

FCD FCAIM0100 - 02

Mark 1000

Installation, Operation and Maintenance Instructions



1 General Information

The following instructions are designed to assist in unpacking, installing and performing maintenance as required on Flowserve Mark 100 control valves. Product users and maintenance personnel should thoroughly review this bulletin prior to installing, operating or performing any maintenance on the valve. Separate Installation, Operation, and Maintenance instructions cover additional features (such as special trim, actuators, handwheels, packing and positioners.)

To avoid possible injury to personnel or damage to valve parts, WARNING and CAUTION notes must be strictly followed. Modifying this product, substituting non-factory parts or using maintenance procedures other than outlined could drastically affect performance and be hazardous to personnel and equipment and may void existing warranties.

⚠ WARNING: Standard industry safety practices must be adhered to when working on this or any other process control product. Specifically, personal protective and lifting devices must be used as warranted.

NOTE ON FASTENERS: Selecting the proper fastener material is the responsibility of the customer. Typically, the supplier does not know what the valve service conditions or environment may be. Flowserve's standard body bolting material is B7/2H. B8 (stainless steel) is optional for applications more than 800°F / 425°C and with stainless steel or alloy-body valves. The customer therefore must consider the material's resistance to stress corrosion cracking in addition to general corrosion. As with any mechanical equipment, periodic inspection and maintenance is required. For more information about fastener materials, contact your Flowserve representative.

2 Terms Concerning Safety

The safety terms **DANGER**, **WARNING**, **CAUTION** and **NOTE** are used in these instructions to highlight particular dangers and/or to provide additional information on aspects that may not be readily apparent.

☠ DANGER: indicates that death, severe personal injury and/or substantial property damage will occur if proper precautions are not taken.

⚠ WARNING: indicates that death, severe personal injury and/or substantial property damage can occur if proper precautions are not taken.

⚠ CAUTION: indicates that minor personal injury and/or property damage can occur if proper precautions are not taken.

NOTE: indicates and provides additional technical information, which may not be very obvious even to qualified personnel.

Compliance with other, not particularly emphasized notes, with regard to transport, assembly, operation and maintenance and with regard to technical documentation (e.g., in the operating instructions, product documentation or on the product itself) is essential, in order to avoid faults, which in themselves might directly or indirectly cause severe personal injury or property damage.

3 Unpacking

1. While unpacking the valve, check the packing list against materials received. Lists describing valve and accessories are in each shipping container.
2. When lifting the valve from shipping container, use the lifting lugs attached to the bonnet bolting. Take care to position lifting straps to avoid damage to the tubing and mounted accessories.
 - ⚠ WARNING:** When lifting a valve using the lifting lugs, be aware that the center of gravity may be above the lifting point. Therefore, support must be given to prevent the actuator from rotating. Failure to do so can cause serious injury to personnel, damage to the valve or nearby equipment.
3. Contact your shipper immediately if there is shipping damage.
4. Should any problem arise, call your Flowserve representative.

4 Installation

1. Before installing the valve, clean the line of dirt, welding chips, scale or other foreign material.
2. Whenever possible, the valve should be installed in an upright position. Vertical installation permits easier valve maintenance.

▲ CAUTION: Do not insulate extension bonnets that are provided for hot or cold services.

3. Be sure to provide proper overhead clearance for the actuator to allow for disassembly of the plug from the valve body. Refer to Table 1 for the necessary clearance needed for valve disassembly.

Table 1: Valve Disassembly Clearance

Valve Size (inches)	Clearance	
	inches	mm
6	10	254
8	13	330
10	14	356
12	16	406
14	18	457
16	20	508
18	23	584
20	25	635
24	31	787
30	37	940

4. Double-check flow direction to be sure the valve is installed correctly. Flow direction is indicated by the arrow attached to the body.
5. If welding the valve into the line, use extreme care to avoid excess heat buildup in the valve.
6. Connect the air supply and instrument signal lines. Throttling control valves are equipped with a valve positioner. Refer to the appropriate positioner bulletin for connections, maximum air supplies, and maintenance instructions.

▲ CAUTION: On valves equipped with air filters, the air filter must point down to perform properly.

NOTE: In some rare cases, the air supply must be limited to less than 150 psi (10.3 bar). This is indicated on a sticker found near the upper air port on the actuator cylinder. An air regulator should be installed to ensure the supply pressure does not exceed the line pressure indicated on the sticker.

