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# What Plumbing Designers Need to Know About Valves, Part 2

Part 1 of this series in the March/April 2007 issue covered the functions of the basic manually operated valves—gate, globe, angle, ball, butterfly, and check—which are used to start and stop the flow in a system, regulate flow, and prevent backflow. Part 2 will cover valve materials, components, connections, working pressures, and where to use what type of valve.

Manufacturers must follow codes and standards when constructing valves. They are as follows:

- ASTM A 126: *Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings* for any valve constructed of iron
- AWWA C500: *Metal-Seated Gate Valves for Water Supply Service* for gate valves for water and sewage systems
- AWWA C504: *Rubber-Sealed Butterfly Valves* for rubber-seated ball valves
- MSS SP-67: *Butterfly Valves* for butterfly valves
- MSS SP-80: *Bronze Gate, Globe, Angle, and Check Valves* for bronze gate, globe, angle, and check valves

## VALVE MATERIALS

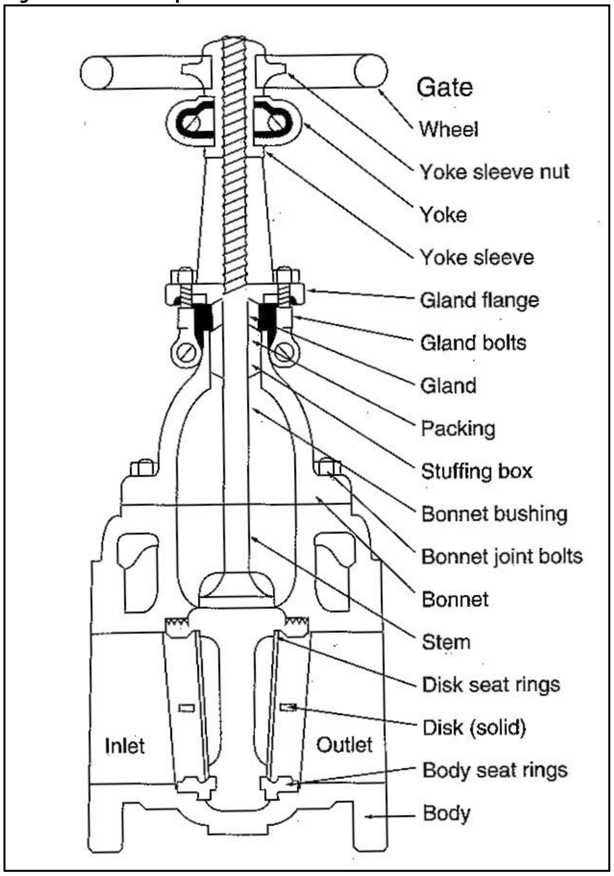
A valve may be constructed of several types of materials, both metallic and nonmetallic. Metallic materials include brass, bronze, cast iron, malleable iron, ductile iron, steel, and stainless steel, and nonmetallic materials are typically thermoplastics.

Bronze and brass valves usually are limited to sizes 2 inches and smaller and are used for water services. Brass valves should not be used for operating temperatures above 450°F (232.2°C), and bronze valves should be limited to uses below 550°F (287.8°C). Cast iron valves commonly are used for water and steam up to 450°F (232.2°C). A higher tensile strength iron can be used in larger sizes. Malleable iron valves are stronger, stiffer, and more durable than cast iron body valves and hold much tighter pressure. This material can withstand tough stresses and shocks. Valves made of ductile iron have a higher tensile strength and good corrosion resistance. Steel valves are recommended for temperatures as high as 450°F (232.2°C) because of the wide variety of alloys in steel. They also are used in high-pressure applications and conditions that may be too severe for iron or bronze bodies. Stainless steel valves are available in a wide variety of alloys and often are used for pure water and other services requiring noncorrosive materials. Seating surfaces, stems, and discs constructed of stainless steel are suitable where foreign materials in the fluids handled could have adverse effects.

