ASCO Engineering has always been a significant contributor to the growth and success of our company. Today, we are better equipped than ever before to meet the challenges of our customers. Whether your specific product needs are routine or exotic, we have the best tools, talent, and experience to design and produce the exact product you need to control, move, and monitor your fluid.

Our engineering teams have the most advanced computers and computer programs at their disposal to aid in new product design. These include the latest 2D and 3D computer modeling programs to assist in development of a design concept, specialized magnetic and flow analysis programs to help optimize the magnetic efficiency of our solenoids and fluid flow-through in our valves. Other computer programs assist us in structural analysis, motion analysis, and the design of molds for thermoplastic parts.

Our Engineering Department has the latest rapid prototyping and computer controlled machining equipment. This allows us to quickly turn our computer designs into functional models. We also have a modern Valve Laboratory to development test and verify the performance of our new products and a Pilot Plant to simulate the production environment and to ensure a smooth transition from Engineering to Manufacturing.

However, the most important elements of our Engineering Department are the many highly educated, creative, experienced, and talented people who comprise it. They not only know how to make the best new products, but they also are there, whenever needed, to help make sure all of our products continue to perform to the standards that have made ASCO the world leader in fluid control.

This section provides additional information which may be necessary to determine the exact ASCO solenoid or air operated valve for your requirements.

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<tr>
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<td>11.19</td>
</tr>
</tbody>
</table>
Solenoid Valves

Principles of Operation

A solenoid valve is a combination of two basic functional units:

- A solenoid (electromagnet) with its core.
- A valve body containing one or more orifices.

Flow through an orifice is shut off or allowed by the movement of the core when the solenoid is energized or de-energized. ASCO valves have a solenoid mounted directly on the valve body. The core is enclosed in a sealed tube, providing a compact, leaktight assembly.

Direct Acting Valves (Figures 1A, 1B)

When the solenoid is energized in a direct acting valve, the core directly opens the orifice of a Normally Closed valve or closes the orifice of a Normally Open valve. When de-energized, a spring returns the valve to its original position. The valve will operate at pressures from 0 psi to its rated maximum.

The force needed to open the valve is proportional to the orifice size and fluid pressure. As the orifice size increases, so does the force required. To open large orifices while keeping solenoid size small, a Pilot Operated construction is used.

Internal Pilot Operated Valves (Figures 2A, 2B)

Normally, these valves have a pilot and bleed orifice which enable them to use line pressure for operation.

When the solenoid is de-energized, the pilot orifice is closed and full line pressure is applied to the top of the piston or diaphragm through the bleed orifice, providing seating force for tight closure.

When the solenoid is energized, the core opens the pilot orifice, relieving pressure from the top of the piston or diaphragm via the outlet side of the valve. The line pressure then opens the valve by lifting the diaphragm or piston off the main orifice.

Two constructions are available for 2 way valves:

- Floating diaphragm or piston which requires a minimum pressure drop across the valve to remain in the open position (Figures 2A, 2B).
- Hung-type diaphragm or piston held open mechanically by the solenoid core. The valve opens and remains open with zero pressure drop (Figures 3A, 3B).

Manual Reset Valves (Figures 4A, 4B)

Manual reset valves must be manually latched into position and will return to their original position only when the solenoid has been energized or de-energized, depending on construction.
Types of Solenoid Valves

2 Way Valves (Figures 1A, 1B, 2A, 2B, 3A, 3B)
Two way valves have one inlet and one outlet pipe connection. They are used to allow or shut off fluid flow, and are available in either:

- Normally Closed - closed when de-energized and open when energized.
- Normally Open - open when de-energized and closed when energized.

3 Way Valves (Figures 5A, 5B)
Three way valves have three pipe connections and two orifices (when one is open, the other is closed, and vice versa). They are commonly used to alternately apply pressure to and exhaust pressure from the diaphragm operator of a control valve, single-acting cylinder, or rotary actuator.

Three modes of operation are available:

- Normally Closed - when the valve is de-energized, the pressure port is closed and the cylinder port is connected to the exhaust port. When the valve is energized, the pressure port is connected to the cylinder port and the exhaust port is closed.
- Normally Open - when the valve is de-energized, the pressure port is connected to the cylinder port and the exhaust port is closed. When the valve is energized, the pressure port is closed and the cylinder port is connected to the exhaust port.
- Universal - allows the valve to be connected in either the Normally Closed or Normally Open position to select one of two fluids or to divert flow from one port to another.

4 Way Valves (Figures 6A, 6B)
Four way valves are generally used to operate double-acting cylinders or actuators. They have four or five pipe connections: one pressure, two cylinder, and one or two exhausts. In Position A, pressure is connected to one cylinder port, the other is connected to exhaust. In Position B, pressure and exhaust are reversed at the cylinder ports.
Solenoids

Solenoid Coils
Except where noted, all ASCO valves are equipped with coils which can be energized continuously without danger of overheating or failure. Standard coils have 18” leads which can be connected to any controlling device. Spade, screw terminal, and DIN-type spade connector coils are also available. For three phase power systems, the two leads can be connected to any two of the three phases.

All coils are constructed in accordance with Underwriters Laboratories Inc., NEMA, IEEE, and other industrial standards. ASCO Class B, F, and H insulation systems are UL listed in the Recognized Component Index (yellow book) under Guide No. OBJY2.

For AC ambient capabilities, see chart to the right. DC ambient capabilities are 104°F (40°C) for Red-Hat II®. These ambients are based on a minimum available voltage of 85% of nominal. If minimum available voltage is greater, a higher ambient limitation may be possible. Consult factory for details.

Coil Insulation Systems and Temperature Limitations
Red-Hat II® Solenoid Class F 314°F (155°C) and Class H 356°F (180°C)

AC Ambient Capabilities

<table>
<thead>
<tr>
<th>Coil Class</th>
<th>FT</th>
<th>FB</th>
<th>HT</th>
<th>HB</th>
</tr>
</thead>
<tbody>
<tr>
<td>M6</td>
<td>6.1</td>
<td>9.1</td>
<td>6.1</td>
<td>9.1</td>
</tr>
<tr>
<td>MXX</td>
<td>10.1</td>
<td>17.1</td>
<td>10.1</td>
<td>17.1</td>
</tr>
<tr>
<td>M12</td>
<td>16.1</td>
<td>20.1</td>
<td>16.1</td>
<td>20.1</td>
</tr>
</tbody>
</table>
Coil Operating Voltage Ranges

All coils are designed for industrial operating voltages and can be used on the following voltage ranges:

<table>
<thead>
<tr>
<th>Nominal Voltage Rating</th>
<th>Normal Operating Range</th>
<th>Nominal Voltage Rating</th>
<th>Normal Operating Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>20-24</td>
<td>6</td>
<td>5.1-6.3</td>
</tr>
<tr>
<td>120</td>
<td>102-120</td>
<td>12</td>
<td>10.2-12.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24</td>
<td>20-25</td>
</tr>
<tr>
<td>240</td>
<td>204-240</td>
<td>120</td>
<td>102-126</td>
</tr>
<tr>
<td>480</td>
<td>408-480</td>
<td>240</td>
<td>204-252</td>
</tr>
</tbody>
</table>

Note: Special coils are required for battery charging circuits where wider voltage ranges are typically encountered. For these applications, special continuous duty Class H coils are available that will accommodate a voltage range equivalent to 12% over nominal, 28% under nominal, and a 140°F (60°C) ambient. Standard nominal voltages are 125 and 250 DC, which translate to a voltage range of 90-140 and 180-280, respectively. Add prefix "HC" to the catalog number. "HC" prefix is only applicable to valves with coil classes FT and HT. Consult factory or other constructions.

