SB 9509.4

AXIAL FLOW VALVES

AMERICAN METER COMPANY

The improved technology for pressure regulation

The American Axial Flow™ Valve provides pressure and flow control in high-capacity pipelines. It can be used for pressure regulation, overpressure relief, flow control or simply as an on/off valve.

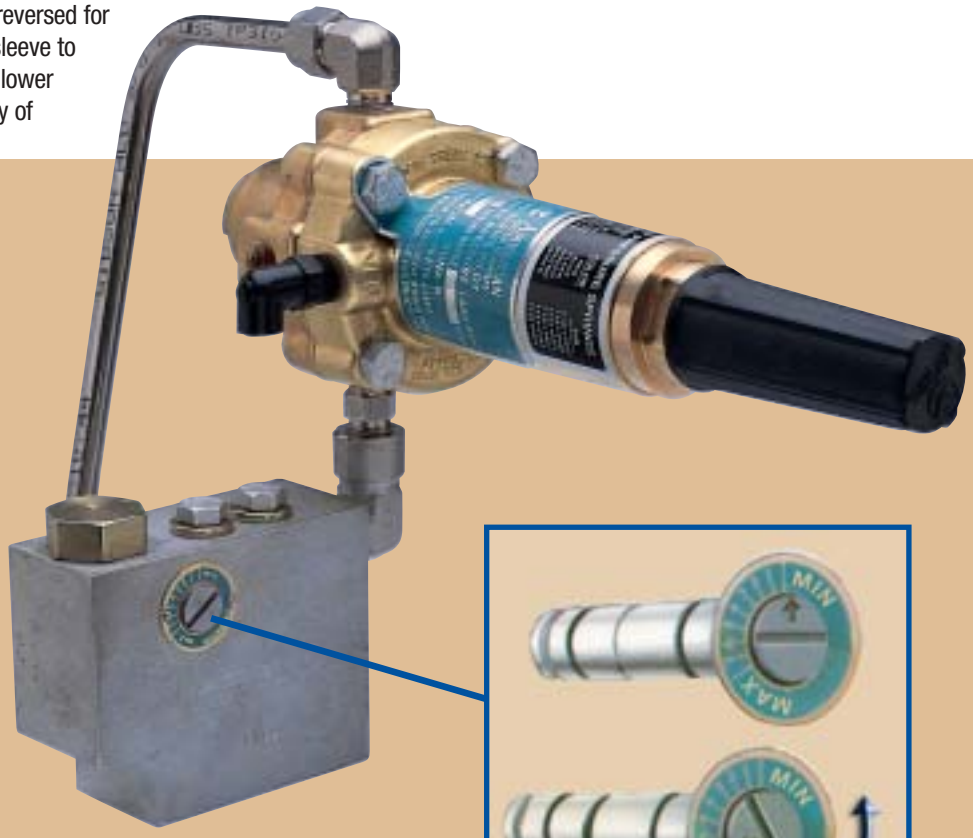
The AFV is unique in that there is no mechanical connection to the control element. Instead, the valve uses an elastomer sleeve which expands or contracts depending on the pressure differential across this sleeve. This principle provides a valve that is extremely compact and lightweight, easy to install and service, and one with a streamlined flow path for quiet operation. Because of its V-shaped design, the sleeve in an American Axial Flow Valve can be reversed for extended service life. This design also causes the sleeve to expand around its entire circumference, producing lower stresses for a given opening. The excellent flexibility of the sleeve material and the double sealing surfaces in the American design combine to provide a positive lockup characteristic for the valve.

Standard sleeve materials provide a wide working temperature range and excellent resistance to abrasion and swelling. They are field-proven in a variety of installations involving natural-gas service. Specialized sleeve materials are also available for applications involving extreme temperatures, where chemical resistance is needed and for specialized services such as water scarfing.

American Meter Axial Flow Valves install between the flanges of standard pipelines. Series 300 valves have a maximum working pressure of 720 PSIG and are available for 2", 3", 4", 6", 8" and 12" pipelines. Series 600 valves with a maximum working pressure of 1440 PSIG are available in 2", 4", 6" and 8" sizes.

Depending on the particular pilot used, the AFV can regulate output pressures from inches W.C. up to 600 PSIG. Higher pressures can be regulated with an instrument controller in place of a pilot. It can therefore be used to provide primary and secondary pressure cuts in a variety of transmission, distribution and industrial applications.

With the standard elastomer sleeve, the American Meter Axial Flow Valve has an operating temperature range from -20° to 150°F. All components exposed to the flow path are fabricated of abrasion- and corrosion-resistant materials.



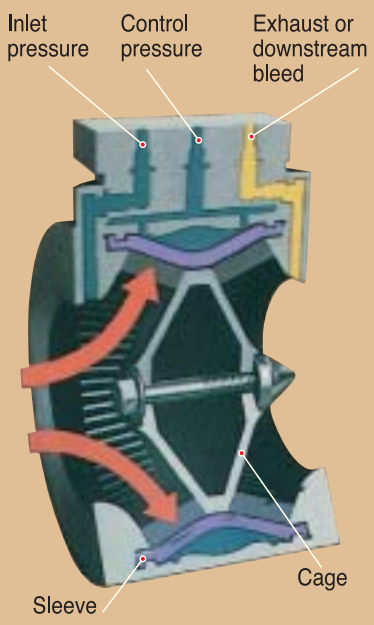
The integral manifold block incorporates a variable restrictor between the inlet pressure port and control pressure port.