Valves constructed of thermoplastics are used widely to carry corrosive fluids where conventional valves are not suitable or other alloy metals are very expensive. It is suggested that thermoplastic valves can be used in 85–90 percent of all utility services.

Many different types of thermoplastic materials are used in the construction of valves, and all standard valve types are available. Generally, plastic valves are limited to a maximum temperature of 250°F (121.1°C) and a maximum pressure of 150 pounds per square inch gauge (1,035 kilopascals). Available valve types and their sizes are given in Table 1.

**Figure 1 Valve components**




Source: *Facility Piping Systems Handbook*

**Table 1 Thermoplastic materials and valve types**

| Valve Design | Materials | Size Range, in. |
|---|---|---|
| Ball, union design | PVC,CPVC,PP,PVDF | ¼–4 |
| Ball, compact design | PVC,CPVC | ½–3 |
| Ball, multiport | PVC,CPVC,PP,PVDF | ½–3 |
| Diaphragm | PVC,CPVC,PP,PVDF | ½–10 |
| Butterfly | PVC,CPVC,PP,PVDF | 1½–24 |
| Globe | PVC,CPVC,PP | ½–4 |
| Gate | PVC | 1½–14 |
| Ball check | PVC,CPVC,PP,PVDF | 1–4 |
| Swing check | PVC,PP,PVDF | ¾–8 |
| Labcock | PVC | ¼ |
| Foot | PVC,CPVC,PP,PVDF | ½–4 |
| Pressure relief | PVC,CPVC,PP | ½–4 |
| Solenoid | PVC,CPVC,PP | ½–1 |

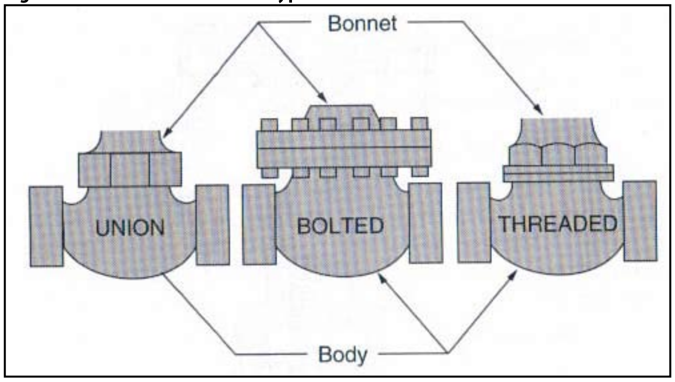
Source: *Facility Piping Systems Handbook*

## VALVE RATINGS

Manufactures rate their valves in terms of saturated steam pressure or pressure of non-shock cold water, oil, or gas (WOG), or both. The rating appears on the body of the valve. A valve with the markings "125" and "200 WOG" will operate safely at a saturated steam pressure of 125 psi (861.3 kPa) or 200 psi (1,378 kPa) cold water, oil, or gas.

The plumbing designer should become familiar with these markings on valves and keep them in mind during a construction inspection. If a valve ruptures, it can cause serious damage and/or injury.

