



Worcester Controls

08164-S

# Cryogenic Ball Valves

## Installation, Operation and Maintenance Instructions

¼" – 2" R5 AND EARLIER THREE-PIECE, BODIED EXTENDED BONNET  
¼" – 2" R6 AND EARLIER C4 THREE-PIECE BODIED NON EXTENDED BONNET  
3" – 6" R12 AND EARLIER ONE-PIECE BODIED EXTENDED AND NON EXTENDED BONNET  
¼" – 2" R6 AND R7 C44 THREE-PIECE BODIED NON EXTENDED BONNET

**IMPORTANT:** Valves intended for ammonia service must be of stainless (not brass) material, with welded bonnet joint. The standard bonnet joint is brazed, not welded.

**CAUTION:** Flowserve recommends that all products which must be stored prior to installation be stored indoors, in an environment suitable for human occupancy. Do not store product in areas where exposure to relative humidity above 85%, acid or alkali fumes, radiation above normal background, ultraviolet light, or temperatures above 120°F or below 40°F may occur. Do not store within 50 feet of any source of ozone.

### I. INSTALLATION

- A. The Worcester Cryogenic Valve is unidirectional for flow in one direction only and therefore can only be installed in one direction. With the valve in the closed position, install it with the relief hole in the ball on the upstream side to ensure that cavity relief is upstream. Note arrow stamped on the body, on a metal tag welded to the body, or on the bonnet plate indicating flow path.
- B. The Worcester Cryogenic Diverter Valve must be installed with the bottom port on the upstream line.

**IMPORTANT:** DO NOT install valves with extended bonnets with the extension tilted more than 30° from the upright vertical position.

The extended bonnet valve is designed to maintain stem seals at normal ambient temperature. Do not insulate the extension fully—allow 3"–4" of tube to protrude above the insulation.

- C. To install valves with welded, brazed or soldered pipe ends (BW, SW, SWO or TE):

**NOTES:** Prior to welding or brazing, THOROUGHLY CLEAN ALL JOINT SURFACES to prevent contamination.

Worcester brass valves are of leaded forging brass. Brazing cannot be successfully accomplished unless a white flux is used.

1. Tack weld the valve in place.
2. Remove three body bolts, loosen the fourth, swing out body with ball open. Close the ball and remove the seats, ball and body seals. (Discard the body seals when removed from the valve.) Note the position of the seats so that they can be replaced in the same position as they were removed.
3. Swing body in and secure it with one additional bolt diagonally from first.
4. Weld pipe ends. When gas welding, DO NOT play the flame upon the valve body.
5. Allow the valve to cool and then reassemble with ball, seats and the new body seals that are included with the valve.
6. **IMPORTANT:**  
The fluoropolymer-coated stainless steel gaskets that are included with the Worcester ¼"–2" Cryogenic Valves make excellent seals, however, some points of caution in their use require emphasis:
  - a. The gaskets are NOT reusable. Upon removal from valve, they should be discarded and replaced with new parts.
  - b. Avoid scratching the fluoropolymer coating of the gaskets during installation. Light lubrication of these seals can help to prevent damage.

- c. "S" type gaskets are installed with their widest flange to the valve body (See view A on page 6).
- d. Swing center section back in line.
- e. Tighten and torque body bolts evenly, alternating in a criss-cross diagonal pattern. Use torque figures below:

Bolt Diameter	in-lb	ft-lb
1/4"	72-94	6-8
5/16"	120-144	10-12
3/8"	192-216	16-18
7/16"	336-384	28-32
1/2"	504-552	42-46

- D. When installing the 3"-6" Worcester Cryogenic Valves, use standard gaskets which are suitable for the specific service. Tighten the flange bolts or studs evenly and in proper tightening sequence.
- E. Please note: on the 3"-6" flangeless short pattern valves (151 or 301), the ball protrudes slightly from each port. After determining the proper valve position (i.e., relief hole in ball from section I.A), open the ball before installation to avoid damaging it.

