	2007VA42-233	52 (3.6)	27 (686)	13⅜ (339.7)
*4″	201.2	IRON	2008VA12-233	32 (2.2)	27¼ (692)	13⅜ (339.7)
		BRONZE	2008VA32-233	32 (2.2)	27¼ (692)	13⅜ (339.7)
		316SS	2008VA42-233	32 (2.2)	27¼ (692)	13⅜ (339.7)

* Valve has flanged connections. Max. USP (PSI) is for Linear Valves. Consult factory for optional trim.



Caution: Use of an actuator supply gas other than air can create a hazardous environment because a small amount of gas continuously vents to atmosphere.

Use the chart to aid in the selection of Hi-Flow™ Control Valve. As long as the maximum upstream pressure (USP) is less than, or equal to, the value listed, the model shown can be manufactured and calibrated to your specific requirements. Specify maximum upstream pressure, USP, when ordering.

Control Valves — Hi-Flow™ Series

2-Way Simplified Selection Guide with Standard Products

PIPE SIZE	Cv 100%	BODY MATERIAL	MODEL NO. (AIR-TO-CLOSE)	MAX. USP psi (bar) 3-15 (.21-1.0)	B IN. (MM)	C IN. (MM)
1/2″	6.45	BRONZE	2000VA32-220	250 (17.2)	18 7/16 (468.3)	7 3/4 (196.9)
		316SS	2000VA42-220	300 (20.7)	18 7/16 (468.3)	7 3/4 (196.9)
3/4″	10.75	BRONZE	2001VA32-220	250 (17.2)	18 7/16 (468.3)	7 3/4 (196.9)
			2001VA32-221	250 (17.2)	19 1/8 (485.8)	10 5/8 (269.9)
		316SS	2001VA42-220	300 (20.7)	18 7/16 (468.3)	7 3/4 (196.9)
			2001VA42-221	300 (20.7)	19 1/8 (485.8)	10 5/8 (269.9)
1″	17.42	BRONZE	2002VA32-220	192 (13.2)	18 7/8 (479.4)	7 3/4 (196.9)
			2002VA32-221	250 (17.2)	19 9/16 (496.9)	10 5/8 (269.9)
		316SS	2002VA42-220	192 (13.2)	18 7/8 (479.4)	7 3/4 (196.9)
			2002VA42-221	300 (20.7)	19 9/16 (496.9)	10 5/8 (269.9)
1¼″	25.30	BRONZE	2003VA32-220	115 (7.9)	19 (482.6)	7 3/4 (196.9)
			2003VA32-221	250 (17.2)	19 11/16 (500.1)	10 5/8 (269.9)
			2003VA32-223	250 (17.2)	23 1/8 (587.4)	13 3/8 (339.7)
		316SS	2003VA42-220	115 (7.9)	19 (482.6)	7 3/4 (196.9)
			2003VA42-221	300 (20.7)	19 11/16 (500.1)	10 5/8 (269.9)
			2003VA42-223	300 (20.7)	23 1/8 (587.4)	13 3/8 (339.7)
1½″	32.10	BRONZE	2004VA32-220	80 (5.5)	19 3/8 (492.1)	7 3/4 (196.9)
			2004VA32-221	235 (16.2)	20 1/16 (509.6)	10 5/8 (269.9)
			2004VA32-223	250 (17.2)	23 1/2 (596.9)	13 3/8 (339.7)
		316SS	2004VA42-220	80 (5.5)	19 3/8 (492.1)	7 3/4 (196.9)
			2004VA42-221	235 (16.2)	20 1/16 (509.6)	10 5/8 (269.9)
			2004VA42-223	300 (20.7)	23 1/2 (596.9)	13 3/8 (339.7)
2″	50.30	BRONZE	2005VA32-220	44 (3.0)	19 5/8 (498.5)	7 3/4 (196.9)
			2005VA32-221	140 (9.7)	20 5/16 (515.9)	10 5/8 (269.9)
			2005VA32-223	250 (17.2)	23 3/4 (603.3)	13 3/8 (339.7)
		316SS	2005VA42-220	44 (3.0)	19 5/8 (498.5)	7 3/4 (196.9)
			2005VA42-221	140 (9.7)	20 5/16 (515.9)	10 5/8 (269.9)
			2005VA42-223	272 (18.8)	23 3/4 (606.3)	13 3/8 (339.7)
*2½″	78.60	IRON	2006VA12-223	190 (13.1)	24 7/16 (620.7)	13 3/8 (339.7)
		BRONZE	2006VA32-223	190 (13.1)	24 7/16 (620.7)	13 3/8 (339.7)
		316SS	2006VA42-223	190 (13.1)	24 7/16 (620.7)	13 3/8 (339.7)
*3″	113.2	IRON	2007VA12-223	132 (9.1)	24 3/4 (629)	13 3/8 (339.7)
		BRONZE	2007VA32-223	132 (9.1)	24 3/4 (629)	13 3/8 (339.7)
		316 SS	2007VA42-223	132 (9.1)	24 3/4 (629)	13 3/8 (339.7)
*4″	201.2	IRON	2008VA12-223	72 (4.9)	25 (635)	13 3/8 (339.7)
		BRONZE	2008VA32-223	72 (4.9)	25 (635)	13 3/8 (339.7)
		316SS	2008VA42-223	72 (4.9)	25 (635)	13 3/8 (339.7)