Most ASCO valves, depending on construction, will operate at 15% under nominal voltage and maximum operating pressure differential, and are capable of operating for short periods at 10% over nominal voltage. For coil classes other than FT and HT, over voltage is not recommended. For wider voltage ranges than shown here or for operating voltage ranges for specific catalog numbers, please consult your local ASCO sales office.

Power Consumption

Power consumption can be determined from the ratings shown on individual Series pages. For AC valves, the watts, volt-ampere "inrush" (the high momentary surge occurring at coil energization), and volt-ampere "holding" (the continuous draw following inrush) are given.

The current rating for inrush and holding may be determined by dividing the voltage into the volt-amp rating:

\[
\text{Inrush Amps} = \frac{\text{volt-amp inrush}}{\text{voltage}}
\]

\[
\text{Holding Amps} = \frac{\text{volt-amp holding}}{\text{voltage}}
\]

DC valves have no inrush current. The amp rating can be determined by dividing the voltage into the DC watt rating:

\[
\text{Amps} = \frac{\text{watts (DC)}}{\text{voltage}}
\]

Notes:
1. When a valve has been energized for a long period, the solenoid becomes hot and can be touched by hand for only an instant. This is a perfectly safe operating temperature. Any excessive heating will be indicated by smoke and the odor of burning coil insulation.
2. Valves for AC service can be converted to other AC voltages simply by changing the coil. Similarly, DC valves can be converted to other DC voltages. When converting from AC to DC, or vice versa, consult your local ASCO sales office for instructions.

Solenoid Constructions

Internal parts in contact with fluids are of non-magnetic 300 and magnetic 400 series stainless steel. In AC constructions, the shading coil is normally copper, except that silver is mostly used in valves with stainless steel bodies. Other materials are available, when required. In DC constructions, no shading coil is required. Typically, the core tubes are of 300 series stainless steel and are formed by deep drawings, eliminating the need for silver brazed or welded joints.
Solenoid Enclosures
ASCO offers two types of enclosures, each for a variety of applications: a one-piece molded epoxy construction called the Red-Hat II® solenoid and a conventional Red-Hat metallic construction. Both meet ICS-6 ANSI/NEMA, and UL Standards 429, 508, and/or 1002. These standards define enclosure protection levels and the tests passed to earn each Type designation.

Red-Hat II®
Red-Hat II® solenoid enclosures are of one-piece molded epoxy construction, with an integral 1/2" NPT conduit hub. This epoxy encapsulation serves as the enclosure. The magnetic frame is molded into the coil.

Red-Hat II® solenoids are offered as Type 1 General Purpose or Type 7 (A, B, C, and D) Explosionproof.

Type 1 - Solenoids are green and come equipped with three 18" long leads (the green lead is a ground wire). Also available as options are 1/4" spade connectors, screw terminals, and DIN-type terminals meeting ISO 4400 and DIN Standard 43650. When ordered with optional electrical connection enclosure, it is defined as Open Frame.

An optional junction box/terminal coil construction is also available for use with spade and screw terminal constructions. See the "Optional Features" Section, page 10.06.

Type 7 - Solenoids are black and are available only in the leaded construction.

All Red-Hat II® solenoids also meet the requirements for Types 2 Dripproof, 3 and 3S Raintight, and 4 and 4X Watertight-Corrosion Resistant.

The Following wattages carry Type 7 and Type 9 approvals as shown; for

<table>
<thead>
<tr>
<th>Wattage</th>
<th>Type 7 Class I, Div. 1 &amp; 2 Gas Groups</th>
<th>Type 9 Class II, Div. 1 Dust Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1, 10.1, 17.1</td>
<td>A, B, C, D</td>
<td>E, F, G</td>
</tr>
<tr>
<td>16.1, 20.1</td>
<td>A, B, C, D</td>
<td>E, F</td>
</tr>
<tr>
<td>10.6, 11.6</td>
<td>A, B, C, D</td>
<td>E, F, G</td>
</tr>
</tbody>
</table>

Enclosure Classifications and Types

<table>
<thead>
<tr>
<th>Type</th>
<th>General Purpose</th>
<th>Intended for indoor use, primarily to provide protection for enclosed parts in locations without unusual service conditions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 2</td>
<td>Dripproof</td>
<td>Intended for indoor use, primarily to provide protection against limited amounts of falling water or dirt.</td>
</tr>
<tr>
<td>Type 3</td>
<td>Raintight, Dusttight, and Sleet (Ice) Resistant</td>
<td>Intended for outdoor use, primarily to provide protection against wind-blown dust, rain, and sleet; undamaged by the formation of ice on the enclosure.</td>
</tr>
<tr>
<td>Type 3S</td>
<td>Raintight, Dusttight, and Sleet (Ice) Resistant</td>
<td>Intended for outdoor use, primarily to provide protection against wind-blown dust, rain, and sleet; external mechanism remains operable when ice laden.</td>
</tr>
<tr>
<td>Type 3R</td>
<td>Rainproof, Sleet (Ice) Resistant</td>
<td>Intended for outdoor use, primarily to provide protection against falling rain and sleet; undamaged by the formation of ice on the enclosure.</td>
</tr>
<tr>
<td>Type 4</td>
<td>Watertight and Dusttight</td>
<td>Intended for indoor or outdoor use to provide protection against splashing water, water seepage, falling or hose-directed water, and severe external condensation; undamaged by the formation of ice on the enclosure.</td>
</tr>
<tr>
<td>Type 4X</td>
<td>Watertight, Dusttight, and Corrosion Resistant</td>
<td>Same as Type 4, but provides additional protection to resist corrosion.</td>
</tr>
<tr>
<td>Type 6</td>
<td>Submersible</td>
<td>Intended for indoor or outdoor use to provide protection against entry of water during submersion at a limited depth. (Tested to 6' for 30 minutes.)</td>
</tr>
<tr>
<td>Type 6P</td>
<td>Submersible</td>
<td>Same as Type 6 Enclosure, but provides prolonged submersion protection at a limited depth. (Tested to 6' for 24 hours.)</td>
</tr>
</tbody>
</table>

Type 7 and Type 9 | See charts on page 11.06
Type 7 (A, B, C, and D)

Explosionproof enclosures are designed to contain an internal explosion, without causing an external hazard, when installed in the following atmospheres or locations:

Class I
Gasses or Vapors

Division 1
Ignitable concentrations of flammable gases, vapors, or liquids which:
• Can exist under normal operating conditions.
• May exist frequently due to repair, maintenance operations, or leakage.
• May exist due to equipment breakdown that simultaneously causes it to become a source of ignition.

Division 2
Volatile flammable liquids, gases, or vapors exist, but are normally contained within closed containers. Ignitable concentrations of liquids, gases, or vapors are normally prevented by positive mechanical ventilation. Location is adjacent to Class I, Division 1, from which ignitable concentrations might occasionally migrate.

Group A
Atmospheres containing Acetylene.

Group B
Atmospheres containing Hydrogen.

Group C
Atmospheres containing Ethyl, Ethylene, Cyclopropane.

Group D
Atmospheres containing Acetone, Gasoline, Hexane, Naptha, Benzene, Butane, Alcohol, Propane, Lacquer.

Type 9 (E, F, and G)

Dust-ignitionproof enclosures are designed to prevent the entrance of dust, and the enclosed devices do not produce sufficient heat to cause external surface temperatures capable of igniting dust on the enclosure or in the surrounding atmosphere.

Class II
Dust

Division 1
Combustible dust is or may be present under normal conditions.

Division 2
Combustible dust is present only under abnormal conditions.

Group E
Atmospheres containing Metal Dust (Aluminum, Magnesium, their alloys, or those with similarly hazardous characteristics).

Group F
Atmospheres containing Carbon Black, Coal, or Coke Dust.