Figure 3 Bonnet construction types




Source: *Facility Piping Systems Handbook*

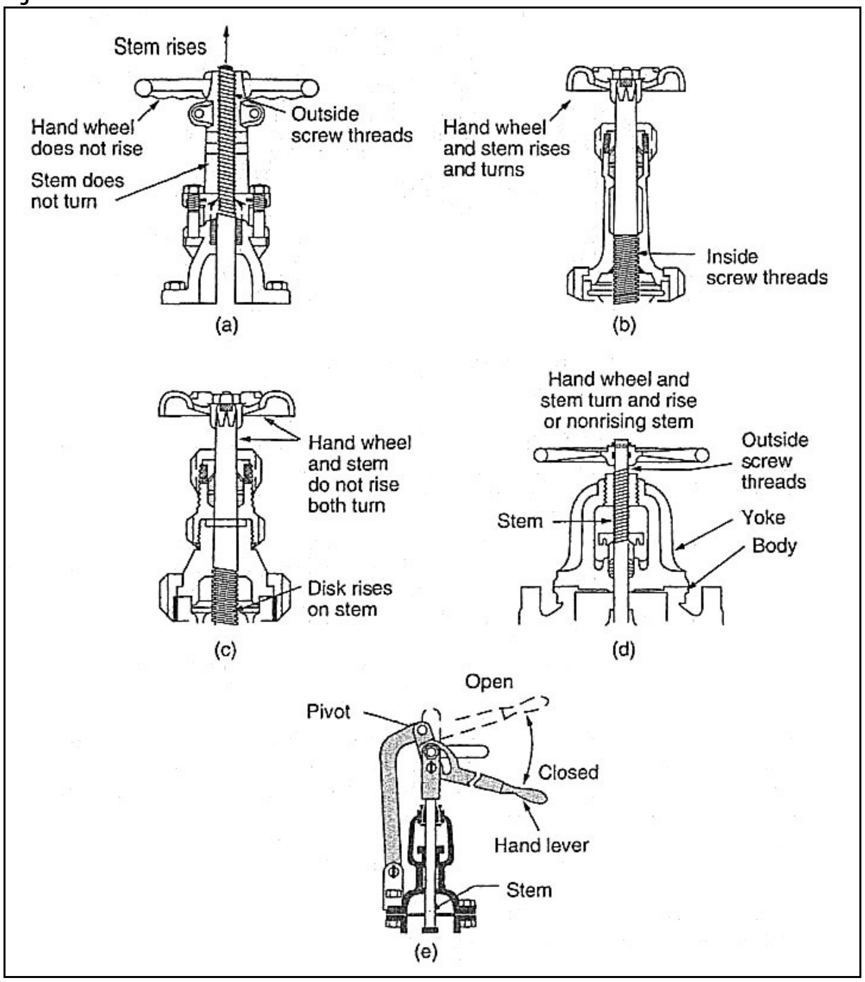
## VALVE COMPONENTS

Figure 1 identifies every component of a valve. The stem and bonnet are two very important components to the valve because they are the only moving parts. The stem design is manufactured in four basic categories: rising stem with outside screw and yoke, rising stem with inside screw, non-rising stem with inside screw, and sliding stem.

**Stem Construction.** The rising stem with outside screw (Figure 2a) and the rising stem with outside screw and yoke (Figure 2d) keep stem threads outside of the valve, away from possible corrosives, high temperatures, and solids in the line that might damage the stem threads. The rising stem with outside screw is ideal where the possibility of sticking is a hazard, such as in fire protection systems. When the hand wheel (which is non-rising) is turned, the stem rises as the yoke bushing engages the stem threads. The threads are easy to lubricate; however, care must be taken to not damage the exposed stem threads. When using a rising stem valve, the plumbing designer should make sure that sufficient clearance is available to allow a full opening of the valve.

The rising stem with inside screw (Figure 2b) is the most common stem design in bronze gate valves. When this valve is opened, both the hand wheel and stem rise, so the plumbing designer must take caution to ensure enough clearance for this valve to be fully opened.

Figure 2 Stem constructions




Source: *Facility Piping Systems Handbook*

A non-rising stem with inside screw (Figure 2c) is the valve to use when a requirement for minimum headroom for operation exists. With this type of valve, the stem does not rise, thus reducing packing wear. Because the threads are inside the valve, heat, corrosion, erosion, and solids can damage the stem threads and cause excessive wear. Also, because the stem does not rise when the hand wheel is turned, it is difficult to determine the disk position.

With the sliding stem (Figure 2e), the operation of the stem is linear, straight up and down. There is a lever instead of a hand wheel, and no threads are on the stem. The sliding stem is available on gate and globe valves and is useful where quick closing or opening of a valve is desired.