* Valve has flanged connections. Max. USP (PSI) is for Linear Valves. Consult factory for optional trim.

Control Valves - Hi-Flow™ Series

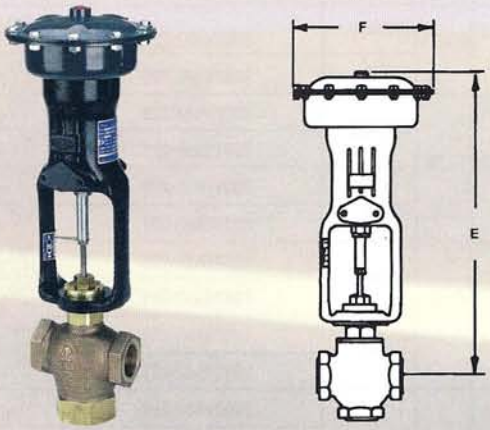
3-Way Standard Products for Mixing or Diverting

Control Valves - Hi-Flow™ Series, 3-Way Simplified Selection Guide with Standard Products

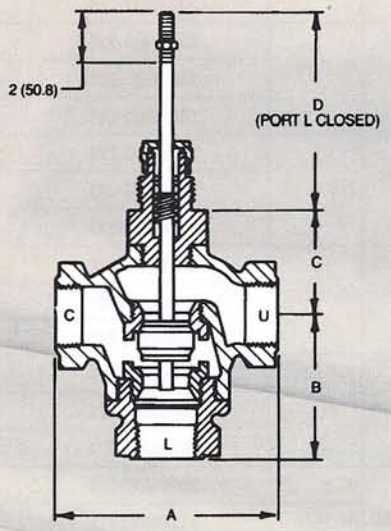
Use the chart below to aid in the selection of the most economical Hi-Flow™ 3-Way Control Valve for your application. Specify maximum upstream pressures (USP's); Mixing: USP_U and USP_L; Diverting: USP_C; based on standard 3-15 psi (.21-1.0 bar) pneumatic control signal.