Group G
Atmospheres containing Flour, Starch, or Grain Dust.
Red-Hat® Metallic Enclosures
Conventional metallic enclosures are offered to meet Type I General Purpose enclosure applications and Type 7 (C and D) Explosionproof enclosure applications.

Type 1 — General Purpose metallic enclosures are epoxy-painted, zinc-coated steel with a 7/8” diameter hole to accept standard conduit hubs or connectors.

Type 7 (C and D) — Explosionproof metallic enclosures are epoxy-painted, zinc-plated steel or die-cast aluminum with a 1/2” threaded conduit hub.

Type 7 enclosures also meet Type 3 (Raintight) requirements as well as Type 7 (C and D) Explosionproof and Type 9 (E, F, and G) Dust-Ignitionproof requirements for Class I, Division 1, Groups C and D; Class I, Division 2, Groups A and B; and Class II, Division 1, Groups E, F, and G.

Also available as options are: Type 3R (Rainproof), Type 4 and 4X (Watertight), Type 6 (Submersible), Type 7B (Explosionproof for Hydrogen Atmospheres, Class I, Division 1, Group B), as well as Splice Box enclosures. Please contact your local ASCO sales office for details on these options.

Note: Metallic solenoid enclosures provide part of the magnetic circuit for the solenoid. Removal will affect valve operation.

Hazardous Location Solenoid Temperature Range Codes
Hazardous location solenoids are marked to indicate the maximum exposed surface temperature or temperature indicating code. This temperature is based on the maximum obtained in the temperature or burnout (blocked core) tests, whichever is higher, at a minimum ambient of 104°F (40°C) or at the rated maximum ambient temperature.

To prevent ignition of hazardous atmospheres, do not install in areas where vapors or gases having ignition temperatures lower than the marked temperatures are present.

The operating temperatures for each indicating code are shown in the following chart:

<table>
<thead>
<tr>
<th>Maximum Temperature</th>
<th>Code Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degrees in C</td>
<td>Degrees in F</td>
</tr>
<tr>
<td>450</td>
<td>842</td>
</tr>
<tr>
<td>300</td>
<td>572</td>
</tr>
<tr>
<td>280</td>
<td>536</td>
</tr>
<tr>
<td>260</td>
<td>500</td>
</tr>
<tr>
<td>230</td>
<td>446</td>
</tr>
<tr>
<td>215</td>
<td>419</td>
</tr>
<tr>
<td>200</td>
<td>392</td>
</tr>
<tr>
<td>180</td>
<td>356</td>
</tr>
<tr>
<td>165</td>
<td>329</td>
</tr>
<tr>
<td>160</td>
<td>320</td>
</tr>
<tr>
<td>135</td>
<td>275</td>
</tr>
<tr>
<td>120</td>
<td>248</td>
</tr>
<tr>
<td>100</td>
<td>212</td>
</tr>
<tr>
<td>85</td>
<td>185</td>
</tr>
</tbody>
</table>

Note: Except where otherwise noted in specific Series, all Red-Hat® metallic enclosure solenoids have temperature range Code T3C.

Most Red-Hat II® solenoids and/or solenoid valves are marked:
“To prevent fire or explosion, do not install where ignition temperature of hazardous atmosphere is less than 329°F (165°C). Open circuit before disassembly.” This corresponds to code number T3B.

Valves with Class H solenoids and valves used on steam service are marked:
“To prevent fire or explosion, do not install where ignition temperature of hazardous atmosphere is less than 356°F (180°C). Open circuit before disassembly.” This corresponds to code number T3A.

The Class II, Group F, Dust Location designation is not applicable for solenoids and/or solenoid valves used for steam service, or when a Class H solenoid is used.

Red-Hat II® Explosionproof solenoids include an internal, non-resettable thermal fuse to limit solenoid temperature in the event that extraordinary conditions occur which could cause excessive temperatures. These conditions include high input voltage, a jammed valve, excessive ambient temperature, shorted coil, etc. This unique feature is standard only in Red-Hat II® solenoids.

When used on valves having fluid temperature ratings exceeding 248°F (120°C), consult ASCO for applicable enclosure class, groups and temperature range codes. For temperature range codes of optional solenoids and features, or if a better temperature range code is desired, consult your local ASCO sales office.
Operating Pressures

Maximum Operating Pressure Differential (M.O.P.D.)
The maximum operating pressure differential refers to the maximum difference in pressure between the inlet and outlet, against which the solenoid can safely operate the valve. If the pressure at the valve outlet is not known, it is safest to regard supply pressure as the M.O.P.D.

Minimum Operating Pressure Differential
The minimum operating pressure differential is that which is required to open the valve and keep it open. For 2 way valves with a floating piston or diaphragm, the valve will start to close below the minimum operating differential pressure. For 3 and 4 way pilot valves, the minimum operating pressure is measured between the pressure and exhaust ports, and must be maintained throughout the operating cycle to ensure complete transfer from one position to the other.

Note: Directing acting, hung diaphragm or hung piston valves do not require a minimum pressure, but may not yield maximum flow on low pressure differentials.

Safe Working Pressure
Safe working pressure is the line or system pressure to which the valve may be subjected without being damaged.

Proof Pressure
Proof pressure is five times the safe working pressure. Contact the factory or your local ASCO sales office if you require this value.

Ambient Temperatures

Minimum Ambient Temperature
The nominal limitation of 32°F (0°C) is advisable for any valve that might contain moisture (water vapor). Where freezing water is not a factor, minimum ambience as low as 0°F (-18°C) can be tolerated. In addition, special constructions are available for ambient temperatures down to -40°F (-40°C). Consult your local sales office with your specific needs.

Maximum Ambient Temperature
The nominal maximum ambient temperatures listed are based primarily on test conditions used by Underwriters Laboratories, Inc. for setting safe limits for coil insulation. They are determined under continuously energized conditions and with maximum fluid temperatures in the valves. Actual conditions, in many applications, will permit use at considerably higher ambient temperatures. In addition, modifications to standard constructions are available to extend maximum ambient temperature limitations. Consult your local ASCO sales office with your specific needs.

Response Times
Response time from fully closed to fully open or vice versa depends on the valve size and operating mode, electrical service, fluids, temperature, inlet pressure, and pressure drop. The response time for AC valves on air service, under average conditions, can be generalized as follows:

- Small direct acting valves: 5 to 10 milliseconds.
- Large direct acting valves: 20 to 40 milliseconds.
- Internal pilot operated valves:
  1. Small diaphragm types: 15 to 50 milliseconds.
  2. Large diaphragm types: 50 to 75 milliseconds.
  3. Small piston types: 75 to 100 milliseconds.
  4. Large piston types: 100 to 150 milliseconds.

Generally speaking, operation on liquids has relatively little effect on small direct acting valves; however, response time of large direct acting and internally piloted valves will slow by 50% to 100%.

Response time of DC valves will be 50% slower than equivalent AC valves. For specific response time on any critical-timing applications, response time can be reduced to meet specific requirements.
Air Operated Valves

Principles of Operation

An air operated valve has two basic functional units:
- An operator with a diaphragm or piston assembly which, when pressurized, develops a force to operate.
- A valve containing an orifice in which a disc or plug is positioned via air pressure to stop or allow flow.

Operators

Two operators are offered in this catalog, each having a pressure range to suit various industrial requirements: instrument air range 3 to 30 psi (0.2 to 2.1 bar) and pneumatic range 30 to 125 psi (2.1 to 8.6 bar).

Control air for the operator is completely isolated from the main line fluid by a unique seal arrangement (see Figure 7). This permits a wide range of main line fluids to be handled.

The instrument air pressure range operator utilizes a diaphragm (see Figure 8A) for operation, while the pneumatic range operator has a piston (see Figure 8B). By applying pressure to and exhausting pressure from the operator, the main valve will open or close.