4.1 Quick-check

Prior to start-up, check the control valve by following these steps:

1. Stroke the valve and observe the plug position indicator on the stem clamp compared to the stroke indicator plate. The plug should change position in a smooth, linear fashion.

NOTE: Due to excessive friction, graphite packing can cause the plug stem to move in a jerky fashion.

2. Check for full stroke by making appropriate instrument signal change.
3. Check all air connections for leaks.
4. Check packing box bolting for the correct adjustment. Refer to the packing installation manual for specific details on maintaining the style of packing supplied.

▲ CAUTION: Do not overtighten packing. This can cause excessive packing wear and high stem friction that may impede plug movement.

5. Make sure the valve fails in the correct direction in case of air failure. This is done by turning off the air supply and observing the failure direction.
6. After a temperature excursion has occurred, bonnet flange bolting should be retorqued to ensure bonnet gaskets do not leak. See Table 2.

Table 2: Recommended Body Bolt Torque Values

Bolt Size (inches)	Bolt/Stud Material			
	Carbon Steel		Stainless Steel	
	ft-lb	N m	ft-lb	N m
7/8	230	312	150	203
1	350	474	220	298
1 1/8	510	691	330	447
1 1/4	730	990	460	624
1 3/8	1000	1356	630	854
1 1/2	1320	1790	840	1139
1 5/8	1710	2318	1080	1464
1 3/4	2170	2942	1400	1898
1 7/8	2700	3660	1700	2305
2	3350	4542	2100	2847
2 1/4	4050	5491	2530	3430
2 1/2	4850	6575	3010	4081

Table 3: Common Packing Lubricants

Lubricant	Manufacturer	Temperature Range	Applications, Description
Krytox 206	E.I. DuPont	-5° to 550°F -20° to 285°C	Fluorinated general purpose grease; handles common liquids and gases; good lubricity in harsh mediums; nonflammable, chemically inert; will not harm plastic or metal parts
GP 460	Graphite Products Co.	32° to 1000°F 0° to 540°C	Graphite in petrolatum; high pressures; anti-galling, graphite remains above 600°F / 316°C
Aeroshell Grease 7	Shell Oil Co.	-100° to 300°F -75° to 150°C	Synthetic oil-based; low-temperature applications
Garlock Luball	Garlock Inc.	32° to 500°F 0° to 260°C	General purpose molybdenum disulfide lubricant economical; good in water, steam and common chemicals; not good in harsh mediums where Krytox 206 is recommended

5 Valve Maintenance

At least once every six months, check for proper operation by following the preventative maintenance steps outlined below. These steps can be performed while the valve is in-line and, in some cases, without interrupting service. If an internal problem is suspected, refer to the “Valve Disassembly and Reassembly” section.