PIPE SIZE	C_V 100%	BODY MATERIAL	MODEL NUMBER*	USP(B) PSI (bar)	E IN. (MM)	F IN. (MM)
½"	6.45	BRONZE	3000WA32-220	250 (17.2)	18 1/16 (458.8)	7 3/4 (196.9)
		316SS	3000WA42-220	300 (20.7)	18 1/16 (458.8)	7 3/4 (196.9)
¾"	10.75	BRONZE	3001WA32-220	250 (17.2)	18 1/16 (458.8)	7 3/4 (196.9)
		316SS	3001WA42-220	300 (20.7)	18 1/16 (458.8)	7 3/4 (196.9)
1"	17.42	BRONZE	3002WA32-220	200 (13.8)	18 3/8 (465.1)	7 3/4 (196.9)
			3002WA32-221	250 (17.2)	19 (482.6)	10 3/8 (269.9)
		316SS	3002WA42-220	200 (13.8)	18 3/8 (465.1)	7 3/4 (196.9)
			3002WA42-221	300 (20.7)	19 (482.6)	10 3/8 (269.9)
1¼"	25.30	BRONZE	3003WA32-220	120 (8.4)	18 3/8 (466.7)	7 3/4 (196.9)
			3003WA32-221	250 (17.2)	19 1/16 (484.2)	10 3/8 (269.9)
		316SS	3003WA42-220	120 (8.3)	18 3/8 (466.7)	7 3/4 (196.9)
			3003WA42-221	300 (20.7)	19 1/16 (484.2)	10 3/8 (269.9)
1½"	32.10	BRONZE	3004WA32-220	80 (5.6)	18 5/8 (473.1)	7 3/4 (196.9)
			3004WA32-221	200 (13.8)	19 3/8 (490.5)	10 3/8 (269.9)
			3004WA32-223	250 (17.2)	21 3/8 (542.9)	13 3/8 (339.7)
		316SS	3004WA42-220	80 (5.5)	18 5/8 (473.1)	7 3/4 (196.9)
			3004WA42-221	200 (13.8)	19 3/8 (490.5)	10 3/8 (269.9)
			3004WA42-223	300 (20.7)	21 3/8 (542.9)	13 3/8 (339.7)
2"	50.30	BRONZE	3005WA32-220	45 (3.1)	19 1/16 (484.2)	7 3/4 (196.9)
			3005WA32-221	100 (6.9)	19 3/4 (501.7)	10 3/8 (269.9)
			3005WA32-223	175 (12.1)	21 13/16 (554.0)	13 3/8 (339.7)
		316SS	3005WA42-220	45 (3.1)	19 1/16 (484.2)	7 3/4 (196.9)
			3005WA42-221	100 (6.9)	19 3/4 (501.7)	10 3/8 (269.9)
			3005WA42-223	175 (12.1)	21 13/16 (554.0)	13 3/8 (339.7)
*2½"	78.6	IRON	3006WA12-223	97 (6.7)	24.52 (622.8)	13 3/8 (339.7)
		BRONZE	3006WA32-223			
		316SS	3006WA42-223			
*3"	113.2	IRON	3007WA12-223	58 (4.0)	24.64 (625.9)	13 3/8 (339.7)
		BRONZE	3007WA32-223			
		316SS	3007WA42-223			
*4"	201.2	IRON	3008WA12-223	32 (2.2)	24.89 (632.2)	13 3/8 (339.7)
		BRONZE	3008WA32-223			
		316SS	3008WA42-223			

* Valve has flanged connections. Max. USP (PSI) is for Linear Valves. Consult factory for optional trim.



Caution: Use of an actuator supply gas other than air can create a hazardous environment because a small amount of gas continuously vents to atmosphere



DIMENSION DATA

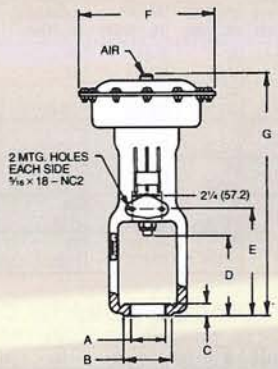
PIPE SIZE	B IN. (MM)	C IN. (MM)	D IN. (MM)
1/2"	2 9/16 (65.1)	2 3/16 (55.6)	4 1/8 (104.8)
3/4"	2 9/16 (65.1)	2 3/16 * (55.6)	4 1/8 (104.8)
1"	3 (76.2)	2 7/16 (61.9)	4 (101.6)
1-1/4"	3 3/16 (81.0)	2 1/2 (63.5)	3 3/4 (95.3)
1-1/2"	3 3/4 (95.3)	2 3/4 (69.9)	3 11/16 (93.7)
2"	3 15/16 (100.0)	3 3/16 (81.0)	3 11/16 (93.7)