Direct Acting Valves (Figures 9A, 9B)

In a direct acting valve, the operator stem is moved by the diaphragm or piston and directly opens or closes the orifice, depending on whether the operator is pressurized or exhausted. The valve will operate from zero psi to its maximum rated pressure.

Internal Pilot Operated Valves (Figure 10A, 10B)

This valve is equipped with a pilot and bleed orifice and uses the line pressure for operation. When the operator is pressurized, it opens the pilot orifice and releases pressure from the top of the valve piston or diaphragm to the outlet side of the valve. This results in unbalanced pressure, which causes the line pressure to lift the piston or diaphragm off the main orifice, thereby opening the valve. When the operator is exhausted, the pilot orifice is closed and full line pressure is applied to the top of the valve piston or diaphragm through the bleed orifice, providing a seating force for tight closure.

Two types of construction are available:
- Floating diaphragm or piston, which requires a minimum pressure drop to hold it in the open position.
- Hung type diaphragm or piston, which is mechanically held open and operates from zero to the maximum pressure rating.
Types of Air Operated Valves

2 Way Valves:
Normally closed and normally open operation. Figures 9A, 9B, 10A, 10B, 11A, 11B.

3 Way Valves:
Normally closed, normally open and universal operation. Figures 12A-D, 13A-D.

4 Way Valves:
Figures 14A-D

Operating Pressures

Minimum Operating Pressure Differential
The minimum operating pressure differential is that which is required to open the valve and to keep it open. Two way valves with floating piston or diaphragm will start to close below the minimum differential pressure. Three and four way pilot valves must maintain the minimum operating pressure throughout the operating cycle to ensure complete transfer from one position to the other.

Maximum Operating Pressure
Maximum operating pressure is the highest pressure at the inlet side of the valve, against which the operator can operate the valve. This pressure may be much less than the maximum safety rating of the valve body.

Note: Direct acting valves do not require a minimum pressure.
Approval Listing Code and Information

UL, FM, CSA listings and compliance to applicable CE directives have been indicated for each Series in this catalog. Listing codes and other information follow in this section.

In addition to approvals with the standard features and for the standard voltages listed in each Series, many valves with optional features and other voltages have also been approved. Consult your local ASCO sales office for details.

Agency Valve Classifications and Code Reference

General Purpose Valve - a Normally Open or Normally Closed valve intended to control the fluid flow, but not to be depended upon to act as a safety valve. This is a UL and CSA classification, and is not intended to indicate valve service or application.

Safety Shutoff Valve - a Normally Closed valve of the "on" and "off" type, intended to be actuated by a safety control or emergency device, to prevent unsafe fluid delivery. It may also be used as a General Purpose valve. A multiple port valve may be designated as a Safety Shutoff valve only with respect to its Normally Closed port. This is a UL, FM, and CSA valve classification.

Process Control Valve - an FM approved valve to control flammable gases, not to be relied upon as a Safety Shutoff valve. Refer to note under individual valve listing. Unless otherwise stated under the individual Series numbers, valves are listed as General Purpose valves.

Canadian Standards Association

Standard C22.2 No. 139, "Electrically Operated Valves," covers the standards governing solenoid valves.

CSA certified valves and solenoids are listed in the "CSA Certified Electrical Equipment Book" under Valves, Guide No. 440-A-0 (File 10381) and Guide No. 440-A-0.8 (File 13976).

CSA valves require special handling, testing, and marking. They are supplied only when specified on an order.

Factory Mutual Research Corporation

FM "approves" and lists in the "Factory Mutual Approval Guide" fuel oil and fuel gas safety shutoff valves, process control valves, explosionproof/dust-ignitionproof, and intrinsically safe valves for hazardous locations. Valves designated for other fluids and operational characteristics, although not subject to FM approval, are usually "accepted" by FM on specific equipment installations.
ASCO’s Quality Assurance Program meets all the requirements of ISO-9001-94. We are also certified to IQ Net, providing customers with the products from 17 ISO-certified facilities around the world. The US, Canada, UK, France, the Netherlands, Germany, and Japan are included.

When desired, ASCO solenoid valves can be supplied to meet the additional requirements of a variety of approval agencies around the world. The following can be requested. Consult your local ASCO sales office for details.

**European Directives - CE**

The Council of the European Communities, under the treaty establishing the European Economic Community (EEC), adopted into law a series of directives to harmonize technical standards. Solenoid valves are controlled by:

- **Machinery** 89/392/EEC Annex II B
- **EMC (electromagnetic compatibility)** 89/336/EEC Art 10.2
- **Low Voltage** 72/23/EEC

ASCO valves complying to these directives, through third-party or self-certification, display the CE mark on the nameplate or coil and on the Instruction and Maintenance sheet packaged with each valve. On request, ASCO will issue a Declaration of Incorporation and/or Declaration of Conformity for the valve supplied.

**Agency Approvals — Worldwide**

ASCO’s Quality Assurance Program meets all the requirements of ISO-9001-94. We are also certified to IQ Net, providing customers with the products from 17 ISO-certified facilities around the world. The US, Canada, UK, France, the Netherlands, Germany, and Japan are included.

To meet the standards of good practice, safety controls must be either listed by Underwriters Laboratories, accepted by Industrial Risk Insurers or other nationally recognized testing laboratories (NRTL). The National Fire Protection Association (NFPA) maintains similar requirements and recommendations for safety shutoff and vent valves in oil and gas burner boiler systems.

**Agency Approvals — Worldwide**

**United States of America**

- **AGA** American Gas Association
- **ANSI** American National Standards Institute, Inc.
- **EIA** Electronic Industries Association
- **ETL** Electronic Testing Laboratory
- **FM** Factory Mutual Research Corporation
- **IEEE** Institute of Electrical and Electronics Engineers, Inc.
- **IRI** Industrial Risk Insurers (formerly Factory Insurance Association)
- **JIC** Joint Industrial Council
- **MIL** Military Standards
- **MSHA** Mine Safety and Health Administration
- **NACE** National Association of Corrosion Engineers
- **NAVSEA** Naval Sea Systems Command
- **NEC** National Electric Code
- **NEMA** National Electrical Manufacturers Association
- **NFPA** National Fire Protection Association
- **NFPA** National Fluid Power Association, Inc.
- **NSF** National Sanitation Foundation
- **UL** Underwriters Laboratories, Inc.
- **USCG** United States Coast Guard
European Economic Community
- CE: European Directives
- CEE: International Commission on Rules for the Approval of Electrical Equipment
- CENELEC: European Committee for Electrotechnical Standardization
- IEC: International Electrotechnical Commission
- ISO: International Organization for Standardization

Austria
- TÜV-A: Technischer Überwachungs-Verein Österreich
- BVFA: Bunderversuchs-und Forschungsanstalt Arsenal
- ETI: Elektrotechnisches Institut

Australia
- AGA: Australian Gas Association
- SAA: Standards Association of Australia

Belgium
- CEB: Comité Electrotechnique Belge
- IBN: Institut Belge de Normalisation
- ISSEP: Institut Scientifique de Service Public (anciennement INIEX)
- K.V.B.G.: Koninklijke Vereniging der Belgische Gasvaklieden
- VERGAS: Technische Vereniging van de Gasindustrie in België V.Z.W.D.