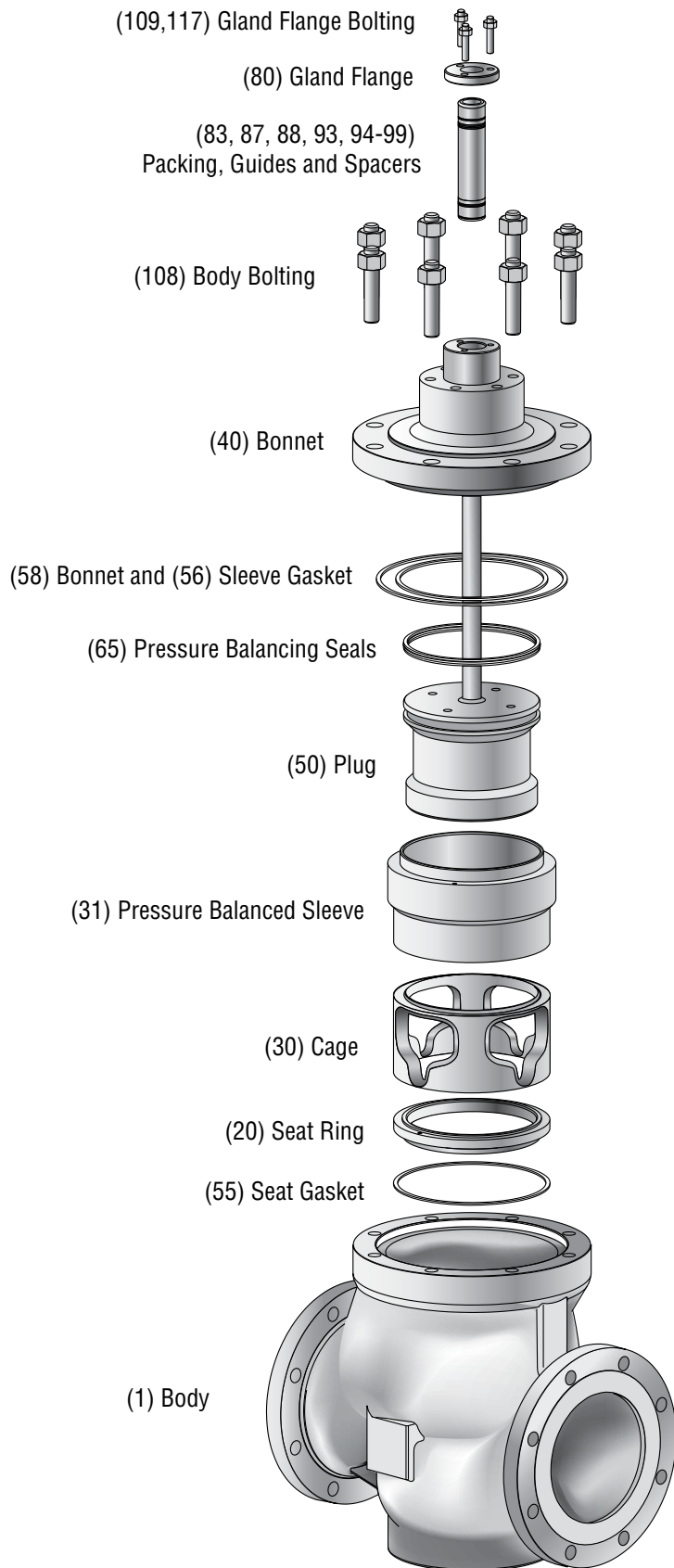
1. Look for signs of gasket leakage through the end flanges and bonnet. Retorque flange and bonnet bolting (if required). See Table 2.
2. Check for fluid leakage to the atmosphere through the body drain plug, if applicable.
3. Examine the valve for damage caused by corrosive fumes or process drippings.
4. Clean valve and repaint areas of severe oxidation.
5. Check packing box bolting for proper tightness. Refer to the packing installation manual for specific details on maintaining the style of packing supplied.
 - ▲ **CAUTION:** Do not overtighten packing. This can cause excessive packing wear and high stem friction that may impede stem movement.
6. If the valve is supplied with a lubricator fitting, check lubricant supply and add lubricant if necessary. See Table 3 for common lubricants.
7. If possible, stroke the valve and check for smooth, full-stroke operation. Unsteady stem movement could indicate an internal valve problem.

NOTE: Due to excessive friction, graphite packing can cause the plug stem to move in a jerky fashion.

⚠ **WARNING:** Keep hands, hair and clothing away from all moving parts when operating the valve. Failure to do so can cause serious injury.

8. Make sure positioner linkage and stem clamp are securely fastened. If the stem clamp is loose, check plug thread engagement (refer to the “Reassembling the Actuator” section for the correct procedure on aligning the plug with the seat.) Tighten stem clamp nut.
9. Ensure all accessories, brackets and bolting are securely fastened.
10. If possible, remove air supply and observe actuator for correct fail-safe action.
11. Check rubber actuator bellows for splits, cuts or wear.
12. Spray a soap solution around the cylinder actuator retaining ring, adjusting screw and actuator stem guide to check for air leaks through the O-rings.
13. Clean any dirt and other foreign material from the plug stem.
14. If an air filter is supplied, check and replace cartridge if necessary.

Figure 1: Exploded Drawing



Parts List

Part	Item
Body	1
Seat Ring*	20
Plug*	50
Plug Stem	51
Cage	30
Pressure Balanced Sleeve	31
Bonnet	40
Seat Gasket	55
Sleeve Gasket	56
Bonnet Gasket	58
Seal Types	
O-ring Seal	65
	66
PTFE Seal	65
Metal Multi-Seal	65
Carbon Single Seal	65
Carbon Triple Seal	65
Gland Flange	80
Gland Flange Bolting	109, 117
Lower Guide	83
Upper Guide	87
Packing	88
Anti-Extrusion Spacer	93
Body Bolting	108
Packing Spacers	94-99

6 Valve Disassembly and Reassembly

6.1 Disassembling the Body

To disassemble the valve body, refer to Figure 1 and 2 then proceed as follows:

⚠ WARNING: Depressurize line to atmospheric pressure and drain all fluids before working on the valve. Failure to do so can cause serious injury.