Low number settings provide:
- **a smaller orifice**
- **quicker valve opening**
- **slower valve closing.**

Higher number settings provide:
- **a larger orifice**
- **slower valve opening**
- **quicker valve closing.**

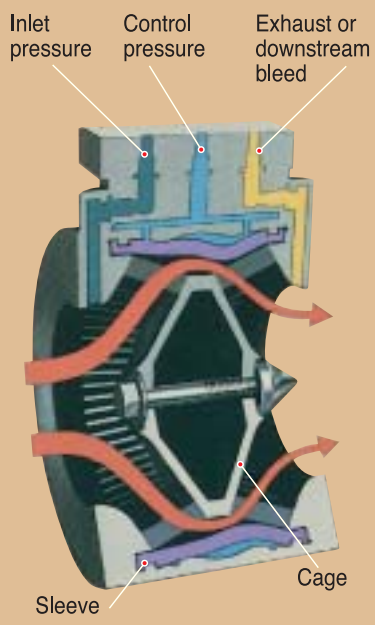
Basic valve operation

Because there is no mechanical connection to the control element, there's no worry about shaft sealing. Except for the valve inlet and outlet, the only connections to the Axial Flow Valve are three pneumatic lines to the manifold – inlet pressure, control pressure and exhaust/downstream bleed. The valve responds to the difference in pressure between the inlet port and the control port. The different functions of the valve (downstream regulation, relief, etc.) are determined by the type of external pilot and the piping of the pilot. The operating characteristics of the valve (fast opening, slow closing, etc.) are determined by the setting of the adjustable restrictor in the manifold.



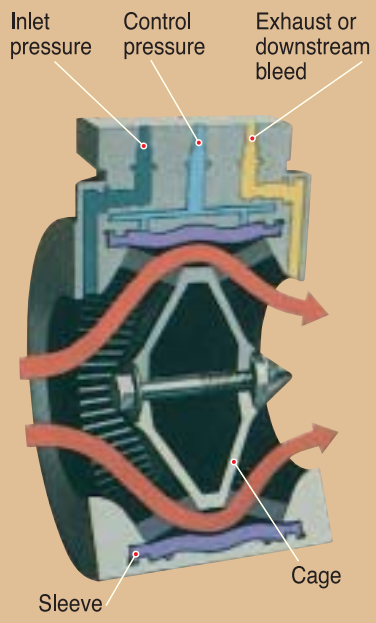
Closed position

Inlet pressure is applied to the inner surface of the sleeve in the upstream section of the valve, and control pressure is applied to the exterior of the sleeve. Because the sleeve is slightly smaller in diameter than the cage, when inlet and control pressure are equal, the sleeve preload keeps the valve closed.



Throttling position

As control pressure is reduced, the inlet pressure overcomes the preload and begins to force the sleeve away from the inlet cage. As the sleeve continues to expand, a portion of the downstream cage is uncovered and flow begins through the valve. When downstream demand is satisfied, the balanced forces on either side of the sleeve maintain it in an equilibrium position.



Full-open position

When fully opened, the downstream cage is completely exposed and the sleeve is expanded to the point where it is supported against the inner body of the valve. Since the control pressure is usually aspirated through the downstream bleed port, the control pressure is significantly lower than downstream pipeline pressure at high flow rates. This minimizes the differential between inlet and outlet required for full valve opening.

Pilot regulators

These spring-loaded regulators are used to balance the pressure applied to the control port of an Axial Flow Valve. It is actually the choice of pilot that determines function (pressure reduction or backpressure) and output pressure or relief setting. The adjustable restrictor, which is an integral part of the AFV, determines operating characteristics; low settings for quick opening and slow closing, higher settings for slow opening and quick closing.

Type 60Series® Pilot – available in four models for Class 600 Pressure Reduction (or) for Relief Valve service:

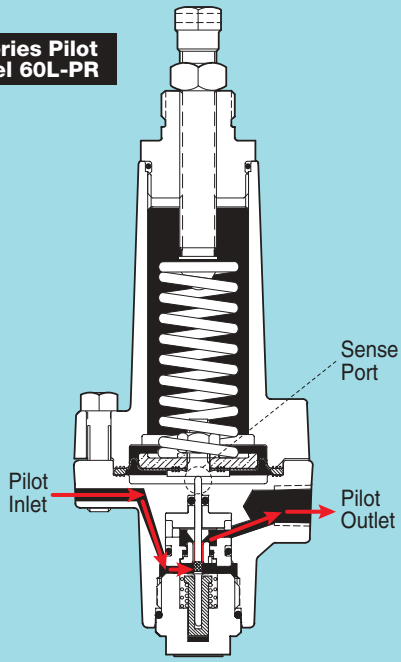
- **60L-PR** Low pressure (3-325 PSIG) – pressure reducing
- **60L-RV** Low pressure (3-325 PSIG) – relief valve
- **60H-PR** High pressure (250-900 PSIG) – pressure reducing
- **60H-RV** High pressure (250-900 PSIG) – relief valve

60Series Pilots are single-diaphragm regulators.