Brazil
- INMETRO: Instituto Nacional de Metrologia

Canada
- CGA: Canadian Gas Association
- CSA: Canadian Standards Association
- EEMAC: Electrical and Electronic Manufacturers Association of Canada
- ULC: Underwriters Laboratories of Canada

China
- NEPSI: National Supervision and Inspection Center for Explosion Protection and Safety of Instrumentation

Denmark
- DEMKO: Danmarks Elektriske Materielkontrol

Finland
- SL: Sähkötarkastuslaitos Laboratorija
- VTT: Technical Research Centre of Finland

France
- AFNOR: Association Française de Normalisation
- INERIS: Institut National de l’Environnement Industriel et des Risques (anciennement CERCHAR)

Germany
- BVS: Bergbau-Versuchsstrecke
- DIN: Deutsches Institut für Normung
- DVGW: Deutscher Verein des Gas- und Wasserfaches e.V.
- Germanischer Lloyd
- PTB: Physikalisch · Technische Bundesanstalt
- VDE: Verband Deutscher Elektrotechniker

Italy
- CEI: Comitato Elettrotecnico Italiano

Japan
- JEM: Japan Electrical Manufacturers Association
- JIS: Japanese Industrial Standards
- MIL: Ministry of Labor
- NK: Japan Maritime Association
- RIJS: Research Institute of Industrial Safety, Department of Labor

Korea
- KISCO: Korea Industrial Safety Corp.
- KGSG: Korea Gas Safety Corp.

Luxembourg
- Service de l’énergie de l’état

Northern Ireland
- Industrial Science Centre, Department of Economic Development

Norway
- Det Norske Veritas
- NEMKO: Norges Elektriske Materiellkontroll

Russia
- USSR Register of Shipping

South Africa
- SABS: South African Bureau of Standards

Spain
- CESI: Centro Elettrotecnico Sperimentale Italiano
- LOM: Laboratorio Oficial José María Madariaga

Sweden
- SEMKO: Svenska Elektriska Material Kontrollanstalen
- SP: Swedish National Testing and Research Institute

Switzerland
- ASE: Association Suisse des Electriciens
- SEV: Schweizerischer Electrotechnischer Verein

The Netherlands
- DGA: Direktoraat - Generaal van de Arbeid
- KEMA: Koninglijk Instituut voor het Testen van Elektrische Materialen N.V.
- NEC: Nederlands Elektrotechnisch Comité
- NNI: Nederlands Normalisatie - Instituut
- REGO: Richtlijnen Voor de Samenstelling van Elektrisch Material In Verband Met Gasontploffinggevaar
- VEG: VEG-Gasistituut N.V.
- VGN: Vereeniging van Gasfabrikanten in Nederland

United Kingdom
- BASEEFA: British Approvals Service for Electrical Equipment in Flammable Atmospheres
- BGIC: British Gas Corporation
- BSI: British Standard Institution
- EEC: Electrical Equipment Certification Service (BASEEFA)
- Lloyds Register of Shipping
- MRS: Midlands Research Station
- NWC: National Water Council
- SCS: Sira Certification Service
- SFA: Special Flammable Atmospheres
- WH: Watson House
Flow Data

Importance of Valve Sizing

Improper sizing of a solenoid valve results in below-standard performance and can involve unnecessary cost.

The basic factors in valve sizing include:

- Maximum and minimum flows to be controlled.
- Maximum and minimum pressure differential across the valve.
- Specific gravity, temperature, and viscosity of fluids being controlled.

The Cv method of valve sizing reduces all variables to a common denominator called the Flow Coefficient. After existing or projected conditions have been converted to this coefficient (the Cv), the proper valve size can be found in the catalog pages.

This section provides the complete procedure and reference data for accurate sizing of ASCO solenoid valves in liquid, gas services, and steam. The graphs provide the simplest means of finding the required Cv factor, and are based on the formula:

\[ \text{Cv} = \frac{\text{Flow Required}}{\text{Graph Factor}} \]

The graph factor can be determined by aligning known pressure conditions on the graphs.

Estimating Cv or Orifice Size:

The table below can be used to estimate a Cv if the orifice size is known or, conversely, to relate the approximate orifice size if the Cv is known. The chart is based on the ASCO designs of inline globe type valves.

The flow charts must be used for precise sizing and converting Cv factors to actual flow terms, and the catalog must be consulted for the actual Cv of a particular valve.

<table>
<thead>
<tr>
<th>Approximate Orifice Size (ins.)</th>
<th>Approximate Cv</th>
<th>Approximate Orifice Size (ins.)</th>
<th>Approximate Cv</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/32</td>
<td>.02</td>
<td>1/2</td>
<td>3.5</td>
</tr>
<tr>
<td>3/64</td>
<td>.06</td>
<td>5/8</td>
<td>4.5</td>
</tr>
<tr>
<td>1/16</td>
<td>.09</td>
<td>11/16</td>
<td>5</td>
</tr>
<tr>
<td>3/32</td>
<td>.20</td>
<td>3/4</td>
<td>7.5</td>
</tr>
<tr>
<td>1/8</td>
<td>.30</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>9/64</td>
<td>.36</td>
<td>1 1/4</td>
<td>17</td>
</tr>
<tr>
<td>3/16</td>
<td>.53</td>
<td>1 1/2</td>
<td>25</td>
</tr>
<tr>
<td>1/4</td>
<td>.70</td>
<td>2</td>
<td>48</td>
</tr>
<tr>
<td>5/16</td>
<td>1.7</td>
<td>2 1/2</td>
<td>60</td>
</tr>
<tr>
<td>3/8</td>
<td>2</td>
<td>3</td>
<td>100</td>
</tr>
</tbody>
</table>

Link to Valve Sizing
Sample Problems

Liquids:
To find \( C_v \): What \( C_v \) is required to pass 20 GPM of oil, with a specific gravity of 0.9 and a pressure drop of 25 psi? The viscosity is less than 300 SSUs.

Solution: Formula is:

\[
C_v = \frac{\text{GPM}}{F_g \times F_{sg}}
\]

To find \( F_g \) (Graph Factor), use Liquid Flow Graph on page 11.16. The \( F_g \) factor is that corresponding to 25 psi pressure drop and equals 5. The \( F_{sg} \) factor (Specific Gravity Factor) can be obtained from the \( F_{sg} \) Chart, and is that corresponding to .9 specific gravity and equals 1.05.

Therefore:

\[
C_v = \frac{20}{5 \times 1.05} = 3.81
\]

Air and Gases:
To find \( C_v \): A valve is required to pass 500 SCFH at an inlet pressure of 60 psig and a \( \Delta p \) of 10 psi. Find \( C_v \) if the fluid is carbon dioxide at room temperature.

Solution: Refer to 10-100 psig graph on page 11.17. The formula to be used is:

\[
C_v = \frac{\text{SCFH}}{F_g \times F_{sg} \times F_t}
\]

Locate \( F_g \) at the intersection of 60 psig inlet pressure and 10 psi \( \Delta p \) (curved lines). Read down to \( F_g \). \( F_g = 1560 \).

Locate \( F_{sg} \) corresponding to specific gravity of carbon dioxide (S.G.=1.5). \( F_{sg} = 0.81 \). (Refer to next page.) Since the gas is at room temperature, the \( F_t \) factor can be ignored.

Insert values into formula:

\[
C_v = \frac{25}{1560 \times 0.81} = 0.015
\]

Steam:
To find \( C_v \): A valve is required to pass 25 lb/hr of saturated steam at an inlet pressure of 7 psig and a \( \Delta p \) of 3 psi. What is the \( C_v \)?

Solution: Refer to the Steam Graph on page 11.18. Use formula:

\[
C_v = \frac{\text{lb} / \text{hr}}{F_g}
\]

Locate \( F_g \) on graph corresponding to 7 psig inlet pressure and 3 psi \( \Delta p \) (curved lines). \( F_g = 23.5 \).

Insert values into formula:

\[
C_v = \frac{25}{23.5} = 1.06
\]

For further information, consult your local ASCO sales office.