## II. OPERATION

- A. To operate the Worcester Cryogenic Ball Valve, turn the stem 1/4-turn clockwise to close and 1/4-turn counter-clockwise to open.  
On manually operated 1/4"-2" valves, the handle acts as a pointer. When it points across the pipeline, the valve is closed.  
On manually operated 3"-6" valves, the stop plate acts as a pointer. When it points across the pipeline, the valve is closed.
- B. To operate the Worcester Cryogenic Diverter Valve, rotate handle 1/4-turn to divert the flow from the bottom port to either of the side ports. (The diverter valve also comes with a special 180° ball and stop plate. In this case the handle would be rotated 1/2-turn and the handle would point to the port to which flow was diverted.)
- C. These valves will provide positive shut-off when used in accordance with Worcester's Cryogenic Valve pressure/temperature chart.
- D. DO NOT leave the ball partly open. DO NOT throttle with Worcester's Cryogenic Valves. It will result in seat breakage.
- E. DO NOT allow media which can solidify, crystallize or polymerize to stand in the valve cavity.

### F. Torque Requirements:

The valve torque will vary depending on the length of the time between cycles, line pressure, type of valve seats, and the media in the system.

All figures in the following table are based on laboratory tests with LN2 as the media. These figures should approximate the actual valve torques. For a more detailed analysis of valve torque requirements, see Worcester's Actuator Sizing Manual.

Valve Size	Maximum Expected Breakaway Torque	Valve Size	Maximum Expected Breakaway Torque
1/4"-1/2"	80 in-lb	2"	625 in-lb
3/4"	150 in-lb	3"	1100 in-lb
1"	200 in-lb	4"	1500 in-lb
1 1/2"	475 in-lb	6"	2200 in-lb

## III. MAINTENANCE

The Worcester Cryogenic Valve with the extended bonnet normally operates with the bonnet at a higher temperature than the valve. Because of this, there will be a frost line about two-thirds of the way up the extension. If the bonnet becomes covered with frost, it's an indication that the stem seals are leaking.

Whether the valve has an extended bonnet or not, if stem leakage is noted, then adjust the stem nut per the following procedure:

### A. Stem Seal Readjustment Procedure:

**CAUTION: Excessive tightening causes higher torque and shorter stem seal life.**

1. Allow the valve to warm to ambient temperature.
2. 1/4"-2" Valves with Two Stem Nuts and Lockwasher:
  - a. On manual valves, loosen the handle nut or handle assembly bolt (as applicable) to allow easy access to the stem seal retaining nut. On actuated valves, loosen top nut.
  - b. While holding the stem to prevent turning, tighten the stem seal retaining nut until Belleville washers are flat (the nut will bottom); then back off 1/8 turn.
  - c. Retighten the handle nut or handle cap screw (as applicable) while making certain that the stem seal retaining nut and stem are immobile.
3. 1/4"-2" Valves with Self-Locking Stem Nut and Four Belleville Washers:
  - a. Tighten self-locking stem nut until Belleville washers are flat (the nut will bottom); then back off 1/8 turn.

**CAUTION: The self-locking stem nut is difficult to tighten and must fully flatten the Belleville washers before backing off.**

4. If seepage is noted at stem on 3"-6" valves, tighten retaining nut 1/8-turn at a time until seepage stops.

## IV. REBUILDING

THIS MANUAL CONTAINS EXPLODED VIEWS OF ALL VALVES COVERED BY THE TEXT. THEY HAVE BEEN INCLUDED TO AID IN THE REBUILDING OF THE VALVE. PLEASE REFER TO THEM WHEN FOLLOWING THE WRITTEN INSTRUCTIONS.

**▲ WARNING: BALL VALVES CAN TRAP PRESSURIZED FLUIDS IN BALL CAVITY WHEN CLOSED. If the valve has been used to control hazardous media, it must be decontaminated before disassembly. It is recommended that the following steps are taken for safe removal and disassembly:**

- **Relieve the line pressure. Operate the valve prior to attempting removal from line.**
- **Place valve in half-open position and flush the line to remove any hazardous material from valve.**
- **All persons involved in the removal and disassembly of the valve should wear proper protective clothing such as face shield, gloves, apron, etc.**

- A. A standard repair kit can be ordered for the Worcester Cryogenic Valve containing all necessary parts for normal valve rebuilding. To order a repair kit you must specify the size, type of valve (extension or no extension), "RK44" and revision ("C" or "R" and number). This information is found on the valve body, stop plate, handle, valve nameplate, or mounting bracket nameplate.