Type 1203 Pilot

The 1203 Pilot Regulator is for Class 125 Pressure Reduction Service requiring outlet pressures from 5" w.c. to 5 PSIG.

60Series Pilot Model 60L-PR

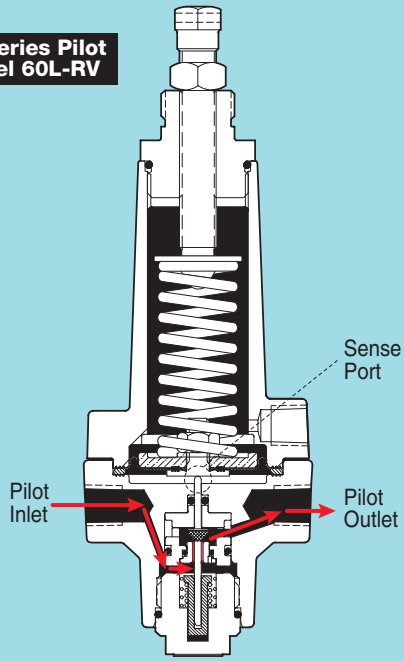


Pressure Reduction Service

In Pressure Reduction Service, spring force holds the regulator open. This spring force is opposed by pressure applied to the sense port. Note that the sense port is ***directly*** connected to the under-diaphragm area and is not in the pilot flow path.

In addition, note that when the downstream pressure is less than the Pilot Regulator set pressure, the regulator is opened wider, increasing flow. This increased pilot flow produces a larger pressure drop across the variable restrictor, thus opening the main AFV to satisfy downstream demand.

60 Series Pilot Model 60L-RV



Relief Valve Service

In Relief Valve Service, as long as the spring force is greater than the force of the (upstream) sense pressure, the regulator is held closed. When upstream pressure increases beyond the setpoint, the regulator opens. This increased pilot flow produces a pressure drop across the variable restrictor, opening the main AFV and relieving the excess pressure.

60Series Pilots can be converted from Pressure Reduction Service to Relief Valve Service without additional parts.

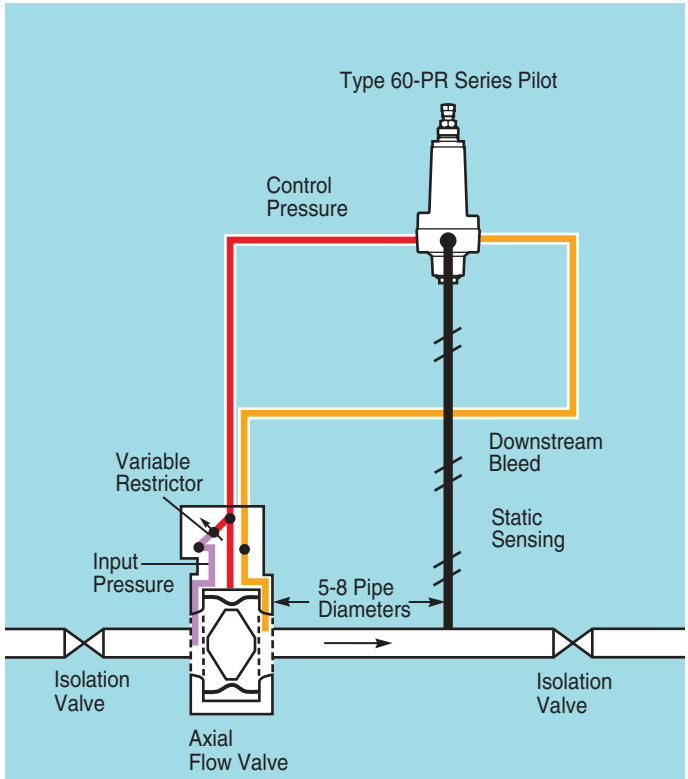
Applications

Axial Flow Valves are versatile and can be configured to perform a variety of control functions. Axial Flow Valves interface with:

- Control Blocks with Pilot Regulators
- Control Blocks with I-P devices
- Control Blocks with 10-turn electric adjusting pilots
- Inspirator Blocks with Pilot Regulators
- Electrically Controlled Solenoid Valves