Notes:
① Liquid formulas and flow graphs are based on US gallons.
② If viscosity is less than 300 SSU, correction factors are not necessary.
③ \( \Delta p \) stands for pressure drop.
Liquid Flow Graph

For others Fsg = \( \frac{1}{\sqrt{SG}} \)

Specific Gravity @ 14.7 PSIA and 60°F.

\[ Ft = \sqrt{\frac{530}{460^\circ + ^\circ F}} \]

The correction for temperature in the range of 20°F to 150°F is very small and, therefore, can be ignored in ordinary applications.
Air and Gas Flow Graphs

Pressure Range, 1-10 Psig

Pressure Drop Across Valve (psi)

Valve Inlet Pressure (Psig)

Graph Factor (Fg)

Pressure Range, 10-100 Psig

Pressure Drop Across Valve (psi)

Valve Inlet Pressure (Psig)

Graph Factor (Fg)

Pressure Range, 100-1500 Psig

Pressure Drop Across Valve (psi)

Valve Inlet Pressure (Psig)

Graph Factor (Fg)

Note: Charts above are useful in temperature range of 20°F to 150°F. Refer to Ft chart on previous page.
Steam Flow Graphs

Pressure Range, 1-15 Psig

Pressure Drop Across Valve (psig)

Valve Inlet Pressure (Psig)

Graph Factor (Fg)

Pressure Range, 10-100 Psig

Pressure Drop Across Valve (psig)

Valve Inlet Pressure (Psig)

Graph Factor (Fg)

Pressure Range, 100-500 Psig

Pressure Drop Across Valve (psig)

Valve Inlet Pressure (Psig)

Graph Factor (Fg)

Equations:
1. $Cv = \frac{LB/HR}{Fg}$
2. $LB/HR = Cv \times Fg$
3. $Fg = \frac{LB/HR}{Cv}$
Material Selection Guide for Commonly Used Fluids

All orders entered using this guide must state actual fluid, fluid pressure, fluid concentration, and fluid temperature of the application. Actual fluid is extremely important when elastomer options are specified because other substitutions may be required.

ASCO valves are available to control many acids, alcohols, bases, solvents, and corrosive gases and liquids. Modified or special designs are sometimes required, depending upon the application.

Corrosion occurs either as a chemical or electrochemical reaction. Therefore, consideration must be given to both the galvanic and electromotive force series, as well as to pressure, temperature, and other factors that might be involved in the application.

General Information on Elastomer Materials Frequently Used in ASCO Valves

NBR (Buna 'N', Nitrile)
NBR is commonly referred to as a nitrile rubber and is the standard synthetic elastomer for accomplishing resilient-type seating or sealing in ASCO valves. It has excellent compatibility for most air, water, and light oil applications. It has a useful temperature range of 0°F to 180°F (-18°C to 82°C)

CR (Neoprene)
CR is principally used as an external seal in refrigeration applications. It is also utilized for oxygen service. It has a useful temperature range of 0°F to 180°F (-18°C to 82°C)

EPDM (Ethylene Propylene)
EPDM is selected for applications above the NBR temperature range, such as handling hot water and steam. Ethylene propylene has an extremely wide range of fluid compatibility, but has the distinct disadvantage that it cannot be used with petroleum-based fluids or contaminated fluids (such as lubricated air). It has a useful temperature range of -10°F to 300°F (-23°C to 149°C).

FKM (Viton*/Fluorel**, etc.)
FKM is a fluorocarbon elastomer primarily developed for handling such hydrocarbons as jet fuels, gasolines, solvents, etc., which normally cause detrimental swelling to NBR. FKM has a high temperature range similar to EPDM, but with the advantage of being somewhat more resistant to “dry heat.” FKM has a wide range of chemical compatibility. It has a useful temperature range of 0°F to 350°F (-18°C to 177°C).

PTFE (Teflon*, Rulon)
PTFE and PTFE with fillers are considered more a plastic than a resilient-type material. They are virtually unattacked by any fluid. Their temperature usage has ranged from discs for cryogenic valves to discs for steam valves. They are not easily fabricated and are known to have “cold flow” characteristics which may contribute to objectionable leakage, particularly on gases.

Other materials referred to in this catalog
CA (Acetal, Celcon, Delrin)
FFKM (Methyl tertiary-butyl)
FMQ (Fluorosilicone)
HYT (Hytrek)
MTBE (Methyl tertiary-butyl ether)
PA (Nylon, Zytel)
PA+FV (Polyamide)
PE (Polyethylene)
PP (Polypropylene)
PPS (Polyphenylene Sulphide, Ryton)
PUR (Polyurethane)
UR (Urethane)
VMQ (Silicone)