**Example:** 1/2" CN RK44 R6 (The "N" indicates there is no extension) or 3" C RK44 R12.

If the valve is a non-standard product, then there is a five-character code called a "P", "T", "C", or similar number, found on the valve body, stop plate, handle, valve nameplate, or mounting bracket nameplate. To order repair kit, include size, type of valve, "RK44", and "P", "T", "C", or similar number.

**Example:** 1/2" CRK44 P2577 or 1/2" CNRK44 T0726

**CAUTION: If the seats and seals installed differ from those removed, the valve nameplate or stop must be replaced or remarked to indicate the altered materials and ratings, or the valve must be tagged to so indicate.**

- B. If replacement parts other than those included in the repair kit are needed, order the part by name and size, including the complete valve code. For non-standard product add "P", "T", "C", or similar number, see valve body, stop plate, handle, valve nameplate, or mounting bracket nameplate for this information.

**Example:** Ball, 1/2" C416 PM SE R3 or Ball, 1/2" CN466 PM SE T0914

Porting (if diverter cryogenic valve) must also be specified when ordering these parts – **Example:** Ball; 1" C416 PM SE V1 R6.

### To Replace the Seats and Seals in 1/4"-2" Cryogenic Valves:

**NOTE:** If stem seal replacement is not required, omit Steps 5, 6, 7, 10, 11, and 12.

- C.
  1. Open valve.
  2. Remove three body bolts and loosen the fourth and swing the center section out from between pipe ends or remove all four bolts and remove valve from line, whichever is more convenient.
  3. Close valve.
  4. Remove the ball, seats and body seals. Discard seats and body seals.
  5. If present, remove handle nut, lockwasher, handle and stop plate. Remove retaining nut or self-locking stem nut, Belleville washers and stem seal follower(s). On valves with a handle and stop plate assembly, first loosen handle socket head cap screw, then remove handle nut and proceed with disassembly.

### Valves Without Extension

6. Push stem into the body cavity and remove thrust bearing(s) from stem, then remove the stem seals and stem seal protector (if any) from body.

### Valves with Extended Bonnet:

7.
  - a. Push stem into body cavity.
  - b. Remove pin from stem.
  - c. Unscrew bottom tang of stem from stem extension (right-hand thread).
  - d. Remove thrust bearing from stem bottom tang.
  - e. Push stem extension out of body.
  - f. Remove fluoropolymer stem seal and metal seal washer (follower).

### Follow Steps 8, 9 & 10 for Both Extended and Non-Extended Valves:

8. Clean all sealing surfaces of valve including the ball.
9. Inspect the ball and the surfaces against which the seats and seals are installed, they should be undamaged, clean and free of pit marks and scratches. Light marring from the action of the ball against the seats is normal and will not affect the operation of the valve. Flaws which can be seen but barely detected with finger tips are acceptable. The stem and body

surfaces that the thrust bearing(s) and stem seal(s) contact must be undamaged, clean and free from pit marks and scratches.

10. The stem seal is generally thicker than the thrust bearing. If they are the same size and color, they are interchangeable. (IMPORTANT: Lightly lubricate stem seal(s) and thrust bearing(s) with a PTFE-based lubricant such as Fluorolube S-30 or equivalent, except for valves with V20 or V33 options, which are assembled dry.)

**Valves Without Extension:**

11. a. Place a new Polyfill thrust bearing as a protector (Rev. R7 and later valves) and/or a new Polyfill thrust bearing on stem shoulder and then insert stem through body cavity.
- b. Install new stem seal(s), a new Polyfill stem seal protector (Rev. R7 and later valves), old follower and two new Belleville washers with larger diameter sides touching. For those valves with single self-locking stem nut, install four new Belleville washers (two pairs of washers with larger diameter sides touching).