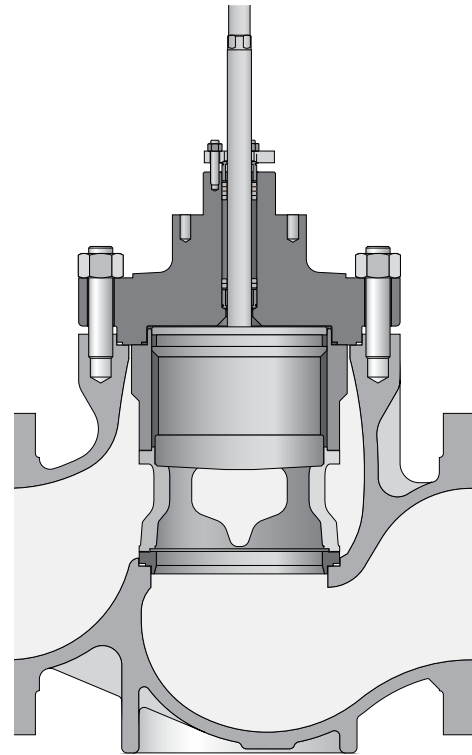
1. Fully retract the plug until the stem clamp indicator points to the open position.
2. Remove the bonnet flange bolting and lift the actuator, bonnet and plug out of the valve body.

⚠ WARNING: Danger exists in removing the actuator, bonnet and plug, especially if PTFE plug seals are used. The sleeve may stick to the plug and fall during disassembly, causing possible serious injury and damage to the valve or nearby equipment. If sleeve is observed sticking to the plug, steps 3–5 should be consulted.

⚠ CAUTION: Heavy actuators may require a hoist. Lift the actuator with the yoke legs using a lifting strap and a hoist. Great care should be taken to lift the actuator and plug straight out of the body to avoid damage to the plug and seat.

3. If the sleeve is observed sticking to the plug during removal, fully extend the plug by applying air above the piston, allowing the sleeve to remain in the body and the bonnet to rise above the body.
4. In the gap between the top of the sleeve and the bottom of the bonnet, place wooden blocking of equal thickness in at least three places. The wooden blocks must not extend in far enough that they interfere with plug movement. The plug must be allowed to stroke up to the bonnet.
5. By applying air below the piston, retract the plug until the plug head is freed from the sleeve. Once the plug is free from the sleeve, remove the plug and bonnet assembly from the body.
6. Lift the sleeve out of the valve body using lifting points on the top of the sleeve.
7. Remove cage, seat ring and gaskets from the valve body.

Figure 2: Cutaway Drawing



8. Remove the plug seals from the plug head.
9. Check to see the seating surfaces on both the seat ring and plug are free of damage to ensure tight shutoff. Make sure the gasket surfaces on the seat ring, bonnet and body are clean and undamaged. Inspect the pressure balanced sleeve for scratches or other damage.
10. Loosen the stem clamp and gland flange. Remove the yoke bolts.

⚠ CAUTION: If a rubber bellows is attached to the gland flange, the gland flange must be removed prior to removing the actuator.

11. Turn the actuator off the plug and bonnet without allowing the plug to rotate within the bonnet. Pull the plug carefully through the packing box. Inspect the plug stem for damage or scoring.

NOTE: With air-to-close, fail-open valves, it may be necessary to apply a small amount of air to the top of the actuator to move the plug away from the bonnet. Otherwise, plug galling may occur.

⚠ CAUTION: To avoid scoring guides and plug stem, follow the above procedure exactly.

- If the seat surfaces need remachining, both surfaces on plug and seat ring must be reworked. The seat angle on the plug is 36 degrees and the seat ring is 33 degrees. Lapping is not necessary if proper assembly procedures are followed.

▲ CAUTION: If remachining, protect the stem while turning. Ensure concentricity of the seat surface with the plug stem (or outside diameter of the seat ring, if machining the seat).