* DuPont Co. trademark
** 3m trademark
<table>
<thead>
<tr>
<th>Fluids</th>
<th>Qualifying Service Information</th>
<th>Materials of Construction and Ordering Information (Refer to List Price Schedule for availability and prices of Special Features)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic Acid</td>
<td>Standard strengths of water solution are: 28, 56, 70, 80, 85, 98%.</td>
<td>For solutions of 40% or less, use stainless steel Type 316 Normally Closed valve with EPDM elastomers. Add suffix “E” to catalog number.</td>
</tr>
<tr>
<td>Acetic Acid, Glacial</td>
<td>99.9% solid.</td>
<td>Use appropriate ball valve with ASCO 3 or 4 way auxiliary air pilot valve.</td>
</tr>
<tr>
<td>Acetone</td>
<td>Colorless, flammable liquid with mint-like odor. Soluble in water and ether.</td>
<td>Standard catalog valves with EPDM elastomers. Add suffix “E” to catalog number. PTFE or metal seated valves also used.</td>
</tr>
<tr>
<td>Acetylene</td>
<td>A colorless, highly flammable gas used for welding and flame cutting of metals, and for producing other chemicals. If moisture is present, copper, silver, and alloys containing more than 66% copper are not suitable.</td>
<td>Standard catalog aluminum, brass, or stainless steel valves. Specify aluminum shading coil. Do not use bar stock brass valves.</td>
</tr>
<tr>
<td>Air, Lubricated (Shop Air)</td>
<td>Most sources of air carry lubrication from pumps and other equipment. Others are directly lubricated in lines.</td>
<td>Standard resilient seated catalog valves. For synthetic diester lubricating oils, FKM seals may be required. Consult local ASCO office.</td>
</tr>
<tr>
<td>Air (or Gas), Dry, Un lubricated</td>
<td>Used in instrument air applications and telephone lines where moisture and oil cannot be tolerated.</td>
<td>Special constructions required. Refer to Long-Life Solenoid Valve Constructions.</td>
</tr>
<tr>
<td>Alcohol, Ethyl (Denatured Alcohol)</td>
<td>A grain alcohol commonly used as solvent. Also used as a radiator antifreeze and rocket fuel.</td>
<td>Standard resilient seated catalog valves.</td>
</tr>
<tr>
<td>Alcohol, Methyl (Methanol)</td>
<td>A flammable wood alcohol used in automotive antifreeze, general solvent, aviation, and rocket fuel.</td>
<td>Standard catalog constructions; however, where high purity of liquid is essential, use Stainless Steel designs.</td>
</tr>
<tr>
<td>Ammonia (Anhydrous or Dissociated)</td>
<td>Used in refrigeration. Other uses include: for cleaning and bleaching, for etching aluminum, and in chemical processing. Presence of slight trace of water moisture can be harmful to brass.</td>
<td>Stainless Steel construction with aluminum shading coil and CR elastomers are required. Specify aluminum shading coil. Add prefix “X” and suffix “J” to catalog number.</td>
</tr>
<tr>
<td>Argon</td>
<td>The valves must be free of contaminants when filling incandescent lamps, lumininescent tubes, gas thermometers, etc. Also used as an inert shielding gas in welding equipment.</td>
<td>Standard catalog aluminum and brass valves used in connection with welding equipment. Most other applications require stainless steel valves, especially cleaned to avoid contamination. Specify AP-1-005.</td>
</tr>
<tr>
<td>Benzene, (Benzol)</td>
<td>Solvent used for waxes, resins, rubber, and other organic materials. Also employed as a fuel or for blending with gasoline or other fuels.</td>
<td>Standard catalog valves with FKM, or PTFE disc and gasket.</td>
</tr>
<tr>
<td>Butane</td>
<td>One of the principal LP gases. Used as fuel for household and other industrial purposes. Also a refrigerant and a propellant in aerosol cans.</td>
<td>Special construction required. Refer to Combustion Section.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<th>Materials of Construction and Ordering Information (Refer to List Price Schedule for availability and prices of Special Features)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Dioxide (Gas or Liquid) (CD)</td>
<td>Also known as carbonic anhydride. Used in industrial refrigeration and refrigeration of foods and carbonated beverages. Also, as a fire extinguisher and inert atmosphere in welding equipment.</td>
<td>For gas pressures below 100 psi, use standard valves with NBR discs. Above 100 psi, use Series 8264, especially designed for this service.</td>
</tr>
<tr>
<td>Carbon Tetrachloride (“Carbona”)</td>
<td>Also known as tetrachloromethane. Mainly used as a metal degrading agent. Also used in fire extinguishers. It is a general solvent and dry-cleaning medium. Its fumes are highly toxic and should be handled in well-ventilated areas.</td>
<td>Standard catalog brass valves with PTFE or FKM discs. Add suffix “T” or “V” to catalog number. Diaphragm valves must be equipped with FKM parts. Add suffix “V” to catalog number. Metal seated valves also used.</td>
</tr>
<tr>
<td>Caustic Soda</td>
<td>See “Sodium Hydroxide.”</td>
<td>Standard catalog designs with EPDM elastomers. Add suffix “E” to catalog number. PTFE or metal seated valves also used.</td>
</tr>
<tr>
<td>Cellulube</td>
<td>One of the phosphate ester lubricating fluids which are fire resistant.</td>
<td>Use appropriate ball valve with ASCO 3 or 4 way auxiliary air pilot valve.</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Chlorine has a powerful suffocating odor and is strongly corrosive to organic tissues and to metals. Uses include: for bleaching textiles and paper pulp, but it is also used for the manufacture of many chemicals.</td>
<td>Use appropriate ball valve with ASCO 3 or 4 way auxiliary air pilot valve.</td>
</tr>
<tr>
<td>City Gas</td>
<td>See “Natural” and “Manufactured Gas.”</td>
<td>Stainless steel or plastic valves. For FDA approved elastomers, consult your local ASCO office.</td>
</tr>
<tr>
<td>Coffee</td>
<td>Automatic or semiautomatic dispensing equipment.</td>
<td>Stainless steel or plastic valves. For FDA approved elastomers, consult your local ASCO office.</td>
</tr>
<tr>
<td>Coke Oven Gas (Bench Gas; Coal Gas)</td>
<td>Flammable gas used in domestic and industrial heating</td>
<td>Standard steel or stainless steel valves with FKM elastomers.</td>
</tr>
<tr>
<td>Coolant Oil</td>
<td>Oil used in automatic screw machines and related equipment as cutting oils or coolants. Usually contain suspended solids.</td>
<td>Consult your local ASCO office.</td>
</tr>
<tr>
<td>Diesel Fuel</td>
<td>Petroleum oil used as fuel for diesel engines.</td>
<td>Standard resilient seated catalog valves with FKM seating.</td>
</tr>
<tr>
<td>Ethylene Glycol (Ethylene Alchohol) “Prestone”</td>
<td>Also known as glycol. Used in permanent antifreeze solutions, brake fluids, and as a dye solvent.</td>
<td>Standard resilient seated catalog valves.</td>
</tr>
<tr>
<td>“Freon® Solvents “DF,” “TF,” and “BF”</td>
<td>Trademark for a solvent which is commonly used in ultrasonic degreasers for removing oil, common grease, and dirt on metal or plastic parts.</td>
<td>Standard catalog items with metal-to-metal seating, or NBR elastomers only.</td>
</tr>
<tr>
<td>Fluids</td>
<td>Qualifying Service Information</td>
<td>Materials of Construction and Ordering Information (Refer to List Price Schedule for availability and prices of Special Features)</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Fuel Oil (Light) Nos. 1, 2, 3</td>
<td>“Distillate” petroleum oil used in combustion applications without preheating.</td>
<td>Refer to Combustion Section.</td>
</tr>
<tr>
<td>Fuel Oil (Heavy) Nos. 4, 5, 6</td>
<td>Heavy “Bunker” fuel oil. Usually preheated to 135°F or more for combustion.</td>
<td>Refer to Combustion Section.</td>
</tr>
<tr>
<td>Gasoline</td>
<td>Special or high-test gasolines have additives or aromatics that affect synthetic rubber by excessive swell, or extraction of plasticizers.</td>
<td>Standard catalog valve constructions with FKM elastomers. Add suffix “V” to catalog number. If MTBE additive is present in gasoline, then use FFKM elastomers. Metal seated valves also used.</td>
</tr>
<tr>
<td>Helium</td>
<td>An inert gas used in heat treating, purging, and welding.</td>
<td>Standard resilient seated catalog valves.</td>
</tr>
<tr>
<td>Hydraulic Oil</td>
<td>Petroleum base only — viscosity usually 50 SSU or 300 SSU. For fire-resistant hydraulic oils, see “Cellulube,” “Pydraul,” and “Skydrol.”</td>
<td>Standard resilient seated catalog valves.</td>
</tr>
<tr>
<td>Hydrochloric Acid</td>
<td>Also known as muriatic acid. Corrosive chemical.</td>
<td>Use an appropriate ball valve with ASCO 3 or 4 way auxiliary air pilot valve. For low pressure, small flow, and a maximum concentration of 20%, refer to Shielded Core valves.</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>A highly flammable gas when exposed to air.</td>
<td>Standard resilient seated catalog valves with soft seats.</td>
</tr>
<tr>
<td>Jet Fuels (J1 through B). For others, consult your local ASCO office.</td>
<td>These fuels are used in jet engines and are petroleum products, similar to kerosene. Some jet fuels contain substantial quantities of aromatics which affect most synthetic rubbers.</td>
<td>Standard catalog valves with FKM elastomers. Add suffix “V” to catalog number. Metal seated valves also used.</td>