*Note: Polyfill thrust bearing and stem seal protectors (if used) are black in color, interchangeable, and are placed outside of seals and bearings. The seals are bearings must contact the body. For valves using two stem seals (Rev. R7 and later valves), the thicker Polyfill stem seal goes over the thinner Polyfill stem seal. If PEEK thrust bearing and stem seal protectors (tan in color) were removed, they must be replaced with the Polyfill parts (black in color) included in the repair kit.*

- c. Add the stem retaining nut or self-locking nut and while holding the stem with the handle or a wrench, tighten the nut to make snug and firm. Follow Section III, Maintenance, for proper stem adjustment. DO NOT overtighten. Excessive tightening causes higher torque and shorter stem seal life.
- d. Replace stop plate and/or handle (if used), lockwasher and handle nut. (This step is not applicable to valves with self-locking stem nut).

**Valves with Extended Bonnet:**

12. a. To reassemble, insert stem extension into valve body. Place a new thrust bearing onto the bottom tang and insert it through the ball cavity into the stem hole recess. Screw both stem pieces together all the way, then unscrew to align pin holes. Insert new grooved pin until flush with stem extension.
- b. Install the following over the stem extension: the seal washer (follower), new stem seal, two followers and two new Belleville washers, making sure that concave surface of washers face each other. Reassemble stem seal retaining nut. Holding the stem with the handle or a wrench to prevent turning, tighten the stem seal retaining nut to make the stem snug and firm. Make sure that the stem is in full upward position so that the thrust bearing is bearing on the valve body. Note that excessive

tightening of the stem seal will only produce higher torque and shorter seal life. Tighten nut to fully compress Belleville washers. DO NOT overtighten. Reassemble stop plate and handle (if used), lockwasher and handle nut and tighten firmly.

- c. Cryogenic Valves C4, size ¼" to 2" with extended bonnet manufactured after the month of May, 1984, are equipped with a new type of handle and stop assembly.

The handle and stop are pinned by the two “drive-lok” pins as a unit, increasing the bearing area with the stem. To eliminate the tolerance between the handle and stem, a socket head cap screw is used to tighten the handle on the stem. An additional step should be taken during assembly:

1. With socket head cap screw loose, slide handle and stop assembly over the stem, add lockwasher and handle nut, tighten handle nut firmly and then tighten handle socket head cap screw on stem tang.

**Follow Steps 13 through 17 for Both Extended and Non-Extended Valves:**

13. Place the ball (see note below) in valve. Make sure the relief hole in ball is on the upstream side of valve when in closed position, to ensure that cavity relief is upstream. Note arrow stamped on body, on a metal tag welded to the body, or on the bonnet plate, indicating flow path.

**NOTE:** For diverter valves, install ball as follows:

**V1 (900 Valves)** – With handle and/or stem flats in-line with body main axis and viewed from bolt head side (normally upstream), one ball port is to the right, one is down, and the other is on opposite end of valve.

**V2 (1800 Valves)** – Using the same convention as V1, one ball port is down, and the other is on the opposite end of the valve.

14. Open valve.
15. Install new seats, which have been specially prepared by Flowserve for cryogenic service.
16. Install new gaskets per section I.
17. Cycle valve several times to ensure even displacement of cryogenic lubrication on seats.

**To Replace Seats and Seals in 3”–6” Cryogenic Valves:**

**NOTE:** If stem seal replacement is not required, omit Steps 5, 6, 7, 10, 11, and 12.

- D. 1. Open valve.
2. Remove valve from between flanges.
3. Remove end plug retaining screws. Close the valve. Remove the end plug by tapping the ball on the other side with nylon or wooden drift.
4. Remove ball, seats and body seal. Discard seats and body seal.

5. Remove the wrench assembly bolt and wrench assembly handle (if any). Hold the stem with the handle or a wrench to prevent it from rotating and remove the retaining nut. Remove the stop plate, or stem spacer (actuated valves). Remove and retain the follower.

**Valves without Extension:**

6. a. Push stem into body cavity.
- b. Remove stem seals and thrust bearing, remove and retain metal washer(s).

**Valves with Extended Bonnet:**

7. a. Push stem into body cavity.
- b. Remove pin from stem.
- c. Unscrew bottom tang from stem extension (right-hand thread).
- d. Remove thrust bearing, remove and retain metal washer (if present).
- e. Push stem extension out of body.
- f. Remove fluoropolymer stem seals, remove and retain metal washer.