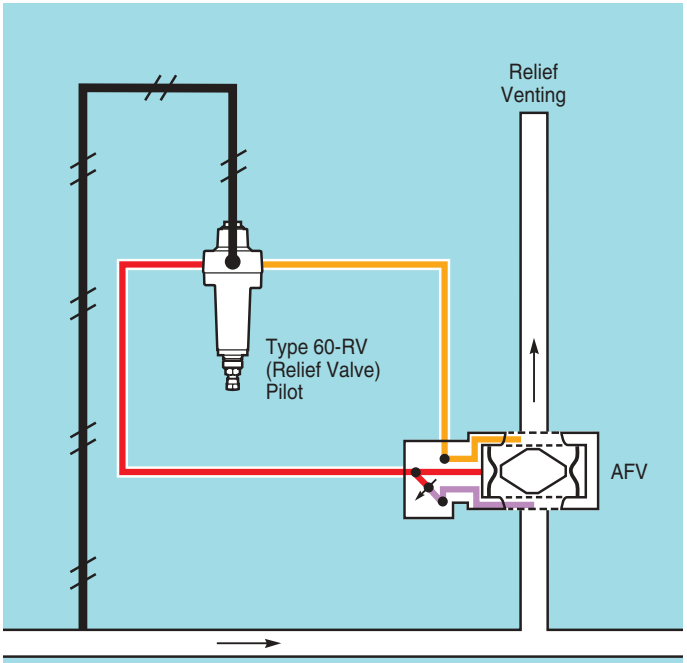
…and many other industrial controls.

Consult your Elster-AMCO sales representative for technical support if your application is not listed in the following examples.



Single-stage pressure reduction

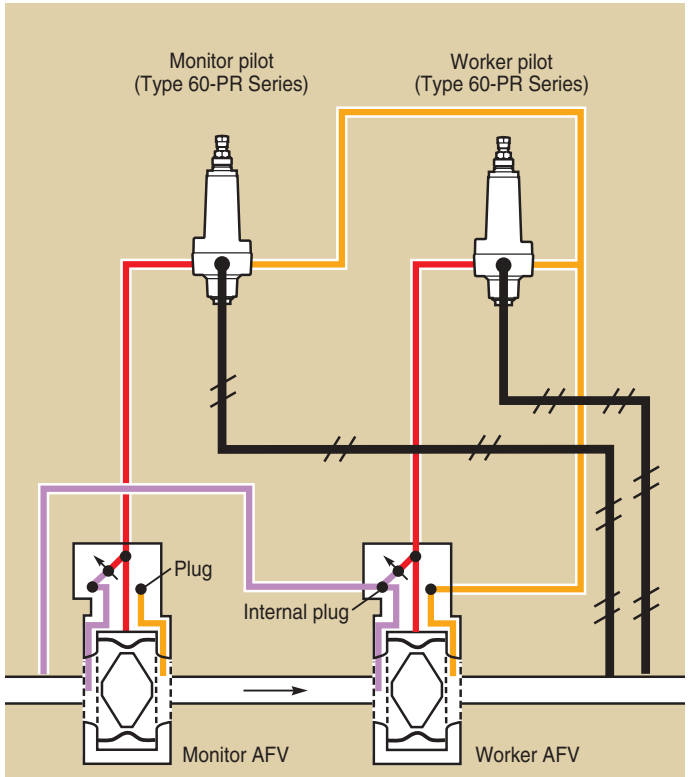
When downstream pressure decreases, spring force increases the effective opening of the pilot. The increase in flow produces a larger pressure drop across the variable restrictor, reducing control pressure to the AFV and increasing flow in the line.



Pressure-relief valve

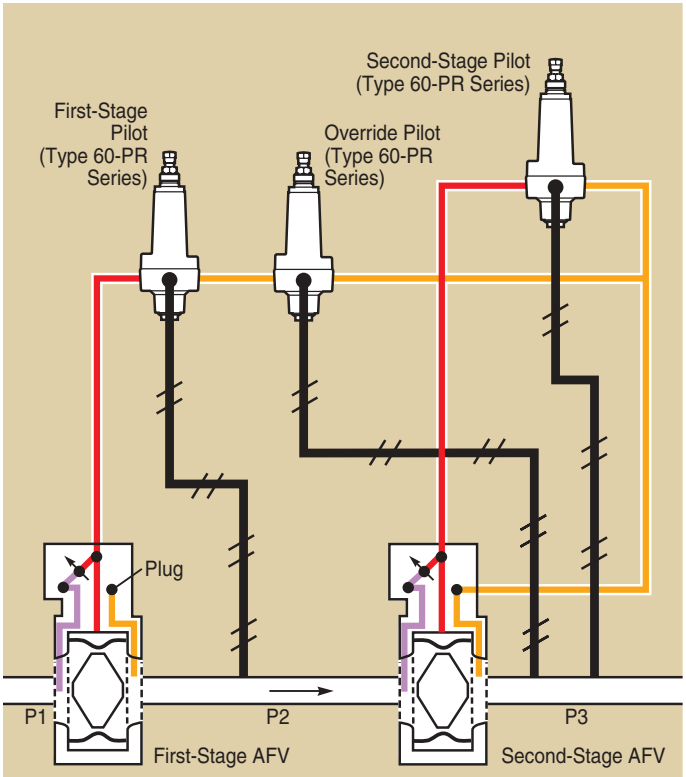
With the 60-RV (relief valve) pilot, the AFV is closed as long as upstream pressure is below the setpoint. Because the exhaust port is normally at atmosphere, once the regulator opens, a large drop occurs across the restrictor, causing the AFV to open quickly.