</tr>
<tr>
<td>Kerosene</td>
<td>Generally used as a solvent for cleaning purposes and as a heating fuel.</td>
<td>Standard catalog valve with FKM elastomers. Add suffix “V” to catalog number.</td>
</tr>
<tr>
<td>LP Gas</td>
<td>See “Propane.”</td>
<td>Refer to Combustion Section.</td>
</tr>
<tr>
<td>Liquid Natural Gas, Nitrogen, and Oxygen</td>
<td>Used in lacquers, paint removers, cements and adhesives. It is a flammable liquid.</td>
<td>Refer to Cryogenic Valves.</td>
</tr>
<tr>
<td>Manufactured Gas</td>
<td>Refine coke oven gas used in city applications.</td>
<td>Refer to Combustion Section.</td>
</tr>
<tr>
<td>Mercury</td>
<td>Uses: mercury cells and other electrical apparatus; mercury vapor boilers, lamps, barometers, thermometers, etc.</td>
<td>Use stainless steel body. Valve must be mounted upside down. Special construction required. Consult your local ASCO office with application details.</td>
</tr>
<tr>
<td>Methyl Ethyl Ketone (MEK)</td>
<td>Used in lacquers, paint removers, cements and adhesives. It is a flammable liquid.</td>
<td>Standard catalog valves with EPDM elastomers. Add suffix “E” to catalog number. PTFE or metal seated valves also used.</td>
</tr>
<tr>
<td>Naphtha</td>
<td>A coal-tar solvent.</td>
<td>Use NBR or FKM elastomers. For FKX elastomer, add suffix “V” to catalog number.</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>Common heating fuel.</td>
<td>Refer to Combustion Section.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fluids</th>
<th>Qualifying Service Information</th>
<th>Materials of Construction and Ordering Information (Refer to List Price Schedule for availability and prices of Special Features)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitric Acid (aquafortis or azotic acid)</td>
<td>Normally, concentrations are 60% nitric and 40% water.</td>
<td>Stainless steel valves with aluminum shading coil and PTFE disc. Add suffix “T” to catalog number. Metal seated valves also used.</td>
</tr>
<tr>
<td>Nitric Acid-Red Fuming</td>
<td>Red fuming is more than 86% nitric acid. These can be handled with all stainless steel valves.</td>
<td>For white fuming acid, use appropriate ball valve with ASCO pilot.</td>
</tr>
<tr>
<td>Nitric Acid-White Fuming</td>
<td>White fuming, which is pure to 97.5% acid, and nitric acid vapors are very difficult to handle.</td>
<td>For white fuming acid, use appropriate ball valve with ASCO pilot.</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>An inert gas used in heat treating, purging, and welding.</td>
<td>Standard resilient seated catalog valves.</td>
</tr>
<tr>
<td>Oils, Lubricating or Motor</td>
<td>Common motor oils known as SAE oils and synthetic lube oils, etc.</td>
<td>Standard catalog valves for 300 SSU maximum. For higher SSU, consult your local ASCO office. For compressor service involving refrigerants, consult your local ASCO office for elastomer selection.</td>
</tr>
<tr>
<td>Oxygen, Gas</td>
<td>Used in conjunction with various fuels in furnaces, ovens, cutting torches, welding, and heat treating. A nonflammable gas. Contact with hydrocarbons will result in spontaneous combustion.</td>
<td>Metal body valves with FKM or CR elastomers, specially cleaned to avoid contamination with hydrocarbons. Add suffix “N” to catalog number.</td>
</tr>
<tr>
<td>Perchlorethylene (Tetrachloroethylene) “Perk”</td>
<td>Used as a dry-cleaning solvent and in vapor degreasing equipment.</td>
<td>Standard catalog items with ASCO 3 or 4 way auxiliary air pilot valve. For low pressure, small flow, and a maximum concentration of 20%, refer to Shielded Core valves.</td>
</tr>
<tr>
<td>Phosphoric Acid</td>
<td>Also known as orthophosphoric acid. Used in pickling and rust-proofing metals, soft drinks and flavoring syrups, as well as pharmaceuticals.</td>
<td>For concentration of up to 20% and temperatures of 100°F, use 300 series stainless steel with ethylene propylene, FKM, or NBR elastomers.</td>
</tr>
<tr>
<td>Photographic Solvents</td>
<td>Also known as sodium thiosulfate or hypo. Most metals corrode sufficiently to cause solution contamination.</td>
<td>For low pressure, small flow, and low concentrations (20% max.), refer to Shielded Core Valves.</td>
</tr>
<tr>
<td>Potassium Sulfate</td>
<td>Used in fertilizers. Also in aluminum and glass manufacturing.</td>
<td>Standard stainless steel catalog valves.</td>
</tr>
<tr>
<td>Propane Gas</td>
<td>One of the principal LP gases commonly used in grain dryer applications, and a bottled gas for heating and cooking.</td>
<td>Special construction required. Refer to Combustion Section.</td>
</tr>
<tr>
<td>Refrigerants, CFC (chlorofluorocarbon) “Freon”</td>
<td>CFCs are used as refrigerants; as blowing agents in the manufacture of insulation, packaging, and cushioning foams; as cleaning agents for metal and electronic components; and in many other applications. CFCs contain chlorine and have been targeted by the EPA to be phased out.</td>
<td>Refrigerants require special selection of elastomers. Consult your local ASCO office.</td>
</tr>
</tbody>
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<td>“Skydrol”</td>
<td>Trademark for fire-resistant jet aircraft hydraulic fluid.</td>
<td>Standard catalog items with EPDM elastomer. Add suffix “E” to catalog number. PTFE or metal seated valves also used.</td>
<td>Standard catalog items with EPDM elastomer. Add suffix “E” to catalog number. PTFE or metal seated valves also used.</td>
</tr>
<tr>
<td>Sodium Hydroxide (Caustic Soda)</td>
<td>Used in pulp and paper industry. Included in detergents and soap also in textile processing. Solutions range between 50% and 73% commercial.</td>
<td>Stainless steel valves with EPDM elastomers. Add suffix “E” to catalog number. Stainless steel or PTFE seated valves also used.</td>
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</tr>
<tr>
<td>Sour Gas</td>
<td>See “Coke Oven Gas.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steam Condensate</td>
<td>This is return condensate from steam boilers, which has various degrees of dissolved carbon dioxide or oxygen. Temperature is normally high to boiling point.</td>
<td>Brass valves suitable with EPDM elastomers. See Series 8210 and 8222 Hot Water Service Listings. Use suffix “E” on all others.</td>
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</tr>
<tr>
<td>Stoddard Solvent</td>
<td>This is a dry-cleaning solvent of usually high-purity naphtha, clear and free of undissolved water. A coal-tar solvent.</td>
<td>Standard catalog items.</td>
<td>Standard catalog items.</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>An oily, highly corrosive liquid oxidizing organic materials and most metals. It is used for pickling and cleaning metals in electric batteries and in plating baths, for making explosives and fertilizers.</td>
<td>Use an appropriate ball valves with FKM elastomers. See Series 8210 or 4 way auxiliary air pilot valve. For low pressure, small flow, and a concentration of up to 60%, refer to Shielded Core Valves.</td>
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<td>Toluene (Toluol)</td>
<td>Also called methyl benzene or methyl benzo. One of the coal-tar solvents. Used in aviation and high octane gasolines. Also a solvent for paints, coatings, resins, etc. It is a flammable liquid.</td>
<td>Standard catalog valves with FKM disc and gasket. Add suffix “V” to catalog number.</td>
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</tr>
<tr>
<td>Trichloroethylene (“Carbona” or “TRIAD”)</td>
<td>Common degreasing solvent, noncombustible, but very toxic. Adequate ventilation required.</td>
<td>Standard brass catalog valves, if dry, use FKM elastomers (add suffix “V” to catalog number). If moisture is present, use stainless steel. Metal and PTFE seated valves also used.</td>
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</tr>
<tr>
<td>Turpentine</td>
<td>Solvent or thinner for paints, varnishes, and lacquers. Also, a rubber solvent and reclaiming agent. The liquid is volatile.</td>
<td>Standard catalog valves with FKM elastomers. Add suffix “V” to catalog number.</td>
<td>Standard catalog valves with FKM elastomers. Add suffix “V” to catalog number.</td>
</tr>
<tr>
<td>Vacuum</td>
<td></td>
<td>Refer to Vacuum Valves.</td>
<td>Refer to Vacuum Valves.</td>
</tr>
<tr>
<td>Vegetable Oils</td>
<td>Edible oils extracted from seeds, fruits, or plants, such as peanut oils, cottonseed oils, etc.</td>
<td>Standard resilient seated catalog valves. For FDA approved elastomers, consult your local ASCO office.</td>
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</tr>
<tr>
<td>Vinegar</td>
<td>A diluted impure solution of acetic acid.</td>
<td>Stainless steel valves with EPDM elastomers (FKM elastomers may also be used). Add suffix “E” to catalog number. For FDA approved elastomers, consult your local ASCO office.</td>
<td>Stainless steel valves with EPDM elastomers (FKM elastomers may also be used). Add suffix “E” to catalog number. For FDA approved elastomers, consult your local ASCO office.</td>
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