**Bonnet Construction.** When choosing a valve, the bonnet should not be overlooked. The bonnet provides a leak-proof closure for the body of the valve. The basic types of bonnet construction include screwed union ring, screwed-in, bolted, and welded designs (see Figure 3). The screwed union ring bonnet is used where valves require frequent inspection or cleaning. While ideal for smaller valves, the screwed union ring bonnet is not practical for large-size valves. The screwed-in bonnet is the simplest and least expensive and usually is used on bronze gate, globe, and angle valves. It also is recommended where frequent dismantling is not required. The bolted bonnet joint is practical and commonly used for large-size valves and for high-pressure applications. If the plumbing designer requires a leak-free body-to-bonnet joint, he should specify a welded construction. The disadvantage of the welded bonnet is that access to the trim parts is not available if repairs are needed.

## END CONNECTIONS

Valves come with several different end connections. They are screwed, welded, brazed, soldered, flared, and flanged ends.

Screwed end connections are by far the most widely used. This type of connection is found in brass, iron, steel, and alloy piping materials. It is suitable for all pressures but usually is confined to small pipe sizes.

The welded-end connection is available only in steel valves and is used mainly for high-pressure and high-temperature services. The plumbing designer should specify welded-end connections only on systems that do not require frequent dismantling. There are two types of welded-end materials: butt and socket welding. Butt-welding valves and fittings come in all sizes; socket-welding ends usually are limited to sizes 2 inches and smaller.

Brazed-end connections are available on brass materials. The ends of such materials are designed for use with brazing alloys to make the joint. While brazing is similar to solder joints, a brazed joint can withstand higher temperatures.

Soldered joints are used with copper tubing for plumbing and heating lines. The joint is soldered by applying heat. The solder flows into the joint between the tubing and the socket of the fitting or valve by capillary action. Solder has a low melting point; thus, solder joints have limited use in high-temperature applications.

The flared end is commonly used on valves and fittings for metal and plastic tubing up to 2 inches (50.8 millimeters) in diameter. The end of the tubing is flared, and a ring nut is used to make a union-type joint.

Flanged-end connections generally are used where screwed-end connections are impractical because of cost, size, and strength of joint. Large-diameter piping usually requires a flanged-end connection. Flanged ends also make assembly and dismantling easier. When using flanged ends, it is important to match the facings. When bolting iron valves to forged steel flanges, the facing should be of the flat-face design on both surfaces.

See Table 2 for a general list of valves by service type, and the sidebar for a breakdown of valve working pressure ratings by service. Valves are very important to a plumbing system, and care should be taken when selecting the right valve for the application. Always verify the valve's working pressure to ensure it can handle the system pressure and material; make sure that the fluid being carried through the system will not corrode the valve; and ensure that the valve material won't have an effect on the fluid. PSD

## RESOURCES


*American Society of Plumbing Engineers Data Book, Volume 4: Plumbing Components and Equipment,* Chapter 3, "Valves."

Michael Frankel. *Facility Piping Systems Handbook.* American Society of Plumbing Engineers.


**Table 2 Valve selection by service type**

| Service | Gate Valve | Ball Valve | Globe Valve | Butterfly Valve | Check Valve |
|---|---|---|---|---|---|
| Hot and cold water | • | • | • | • | • |
| Compressed air | | • | | • | • |
| Vacuum | | • | | • | |
| Medical gas | | • | | | |
| Low-pressure steam | • | • | • | | • |
| Medium-pressure steam | • | | • | • | • |
| High-pressure steam | • | | • | | • |
| Fire protection | • | | | | |

## WORKING PRESSURE RATINGS BY SERVICE

### Hot and Cold Water Service

**Gate Valves:**

- 2 in. and smaller: Class 125, rated 125 psi SWP (steam working pressure), 200 psi non-shock CWP (cold working pressure)
- 2½ in. and larger: Class 125, rated 100 psi SWP, 150 psi non-shock CWP