- To replace packing or change the packing box configuration, push out packing, spacer and guides with a dowel slightly larger than the plug stem from underneath the bonnet.

6.2 Reassembling the Body

To reassemble the valve body, refer to Figure 1 and 2 then proceed as follows:

- Install new bonnet and seat gaskets with the beveled edge up on fluoropolymer gaskets.

NOTE: All gaskets should be replaced whenever the valve is disassembled.

- Relocate the seat ring. Carefully install the cage and then the sleeve, taking care to ensure they installed with the correct ends up.
- Replace the plug seals on the plug, referring to Figure 3 and observing the following directions:

☠ WARNING: Gloves should be worn to help prevent the hands from being burned.

PTFE Seals Heat one seal to 300°F (150°C) and slip it over the plug into the seal groove. Thermal expansion causes the ring to stretch, thereby making it relatively easy to slide over the plug head.

Care must be taken to prevent the seal from rolling, rather than sliding over the plug. The second seal can be installed following the same procedures as the first. If for any reason the second seal cannot be slipped onto the plug, cut the seal at approximately a 30° angle (see Figure 4) and place over the plug. Make certain the cut seal is on the low-pressure side.

Carbon Seals

Single Seals Each seal must be scored with a sharp knife at two places, 180 degrees apart. Holding the ring gently in a padded vise, pull gently on the ring, breaking the ring on the score marks into two equal pieces. Install the two pieces into the plug seal grooves with the score marks on the pressure side.

Triple Seals Score and break each ring as described for the single seals. Install the inside ring first, followed by the two outside rings with joints offset 120 degrees on all three rings.

▲ CAUTION: Install rings starting with one end and working the ring carefully into place. Do not spread ring more than necessary. Spreading the ring can cause the ring to break.

Figure 3: Seal Designs

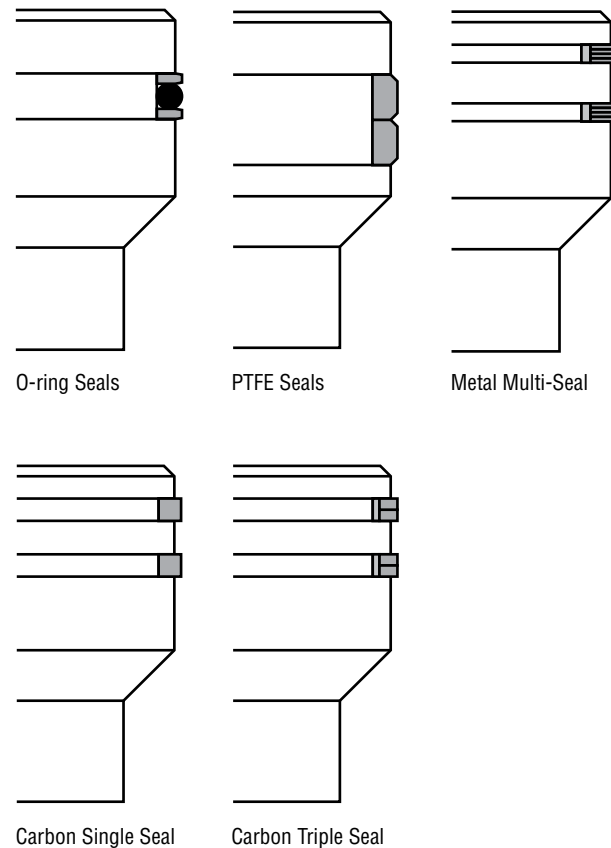
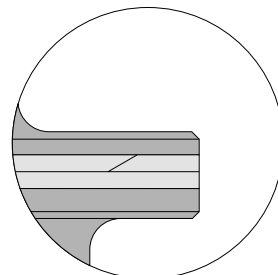


Figure 4: PTFE Seal Cutting Detail



Metal Multi-Seals Install wave spring followed by four seal rings. Stagger ring openings by at least 90 degrees. Take care not to bend the seal rings as they are installed.

O-ring with Back-up Rings Both the O-ring and back-up rings can stretch over plug and into place.