**Follow Steps 8, 9, and 10 for Both Extended and Non-Extended Valves:**

8. Clean all sealing surfaces on valve, stem, end plug and ball.
9. Inspect the ball and the surfaces against which the seats and seals are installed. They should be undamaged, clean and free of pit marks and scratches. Light marring from the action of the ball against the seats is normal and will not affect the operation of the valve. Flaws which can be seen but barely detected with finger tips are acceptable. The stem and body surfaces that the thrust bearing and stem seal(s) contact must be undamaged, clean and free from pit marks and scratches.
10. The thrust bearing can be distinguished from the stem seals by the darker color of the 25% filled fluoropolymer used in the thrust bearing.

**IMPORTANT:** Lightly lubricate stem seals and thrust bearing with a PTFE-based lubricant (such as Fluorolube S-30 or equivalent), except for valves with V20 or V33 options, which are assembled dry.

**Valves without Extension:**

11. a. Place new thrust bearing and metal washer (if one was removed) on the stem shoulder.
- b. Replace stem through valve body.
- c. Place metal washer over stem into the body.
- d. Place three new stem seals over stem.
- e. Place follower, stop (for manual valves only) or stem spacer (for actuated valves only) and retaining nut over stem.

- f. Replace handle assembly (manual valves only).
- g. Tighten retaining nut to fully compress packing, then back off 1/8-turn. Try not to overtighten. Excessive tightening causes higher torque and shorter stem seal life.

**Valves with Extended Bonnet:**

12. a. Insert stem extension into body.
- b. Place new thrust bearing and metal washer (if one was removed) onto bottom tang shoulder and insert it through the ball cavity into the stem hole recess.
- c. Screw bottom tang into the stem extension until it bottoms out.
- d. Align pin holes.
- e. Insert new grooved pin until flush with the outside of the extension.
- f. Place metal washer over stem extension.
- g. Place three new stem seals over extension.
- h. Replace follower, stop (manual valves only) or stem spacer (actuated valves only) and retaining nut.
- i. Replace handle assembly (manual valves only).
- j. Tighten retaining nut to fully compress packing, then back off 1/8-turn. Try not to overtighten. Excessive tightening causes higher torque and shorter stem seal life.

**Follow Steps 13 through 17 for Both Extended and Non-Extended Valves:**

13. Insert a new seat into body. Make sure seat rests firmly against back surface of recess.
14. Place ball into body making sure that the relief hole in the ball is upstream (end plug side), when valve is closed. Note arrow stamped on the body or on the bonnet plate indicating flow path. Rotate stem to align with ball slot. Place new body seal into body. Make sure it rests squarely on sealing surface.

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**CAUTION: If the body seal is installed in the end plug, it will be damaged.**

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15. Insert new second seat in cavity of end plug.
16. Assemble end plug and body, securing with end plug retaining screws. It may be necessary to assist seating of the end plug into valve cavity before securing with retaining screws. Proper installation will allow no more than .010" protrusion of the end plug beyond the valve body.
17. Rotate ball to open position. Place the valve between flanges with gaskets and secure, making sure that relief hole in ball will be on upstream side when in closed position. Retighten end plug retaining screws.
18. Cycle valve several times before putting into service to assure even distribution of cryogenic lubrication on valve seats.