Applications



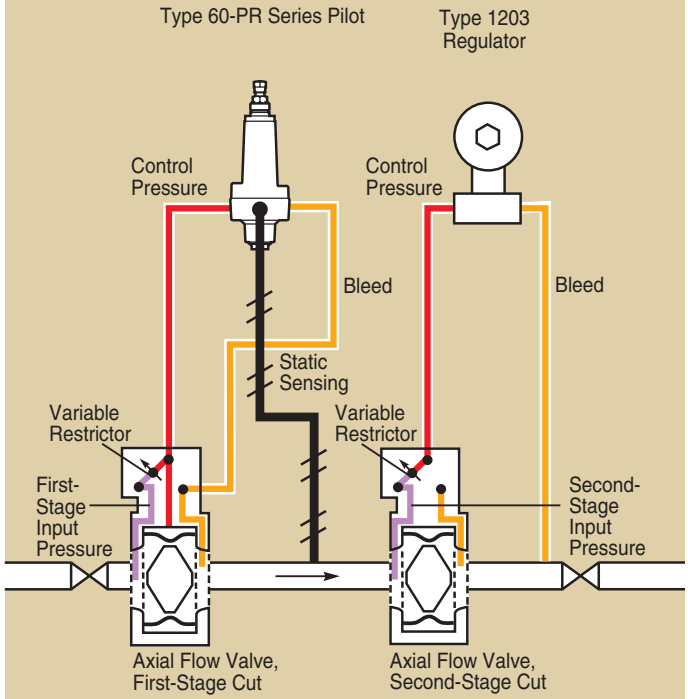
Pressure reduction with monitor

During normal operation, a single AFV, the worker, performs the pressure cut. The monitoring pilot is set at an output pressure slightly higher than the working pilot. Since the monitoring pilot is always open, the monitor AFV is held in the full-open position. If a malfunction occurs on the worker side, the output pressure rises to the monitor setpoint and it assumes control. The roles of worker and monitor can be reversed by simply resetting the pilots.



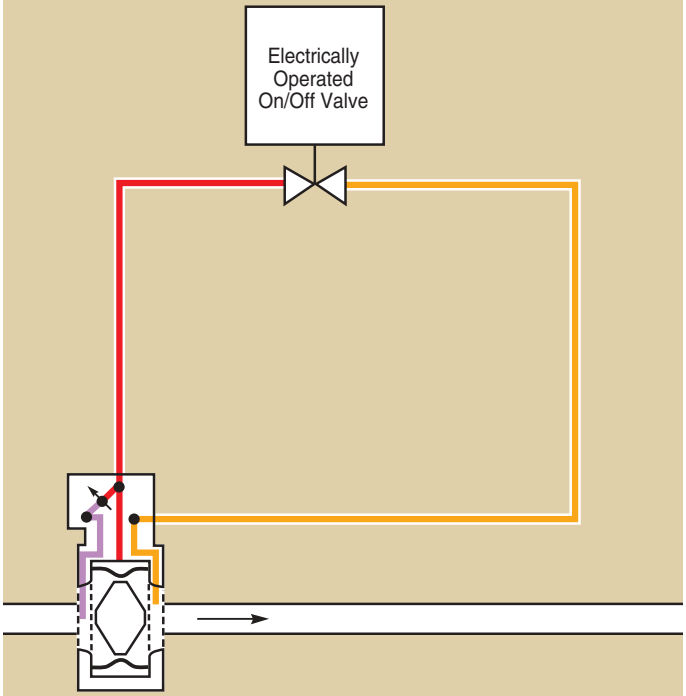
Two-stage regulators with monitor override

Under normal conditions, both AFVs are performing pressure cuts. However, they are sized so either one can handle the entire cut in the event of a malfunction. If a problem occurs in the first stage, P2 increases and the second stage makes a correspondingly larger cut. If the second stage malfunctions, P3 increases and the override pilot assumes control of the first stage AFV, causing it to take a larger single-stage pressure cut. The maximum interstage pressure (P2) is limited to the maximum spring adjustment of the first-stage pilot – 325 psi for the 60L-PR or 900 psi for the 60H-PR.



Two-stage pressure reduction: psi to psi to inches W.C.