4. Lower the plug into the body and sleeve. Care should be taken with the plug seals to avoid scoring or galling the sealing surface while fitting them into the sleeve bore. With metal multi-seals and carbon triple seals, use a ring compressor on the rings. A suitably sized screw-type hose clamp will also serve to compress the rings for reassembly.
5. Lower the bonnet onto the plug and body, taking great care to avoid scoring the plug stem.
6. Once the bonnet is resting squarely in the valve body, finger-tighten the bonnet flange bolting.
7. Reinstall the packing and guides referring to the appropriate packing installation manual and reinstalling new packing exactly as shown. Make sure at least 1/8" is left at the top of packing box

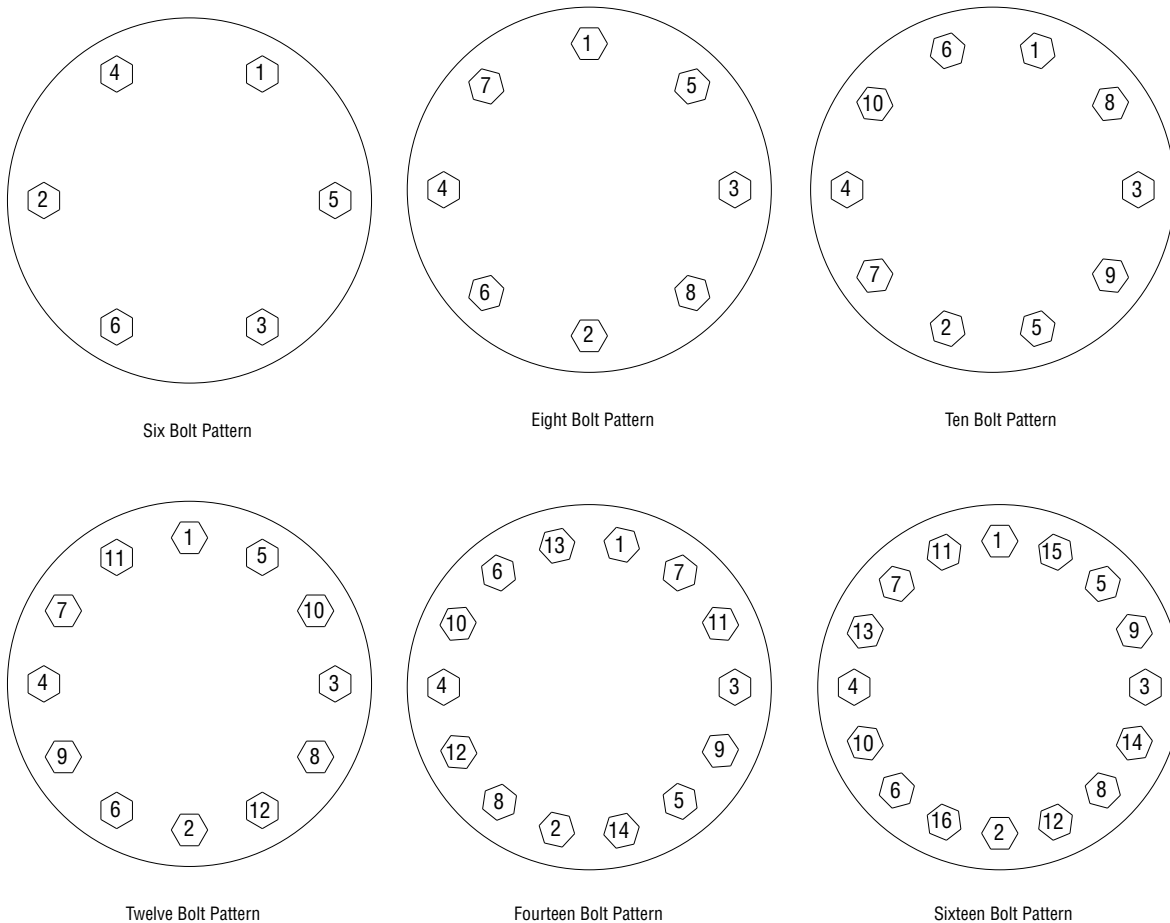
for the top guide to enter. Different spacer lengths permit a wide variety of packing configurations, such as twin seal and vacuum-pressure packing.

WARNING: Valves with extended bonnets must not have lower packing installed. Instead, lower packing rings should be installed with the upper set. Lower packing installed in extended bonnets will diminish the integrity of the packing assembly.