Figure 1

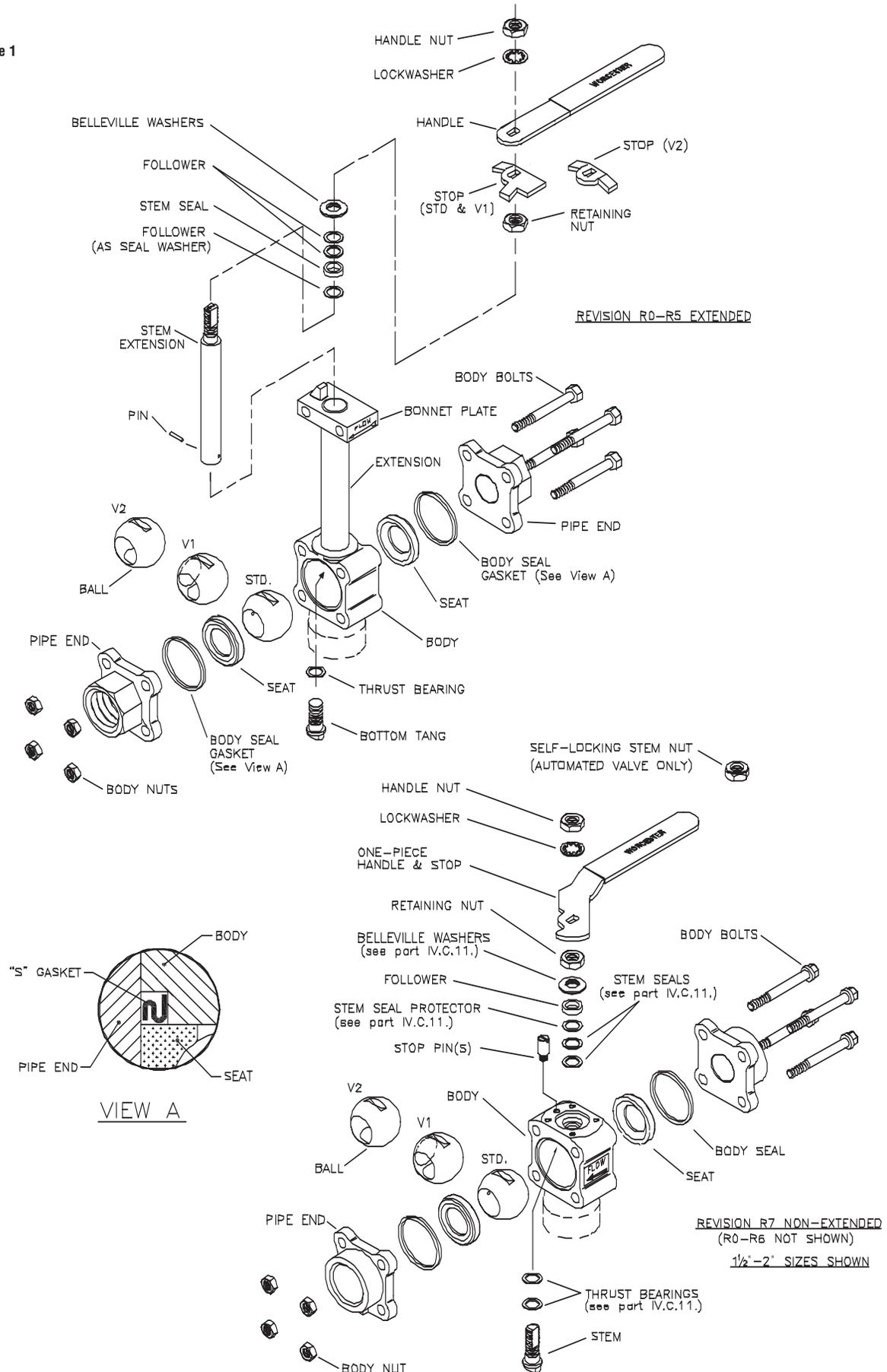
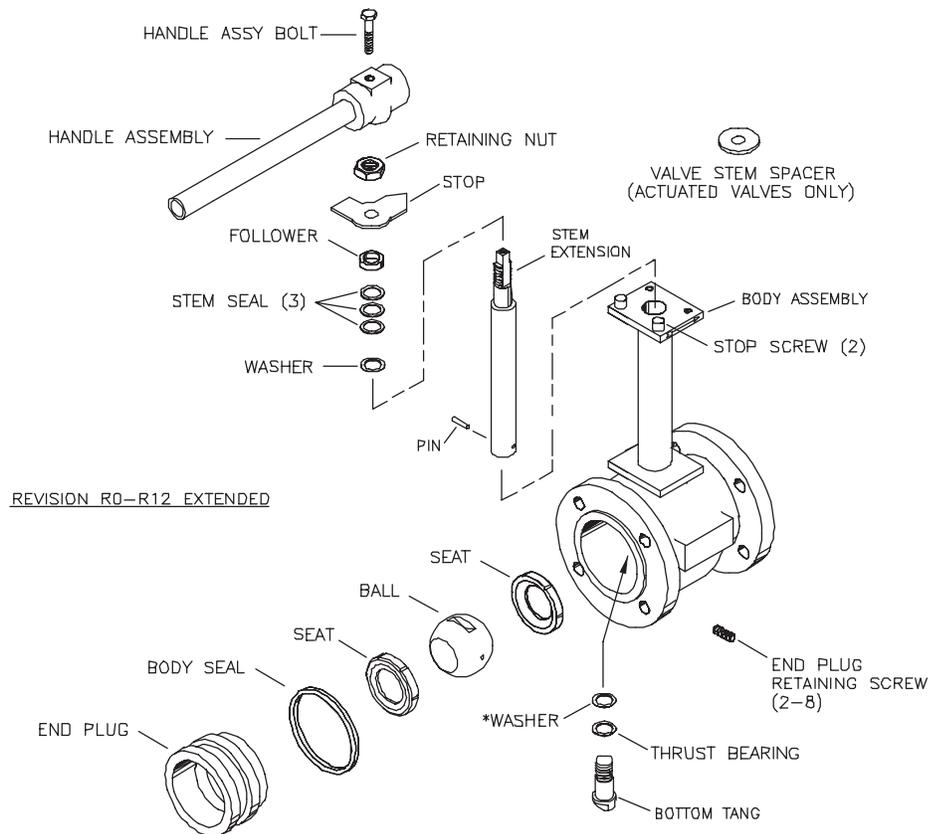
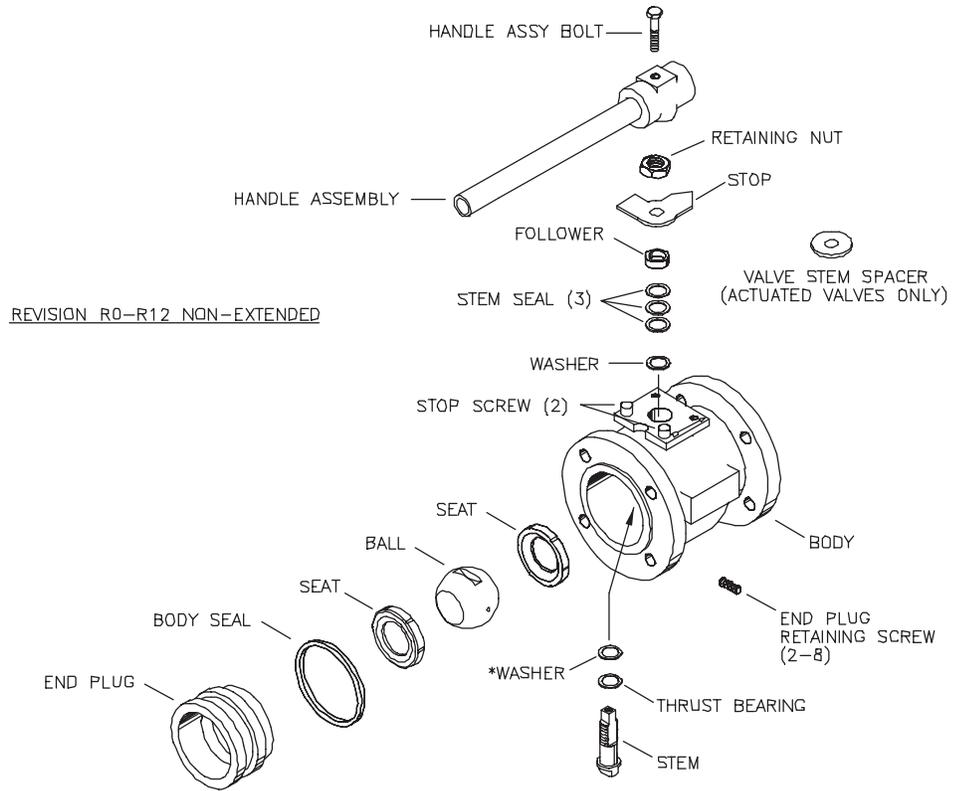


Figure 2



**NOTE:**

FLANGED VALVE IS SHOWN. FOR WAFER VALVE, DISASSEMBLY IS EXACTLY THE SAME.

\*THIS WASHER IS NOT USED ON ALL 3'-6" VALVES, USE EXISTING WASHER WHEN PRESENT.

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