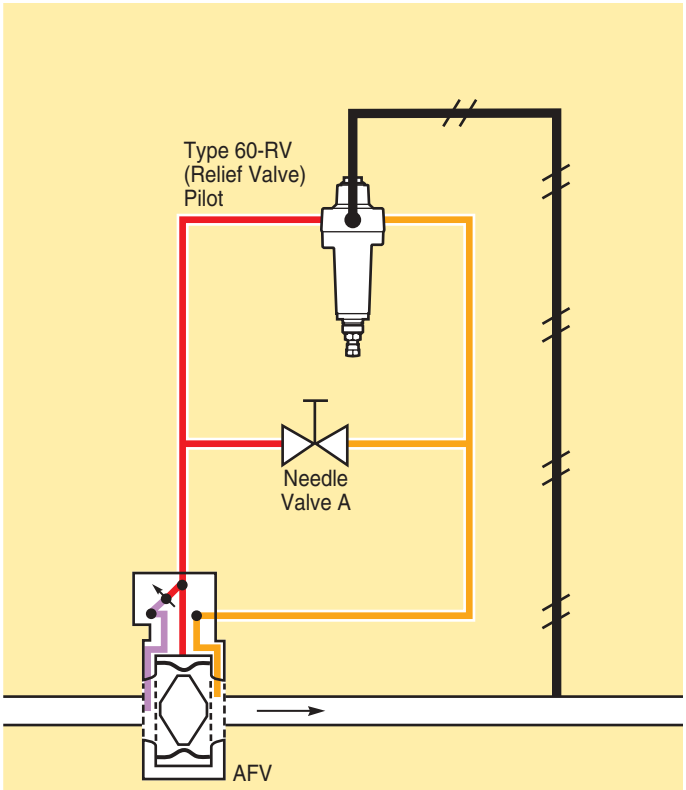
When large reductions in pressure are required, the cut can be made in two stages. Here, an American Meter AFV and Type 60-PR Series Pilot control a psi to psi cut. The second stage incorporates a Type 1203 Regulator to give a final output pressure in the inches W.C. range.



On/off control of flow in a pipeline

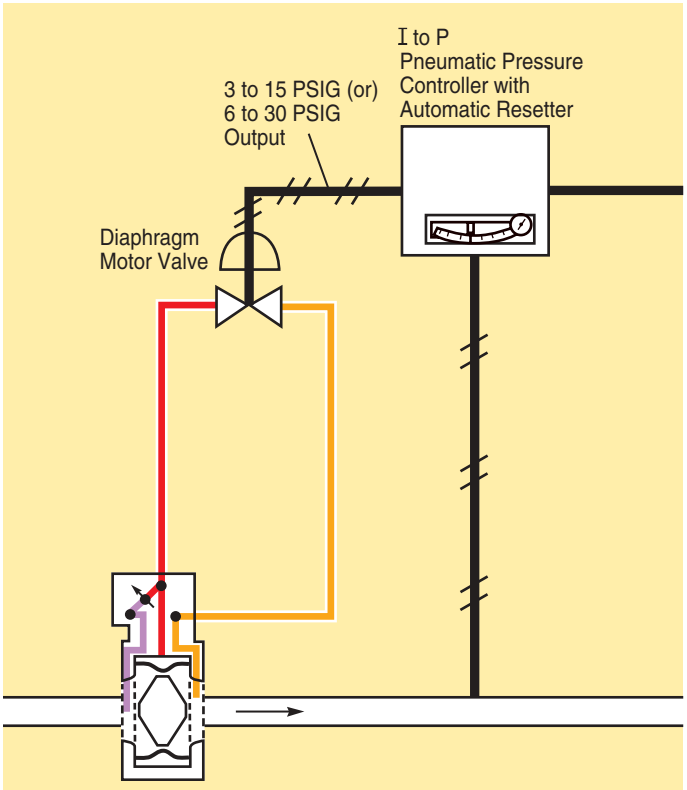
When the electrically operated valve is open, the input pressure is bled downstream causing a drop across the restrictor. Since the control pressure is less than the input pressure, the AFV opens to allow flow in the pipeline. Closing the electrically operated valve causes the control pressure to build up to the input pressure, closing the AFV.

Applications



Underpressure shutoff

As long as the downstream pressure is above the setpoint, the pilot is held open causing a drop across the restrictor and allowing the valve to remain open. If downstream pressure decreases below the setpoint, the pilot is forced closed and inlet pressure is applied to the control port of the AFV, equalizing the pressure across the sleeve and closing the valve. The needle valve is used to start up and reset the system. With Valve A open, there is a pressure drop across the restrictor, allowing the AFV to open. Once the downstream system is pressurized, close Valve A.



Pressure regulation with instrument controller

To overcome the limitations of spring-loaded regulators, the AFV can be used as the final control element with a pressure controller and a small diaphragm-motor valve. Among the advantages are overcoming spring droop, responding to the rate of change in downstream demand and the ability to regulate pressures above 600 PSIG (up to 1440 PSIG).