NOTE: Graphite guide liners should be replaced each time the valve packing is replaced. Do not rebuild the valve without new graphite liners in the guides.

8. Replace and tighten the packing gland and bolting. Refer to the packing installation manual for specific details on maintaining the style of packing supplied.
9. Turn actuator back onto the body assembly, without turning the plug inside the bonnet. Leave a 3/32" to 1/8" (2 mm to 3 mm) gap between the mating surfaces of the bonnet and yoke. Tighten yoke bolting to close this gap. Firmly tighten the yoke bolting.

Figure 5: Bolt Patterns



10. Using the actuator, seat the plug two or three times to center the seat ring using pressure on the top of the actuator.
11. Tighten the body bolting, following the bolting sequence outlined in Figure 5. Use a minimum of four steps to reach the suggested bolt torque values shown in Table 2. Never exceed more than 30% of the suggested bolt torque value in a single step.
12. Slowly stroke the plug up and down to check the alignment of the plug with the sleeve.
 - ▲ **CAUTION:** If binding or sticking is observed, discontinue stroking the valve and reassemble using the above steps. Failure to do so could cause serious valve damage. Contact your Flowserve representative if binding cannot be resolved.
13. Perform a Quick Check as described in section 4.1.

Troubleshooting Chart

Problem	Possible Cause	Corrective Action
Stem motion impeded	1. Overtightened packing.	1. Refer to proper maintenance instructions and readjust.
	2. Service temperature is beyond operating limits of trim design.	2. Reconfirm service conditions and contact factory.
	3. Inadequate air supply.	3. Check for leaks in air supply or instrument signal system; tighten loose connections and replace leaky lines.
	4. Malfunctioning positioner.	4. Refer to positioner maintenance instructions.
Excessive leakage	1. Improperly tightened bonnet flange bolting.	1. Refer to step 11 of “Reassembling the Body” section for correct tightening procedure.
	2. Worn or damaged seat ring.	2. Disassemble valve and replace or repair seat ring.
	3. Worn or damaged seat or bonnet gasket.	3. Disassemble and replace gaskets.
	4. Inadequate actuator thrust.	4. Check for adequate air supply to actuator; if air supply is adequate, reconfirm service conditions and contact factory.
	5. Incorrectly adjusted plug.	5. Refer to step 9 of “Reassembling the Body” section for correct plug adjustment.
	6. Improper flow direction.	6. Refer to original specifications or contact factory.
	7. Improper handwheel adjustment; handwheel acting as a limit-stop.	7. Adjust handwheel until plug seats properly.
Inadequate flow	1. Improper plug adjustment, limiting stroke.	1. Refer to step 9 of “Reassembling the Body” section for correct plug adjustment.
	2. Malfunctioning positioner.	2. Refer to positioner maintenance instructions.
	3. Service conditions exceed trim design capacity.	3. Verify service conditions and consult factory.
Plug slams	1. Incorrect plug adjustment allowing improper cushion of air between actuator piston and yoke.	1. Refer to step 9 of “Reassembling the Body” section for correct plug adjustment.
	2. Inadequate air supply.	2. Check air supply to actuator; repair leaks and remove any restrictions in supply line.
	3. Trim sized too large for flow rate.	3. Install reduced trim.
Valve does not fail in correct position	1. Incorrect flow direction.	1. Reconfirm direction and, if necessary, correct flow direction through valve.

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Flowserve Corporation has established industry leadership in the design and manufacture of its products. When properly selected, this Flowserve product is designed to perform its intended function safely during its useful life. However, the purchaser or user of Flowserve products should be aware that Flowserve products might be used in numerous applications under a wide variety of industrial service conditions. Although Flowserve can (and often does) provide general guidelines, it cannot provide specific data and warnings for all possible applications. The purchaser/user must therefore assume the ultimate responsibility for the proper sizing and selection, installation, operation, and maintenance of Flowserve products. The purchaser/user should read and understand the Installation Operation Maintenance (IOM) instructions included with the product, and train its employees and contractors in the safe use of Flowserve products in connection with the specific application.

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For more information about Flowserve Corporation, visit www.flowserve.com or call USA 1-800-225-6989.

FLOWSERVE CORPORATION
FLOW CONTROL DIVISION
1350 N. Mt. Springs Parkway
Springville, UT 84663
Phone: 801-489-8611
Fax: 801-489-3719