**Ball Valves:**

- 2 in. and smaller: Rated 150 psi SWP, 600 psi non-shock CWP

**Globe Valves:**

- 2 in. and smaller: Class 125, rated 125 psi SWP, 200 psi non-shock CWP
- 2½ in. and larger: Class 125, rated 125 psi SWP, 200 psi non-shock CWP

**Butterfly Valves:**

- 2½ in. and larger: Rated 200 psi non-shock CWP

**Check Valves:**

- 2 in. and smaller: Class 125, rated 125 psi SWP, 200 psi non-shock CWP
- 2½ in. and larger: Class 125, rated 125 psi SWP, 200 psi non-shock CWP

### Compressed-Air Service

**Ball Valves:**

- 2 in. and smaller: Mainline valves shall be rated 150 psi SWP, 600 psi non-shock CWP

**Butterfly Valves:**

- 2½ in. and larger: Rated 200 psi non-shock CWP

**Check Valves:**

- 2 in. and smaller: Class 125, rated 125 psi SWP, 200 psi non-shock CWP
- 2½ in. and larger: Class 125, rated 200 psi non-shock CWP

### Vacuum Service

**Ball Valves:**

- 2 in. and smaller: Rated 150 psi SWP, 600 psi non-shock CWP

**Butterfly Valves:**

- 2½ in. and larger: Rated 200 psi non-shock CWP

### Medical Gas Service

**Ball Valves:**

- 2 in. and smaller: Rated 150 psi SWP, 600 psi non-shock CWP
- 2½ in. and larger: Rated 600 psi non-shock CWP

### Low-pressure Steam

*(including service up to 125-psi saturated steam to 353°F [178°C])*

**Gate Valves:**

- 2 in. and smaller: Class 125, rated 125 psi SWP, 200 psi non-shock CWP
- 2½ in. and larger: Class 125, rated 100 psi SWP, 150 psi non-shock CWP

**Ball Valves:**

- 2 in. and smaller: Rated 150 psi SWP, 600 psi non-shock CWP

**Globe Valves:**

- 2 in. and smaller: Class 125, rated 125 psi SWP, 200 psi non-shock CWP
- 2½ in. and larger: Class 125, rated 125 psi SWP, 200 psi non-shock CWP

**Check Valves:**

- 2 in. and smaller: Class 125, rated 125 psi SWP, 200 psi non-shock CWP
- 2½ in. and larger: Class 125, rated 125 psi SWP, 200 psi non-shock CWP

### Medium-pressure Steam

*(including up to 200-psi saturated steam to 391°F [201°C])*

**Butterfly Valves:**

- Not allowed in steam services unless stated as acceptable for the application by the manufacturer

**Gate Valves:**

- 2 in. and smaller: Class 200, rated 200 psi SWP, 400 psi non-shock CWP
- 2½ in. and larger: Class 250, rated 250 psi SWP, 500 psi non-shock CWP

**Globe Valves:**

- 2 in. and smaller: Class 200, rated 200 psi SWP, 400 psi non-shock CWP
- 2½ in. and larger: Class 250, rated 250 psi SWP, 500 psi non-shock CWP

**Check Valves:**

- 2 in. and smaller: Class 200, rated 200 psi SWP, 400 psi non-shock CWP
- 2½ in. and larger: Class 250, rated 250 psi SWP, 500 psi non-shock CWP

### High-pressure Steam Service

*(including up to 300-psi saturated steam to 421°F [216°C])*

**Gate Valves:**

- 2 in. and smaller: Class 300, rated 300 psi SWP
- 2½ in. and larger: Class 300, rated 300 psi SWP

**Globe Valves:**

- 2 in. and smaller: Class 300, rated 300 psi SWP
- 2½ in. and larger: Class 300, rated 300 psi SWP

**Check Valves:**

- 2 in. and smaller: Class 300, rated 300 psi SWP
- 2½ in. and larger: Class 300, rated 300 psi SWP

### Fire Protection Systems

**Gate Valves:**

- 2 in. and smaller: Class 175 psi WWP (water working pressure)
- 2½ in. and larger: Class 175 psi WWP

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