MIXING SERVICE:
FLOW IN - ports U&L
FLOW OUT - port C
DIVERTING SERVICE:
FLOW IN - port C
FLOW OUT - ports U&L
Standard Models include LIN-E-AIRE® Air-To-Lower Actuator - port L opens on loss of Air

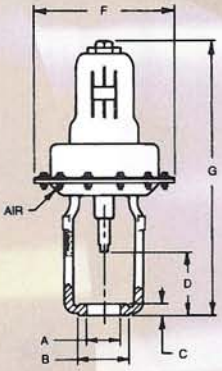
For diverting service, add USP_U and USP_C to determine the shut-off pressure. For mixing service compute: (USP_U - USP_C) + (USP_L - USP_C) to determine the shutoff pressure.

LIN-E-AIRE® Pneumatic Valve Actuator

Air-To-Lower or Air-To-Raise



Air-to-Lower



Air-to-Raise

**Effective diaphragm area (A_e) decreases linearly with stroke: 20 in.² (129 cm²) — 2 in.²/in. (.5 cm²/mm); 45 in.² (290 cm²) — 3 in.²/in. (.76C m²/mm); 80 in.² (516 cm²) -3.5 in.²/in. (.89 cm²/mm).

TERM* NO.	PART NO.†	ACTION	T IN. (MM)	A_e** IN.² (CM²)	A IN. (MM)	B IN. (MM)	C IN. (MM)	D IN. (MM)	E IN. (MM)	F IN. (MM)	G IN. (MM)	P PSI(KG/CM²)	REPLACEMENT DIAPHRAGM
–220	**15S620**	AIR-TO-LOWER	1 (25.4)	20 (129)	1½ (38.1)	3 (76.2)	11/16 (17.5)	3⅝ (92.1)	7¼ (184.2)	7¾ (196.9)	15⅝ (403.2)	100 (7.0)	61P252
–221	**15S621**	AIR-TO-LOWER	1 (25.4)	45 (290)	1½ (38.1)	3 (76.2)	11/16 (17.5)	3⅝ (92.1)	7¼ (184.2)	10⅝ (269.9)	16⅝ (420.7)	50 (3.5)	61P254
–222	**15S622**	AIR-TO-LOWER	1½ (38.1)	45 (290)	1 15/16 (49.2)	3¾ (95.3)	⅞ (22.2)	3½ (88.9)	8⅜ (212.7)	10⅝ (269.9)	18⅝ (473.1)	100 (7.0)	61P254
–223	**15S623**	AIR-TO-LOWER	1½ (38.1)	80 (516)	1 15/16 (49.2)	3¾ (95.3)	⅞ (22.2)	3½ (88.9)	8⅜ (212.7)	13⅜ (339.7)	20 (508.0)	50 (3.5)	61P256
–230	**15S630**	AIR-TO-RAISE	1 (25.4)	20 (129)	1½ (38.1)	3 (76.2)	11/16 (17.5)	3 (76.2)	–	7¾ (196.9)	17 3/16 (436.6)	100 (7.0)	61P253
–231	**15S631**	AIR-TO-RAISE	1 (25.4)	45 (290)	1½ (38.1)	3 (76.2)	11/16 (17.5)	3 (76.2)	–	10⅝ (269.9)	17 13/16 (452.4)	50 (3.5)	61P255
–233	**15S633**	AIR-TO-RAISE	1½ (38.1)	80 (516)	1 15/16 (49.2)	3¾ (95.3)	⅞ (22.2)	3 (76.2)	–	13⅜ (339.7)	22 5/16 (565.9)	50 (3.5)	61P347

*Add Termination No. suffix to base Valve Model No. for complete valve automation package.
†Specify Part No. for Pneumatic Actuator assembly only.