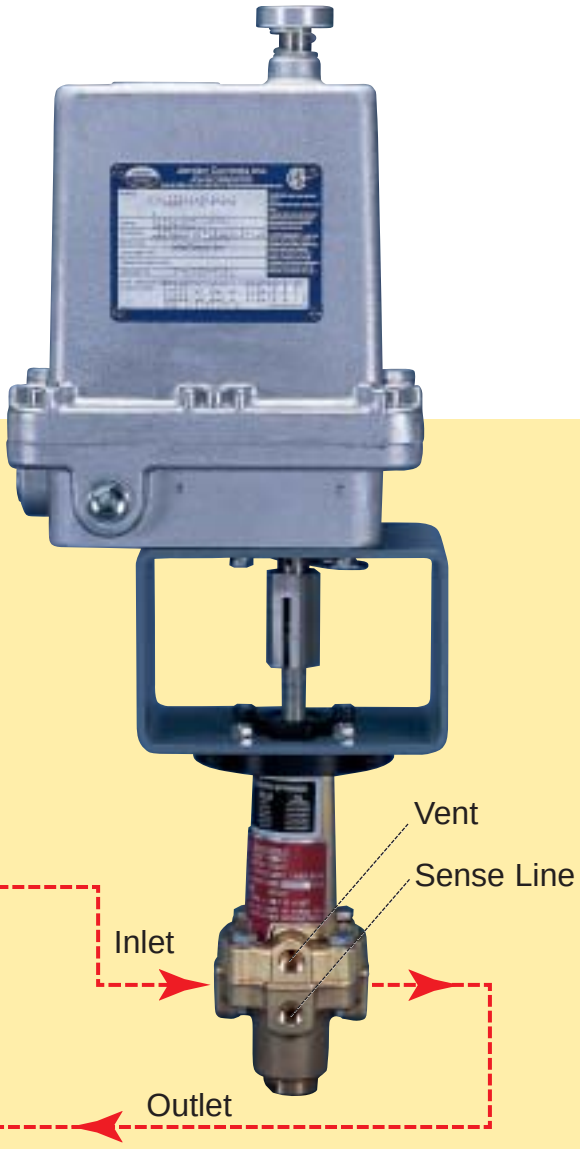
Single-Stage Pressure Reduction Service with Jordan® Model SM1020 10-Turn Electric Controller

American Meter 60Series Pilot Regulators can be purchased with an OEM-mounted and tested Jordan Electric Controller.

The Jordan Controller/60Series assembly is remotely wall or post mounted. The three standard tubing connections are run from the AFV to the Jordan Controller/60Series as shown.

Jordan controllers allow remote adjustment of regulator-station pressures from a central gas control. Available in the Jordan Controller is a 4-20mA feedback position indicator to confirm adjustment position.

Axial Flow Valve



Wall- or Post-Mounted Jordan Controller/60Series Pilot

Sizing the American Meter AFV for pressure-reducing service

To properly size an axial flow valve for a pressure regulation application, three parameters are needed:

- the maximum flow rate through the valve in MSCFH
- the pressure range at the inlet in PSIG
- the controlled or regulated pressure at the outlet in PSIG

As an example, consider an application with:

- maximum flow (Q) = 2000 MSCFH
- inlet pressure range (P1) = 275-300 PSIG
- outlet pressure (P2) = 125 PSIG

The fluid is natural gas, 0.6 SG, 14.73/60°F base conditions.

1. Determine the maximum differential pressure across the valve and use this value to select the appropriate sleeve. Specifications on standard sleeves are as shown below.

		Minimum		Maximum	
AFV Series	Sleeve Number	Cracking	Full Open	Continuous Operation	Intermittent Operation
300	H-5L, B-5L	1.5 PSID	5 PSID	30 PSID	50 PSID
	H-5, B-5	3.5 PSID	15 PSID	125 PSID	180 PSID
	F-5	2.0 PSID	10 PSID	60 PSID	60 PSID
	H-7, B-7, HB-7	14 PSID	30 PSID	500 PSID	720 PSID
600	B-7, H-7, HB-7	30 PSID	60 PSID	1000 PSID	1440 PSID

Note:
- Hydrin sleeves are the standard sleeve – best for most AFV applications.
- Buna sleeves can be substituted in applications >0°F.
- Buna sleeves are the standard sleeve for Class 600 AFV applications.
- Flourosilicone sleeves are low temperature units, but limited to 125 PSI inlet pressure.
- Viton sleeves are chemically resistant, but limited to temperatures >32°F.
- HNBR sleeves are a special tough Buna not available in all sizes >0°F.

In this case, the maximum differential pressure is:
300 – 125 = 175 PSID (the H-7 sleeve is a good choice)

2. Using the valve-capacity tables from American Meter, select the appropriate valve size based on the lowest inlet pressure. The tables show capacity with the valve fully open. It is good practice to size the valve based on 75 percent of the maximum capacity to allow for variations in piping, pilots, etc. In the example, this value would be:

$$\frac{2000 \text{ MSCFH}}{0.75} = 2667 \text{ MSCFCH}$$

From AMCO AFV capacity tables (AMCO TDB 9610) a six-inch Class 300 AFV has a maximum capacity of 3275 MSCFH @ 275 PSIG inlet pressure and 125 PSIG outlet pressure. (Linear interpolation is needed between 100 and 150 PSIG tables) With a load of 2000 MSCFH and a gross AFV capacity of 3275 MSCFH, the 6"/300 AFV will be about 61 percent open at full demand – a good choice.

3. Select a pilot with a spring suitable for the desired setpoint using the lowest outlet pressure range covering the setpoint.

Pilot Type	Outlet Pressure	Part Number
60L – PR and 60L – RV	3-30 PSIG (red)	71411P055
	10-75 PSIG (blue)	71411P060
	25-150 PSIG (black)	71411P061
	100-325 PSIG (green)	71411P062
60H – PR and 60H – RV	250-450 PSIG (brown)	71411P063
	400-900 PSIG (white)	71411P064
1203 125 PSIG maximum inlet pressure	6-12" w.c.	70017P001
	11-17" w.c.	70017P002
	8-14" w.c.	70017P003
	14" w.c.– 2 PSIG	70017P073
	2-5 PSIG	70017P078

Note: 5" w.c. applications can use 70017P001 spring and internal adjuster.