STANDARD SPRING SPECIFICATIONS

PART NO.	K LBF/IN.(DGF/MM)	F LBF(KGF)	COLOR CODE	USED IN TERM. NOS.
11P376	100 (1.79)	315 (143)	WHITE–YELLOW	220,221 230,231
11P377	180 (3.21)	448 (203)	WHITE–RED	
11P378	260 (4.64)	572 (259)	WHITE–BLUE	
11P379	350 (6.25)	870 (395)	WHITE–BROWN	
11P381	450 (8.04)	963 (437)	WHITE–GREEN	
11P382	560 (10.00)	1180 (535)	WHITE–ORANGE	
11P383	680 (12.14)	1530 (694)	WHITE–BLACK	
11P384	820 (14.64)	1435 (651)	WHITE–WHITE	
11P356	1000 (17.86)	1500 (680)	BROWN–BROWN	
11P901	1250 (22.32)	1875 (850)	BROWN–GREEN	221 & 231
11P385	100 (1.79)	368 (167)	YELLOW–RED	222, 223 & 233
11P386	180 (3.21)	600 (272)	YELLOW–BLUE	
11P387	260 (4.64)	847 (384)	YELLOW–BROWN	
11P388	350 (6.25)	1050 (476)	YELLOW–GREEN	
11P389	450 (8.04)	1150 (522)	YELLOW–ORANGE	
11P391	560 (10.00)	1210 (549)	YELLOW–BLACK	
11P392	680 (12.14)	1500 (680)	YELLOW–YELLOW	
11P902	820 (14.64)	1645 (746)	BROWN–ORANGE	223 & 233
11P903	1000 (17.86)	2630 (1193)	BROWN–BLACK	
11P904	1300 (23.22)	2460 (1116)	PURPLE–WHITE	

1. Select Air-To-Raise (Lower) actuator based on control (valve) action and fail-safe condition requirements.
2. Select minimum actuator size based on stroke, pneumatic control signal and maximum deliverable force requirements.
3. Select spring based on stroke (T), pneumatic control range (typically, P_1 = 3 PSI and P_2 = 15 PSI), pre-load (typically, pressure drop x unbalanced area of plug $\Delta P \times A_P$) and maximum allowable spring force (F_{max}).

$$K = \frac{(P_2 \times A_{e2}) - (P_1 \times A_{e1}) - \Delta P \times A_P}{T}$$

$F_{max} > (P_1 \times A_{e1}) + (K \times T) + [(\Delta P \times A_P)$ on air-to-open systems only].

SPECIFICATIONS

Type: Pneumatic spring/diaphragm.
Control Signal: 3 to 15 psi (0.21 to 1.0 bar) standard. Custom ranges available.
Maximum Supply Pressure: 220, 222, and 230: 100 psi (6.89 bar). 221, 223, 231, and 233: 50 psi (3.45 bar).
Air Connection: 1/4″ female NPT.
Diaphragm: Buna-N, nylon reinforced.
Diaphragm Support Plate, Spring, and Push Rod, Spring Adjustment: Plated steel.
Housing: Enamel coated steel.
Yoke: Enamel coated iron.
Temperature Limit: 150°F (66°C).

CAUTION: Use of an actuator supply gas other than air can create a hazardous environment because a small amount of gas continuously vents to atmosphere.

Suggested Specification

Pneumatic Actuator shall be (Air-To-Lower) (Air-To-Raise) type with minimal internal volume for fast response and molded nylon reinforced BUNA-N diaphragm capable of delivering near constant force throughout (1")(1½") minimum stroke. Actuator shall have a wide choice of interchangeable range springs with readily accessible compression nuts permitting easy range change and adjustment. Actuator shall include a position indicator to provide a visual aid in determining inner valve position. Pneumatic Actuator shall be W.E. Anderson LIN-E-AIRE® Part No.___ with spring Part No.___.