4. Determine the outlet pipe size required to maintain the 200 ft/sec limits commonly used in the gas industry:

$$D = 2\sqrt{\frac{Q}{P_2}}$$

where: D = outlet pipe diameter (inches)
Q = flow rate, (MSCFH)
P_2 = downstream pressure (psia)
In our example,

$$D = 2\sqrt{\frac{3276}{(125 + 14.73)}} = 9.684"$$

Therefore, the outlet of the 6" AFV should be expanded to a 10" pipe using 15° cones at the outlet or within 5d (30") of the outlet. The sensing tap should be 5d to 8d downstream of the valve or cone outlet. The smaller the valve size, the more critical the need for expanding the outlet piping in order to achieve the full capacity of the valve.

When using two similar size AFVs in series, such as a monitor and worker, size should be based on 71 percent of the maximum values in the capacity tables *before* applying the 75 percent allowance for variations.

Sizing the American Meter AFV for pressure-relief service

When sizing an AFV for relief services, it's necessary to determine the allowable pressure rise above the set (relief) point and to assure that the relief valve has a capacity that is large enough to fully discharge the open capacity of the control (working) regulator. Generally, the relief valve will be one or two sizes larger than the working regulator.

A typical situation might be an application using a 3-inch Series 300 AFV with a 60-PR pilot as an operating regulator. The inlet pressure to the worker is 75 to 150 PSIG and the worker is set at 50 PSIG. Maximum flow rate is 654 MSCFH, based on 150 psi maximum inlet pressure. The maximum allowable operating pressure is 60 PSIG, and the maximum pressure buildup above the relief point is 6 PSIG.

1. Determine the range and type of control pilot operator.
   60 PSIG MAOP + 6 PSIG max buildup = 66 PSIG
   From the pressure spring table, select a 60-RV pilot (backpressure type) with spring 71411P012 (10 to 75 PSIG). The pressure buildup above the setpoint is three percent of the maximum of the spring range, in this case 0.03 x 75 = 2.25 PSIG. (This is a characteristic of the 60-RV Pilot as used with AFVs.)
2. Determine the maximum relief valve setting, maximum permitted line pressure minus pressure buildup.
   66 PSIG – 2.25 PSIG = 63.75 PSIG
3. Establish the size of the relief valve using 644 MSCFH and the maximum permitted line pressure of 66 PSIG. Using the capacity tables, find the smallest valve that will discharge 654 MSCFH at 66 PSIG inlet pressure and 0 PSIG outlet pressure. The 66 PSIG inlet pressure will require interpolation.

   A 4-inch valve has a capacity of 548 MSCFH. While this capacity is too small, this type of situation might justify a closer look at the specified 644 MSCFH for economic reasons.

If the 654 MSCFH is validated, a 6-inch American Meter AFV will discharge 980 MSCFH. To fully realize the relief capacity of the AFV, the discharge should be to atmosphere or not more than 5d of equivalent pipe at the outlet. If outlet piping is required, an expander 15° cone is advisable. At outlet piping velocities in excess of 100 ft/sec, the relieved gas generates excessive reactive forces and the relief system must be supported.

Other parameters necessary to obtain the full relief capacity are:

- pilot downstream bleed should be connected to the AFV aspirator port
- restrictor setting should be 3 or less, consistent with stability and speed of opening
- the upstream sensing line tap should be 2d to 3d from the inlet of the AFV

A Complete Family of Gas Measurement, Pressure Regulation, and Testing Systems

Rotary Meter With Continuous Mechanical Temperature Compensator

The new CMTC RPM® Series gas meter provides flowing-gas volume registration continuously and mechanically corrected to the standard base temperature (60°F). See bulletin SB 5520 for more information.

Rotary Meter with Integral Mercury Corrector

A new generation of Mercury Mini-Max® and Mini-AT® Correctors now mount integrally to American Meter's RPM® Series Rotary Meters. See bulletin SB 5510 for more information.

Diaphragm Meters

American Meter's compact, light-weight, aluminumcase meters are designed to provide positive displacement accuracy for industrial or commercial loads. See bulletin SB 3510 for more information.

1800 PFM Series

1800 PFM industrial regulators are designed for applications requiring medium-to-high capacity, extremely precise outlet-pressure control, and fast response to changing loads. See bulletin SB 8551 for more information.

Turbine Gas Meters

High-performance meters provide accurate measurement of high-volume gas flow. Turbines are available from 3" to 12" line sizes and line pressures up to 1440 PSIG. See bulletin SB 4510 for more information.

ISO 9001: 2000

Certificate #009659

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Filters

Filtration down to 10 microns. Protects meter and regulator stations from dirt and pipe scale damage. See bulletin SB 12521 for more information.

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Fax 215/830-1890
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275 Industrial Road
Cambridge, Ontario
Canada N3H 4R7
Phone: 519/650-1900
Fax 519/650-1917
www.canadianmeter.com

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